



Inventory of Climate Smart Agriculture Technologies, Innovations and Management Practices for Banana Value Chain



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DISCLAIMER

The information presented in this inventory of Technologies, Innovations and Management Practices (TIMPs) book is for advisory use only. Users of this book should verify site-specific details that relate to their agro-climatic zones from their area agricultural extension officers.

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FOREWORD

The Kenya Agricultural and Livestock Research Organization (KALRO) through the support of development partners has laid a strong foundation for growth and commercialization of agriculture in Kenya. This has been done through the development of Climate Smart Technologies, Innovations and Management Practices (TIMPs) through the adaptive and applied research guided by some of the research gaps identified earlier. In addition, the organization has embraced an interconnected information communication technology to ease the handling of data and information from research. A notable inclusion is the use of the Big Data Platform to integrate digital information from value chains. The National Agricultural Value Chain Development Project (NAVCDP) seeks to build on and deepen investments into interventions on productivity enhancement, community-led farmer extension, water management investments and data-driven value chain services from KCSAP and NARIGP previous projects. In this NAVCDP project, KALRO seeks to strengthen, customize and update the existing inventories of TIMPs, with emphasis on climate resilience, safer food production practices, value addition, nutrition, market participation and commercialization.

With the continued support, KALRO also is poised to continue providing quality technical assistance for value chain development at all levels and build capacity of county level implementation units to anchor project activities. With the support of NAVCDP, KALRO has developed inventories of TIMPs for the two new value chains, pyrethrum and rice and is continuously expanding, updating and revising existing inventories of TIMPs. In doing so, KALRO further strengthens climate resilience, value addition and market participation aspects of the updated TIMPs to support farmers to transition from subsistence to commercial farming. The organization continues to support the strengthening of the current Big Data platform at KALRO as the foundational database for insight-driven, more productive, resource efficient and climate-resilient farming. To enhance the effective coordination of research linkages and agriculture digitization, KALRO and the Ministry of Agriculture and Livestock Development have put in relevant support mechanisms to oversee the implementation of these activities.

Extensive information from research and background data has been used to develop this revised Inventory of TIMPs for the Banana Value chain. To disseminate the TIMPs, a Training of Trainers (ToT) manual has been developed. The design of the manual takes into consideration the delivery system, partners and their roles, duration of training and logical flow of the modules. The training modules have a uniform outline that ensures every aspect of the TIMPs are fully covered in way that the trainees can absorb and relate to. Various delivery methods are deployed and where possible demonstrations and practical work are incorporated to enable the trainees learn by participating in the actual field activities. The use of this TIMPs inventory is expected to contribute to the achievement of the Project Development Objective (PDO), which is to increase market participation and value addition for targeted farmers in select value chains in project areas. This revised TIMPs inventory is to be used in conjunction with the respective ToT Manual.

Finally, I am greatly indebted to the value chain leaders and all those who participated in the preparation and revision of this Inventory of TIMPs for the Banana Value Chain. It is expected to herald new ways of delivering training content that will enable realization of the project objectives and aspirations.

Eliud K. Kireger, PhD, OGW
Director General, KALRO

PREFACE

The National Agricultural Value Chain Development Project (NAVCDP) is a Government of Kenya project with support from the World Bank. The five-year project is being implemented in 34 counties clustered in seven regions at an approximate cost of US\$ 275 million. The project development objective (PDO) is “increase market participation and value addition for targeted farmers in select value chains in project areas.” It is expected that this objective will be achieved through implementing the five project components, namely: Building Producer capacity for climate resilient stronger value chains; Climate Smart Value Chain Ecosystem Investments; Piloting Climate Smart Safer Urban Food Systems; Project Coordination and Management; and Contingent Emergency Response Component.

The National Agricultural Value Chain Development Project aims to support 3.8 million small-scale farmers transitioning from subsistence to commercial farming or are selling only a small percentage of their produce commercially. Additional beneficiaries of the Project include value chain actors at various levels, the extension workers, aggregators, logistics support providers and SMEs operating within the value chain. The Project places a strong focus on inclusion of women farmers within the supported Value Chains (VCs). Thirteen VC’s have been selected based on a thorough qualitative and quantitative assessment of their potential. The selected VCs based on their ranking are Dairy, Chicken, Coffee, Avocado, Banana, Mango, Irish potatoes, Tomato, Apiculture, Pyrethrum, Cashew nut, Cotton and Rice. Additional value chains prioritized by counties will be supported by their respective County Project Coordination Units.

The National Agricultural Value Chain Development Project has partnered with KALRO to continue strengthening and expanding the existing inventory of TIMPs with an emphasis on climate resilience, value addition, nutrition, and safer food production practices. Through this partnership, KALRO has developed Technologies, Innovations and Management Practices (TIMPs) inventories for the two new value chains - Rice and Pyrethrum and revised existing inventories of TIMPs for all other value chains developed during the implementation of KCSAP and NARIGP. It also supports the strengthening of the existing Big Data platform at KALRO as the foundational database for insight-driven, more productive, resource-efficient and climate-resilient farming. Finally, the Ministry of Agriculture, Livestock Development (MoALD) has put in place relevant support mechanisms with KALRO to oversee effective implementation, coordination of research linkages and agriculture digitization.

In developing suitable inventories of TIMPs and corresponding ToT manuals, KALRO has leveraged information resources as well as those of its partners and collaborators. Use of these information resources, coupled with the accompanying training and contribution of the other project components, will go a long way in enabling NAVCDP to meet its development objectives.

The National Project Coordination Unit is grateful to all who participated in the development and production of this revised Inventory of TIMPs for Banana Value Chain. It is my hope that counties and other users will put this resource to good use as they transform and reorient their agricultural systems to make them more productive and resilient while minimizing GHG emissions under the new realities of the changing climate.

Samuel Guto, PhD
National Project Coordinator
National Agricultural Value Chain Development Project

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro-ecological zone
ASALs	Arid and Semi-Arid Lands
B	Boron
CA	Conservation Agriculture
CIGs	Common Interest Group
CC	Climate Change
CSA	Climate Smart Agriculture
FFBS	Farmer Field and Business School
FSMS	Food Safety Management System
GAPs	Good Agricultural Practices
ha	Hectare
HCD	Horticulture Crop Directorate
IDM	Integrated Disease Management
IPM	Integrated Pest Management
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KALRO	Kenya Agricultural and Livestock Research Organization
KCSAP	Kenya Climate Smart Agriculture Project
kg	Kilogram
TC	Tissue Culture
TIMPs	Technologies, Innovations and Management Practices
ToT	Training of Trainers
VMG	Vulnerable and Marginalized Groups
SWOT	Strengths Weaknesses Opportunities and Threats
NGO	Non-Governmental Organizations
NARI	National Agricultural Research Institutions
NAVCDP	National Agricultural Value Chain Development Program
GHG	Green House Gases
IMM	Integrated Manure Management
CBO	Community Based Organization
KES	Kenya Shillings
KEPHIS	Kenya Plant Health Inspectorate Services
MoALD	Ministry of Agriculture and Livestock Development
CoG	Council of Governors
WP	Wettable Powder
PCPB	Pest Control Products Board
ZECC	Zero Energy Colling Chamber

1.0 DEFINITION OF TERMS AND SUMMARY TABLES OF BANANA TECHNOLOGIES, INNOVATIONS AND MANAGEMENT PRACTICE (TIMPs)

1.1 DEFINITION OF TERMS

Technology

This is defined as an output of a research process which is beneficial to the target clientele (mainly farmers, pastoralists and agro-pastoralists for NAVCDP case), can be commercialized and can be patented under intellectual property rights (IPR) arrangements. It consists of research outputs such as tools, equipment, genetic materials, breeds, farming and herding practices, gathering practices, laboratory techniques, models etc.

Management practice

This is defined as recommendation(s) on practice(s) that is/are considered necessary for a technology to achieve its optimum output. These include, for instance, different agronomic practices (seeding rates, fertilizer application rates, spatial arrangements, planting period, land preparation, watering regimes, etc.), protection methods, for crops; and feed rations, management systems, disease control methods, etc. for animal breeds. This is therefore important information which is generated through research to accompany the parent technology before it is finally released to users and the technology would be incomplete without this information.

Innovation

This is defined as a modification of an existing technology for an entirely different use from the original intended use. (e.g. fireless cooker modified to be used as a hatchery)

1.2 SUMMARY OF INVENTORY OF TIMPs IN THE BANANA VALUE CHAIN

The inventory process resulted in a total of 107 TIMPs including 63 technologies, one innovation and 40 management practices, distributed among the three sub-themes, as indicated in Table 1

Table 1: Inventory of identified Banana TIMPs

Commodity /VC	Sub-Theme	Technologies	Innovations	Management Practices
Banana	Improved varieties	13	0	0
Banana	Seed Systems	2	0	3
Banana	Good Agricultural Practices (GAP) and Food Safety Management Systems	0	0	2
Banana	Agronomic Management Practices	0	0	6
Banana	Soil and Water Management	4	2	7
Banana	Crop Health	5	2	18
Banana	Postharvest Management	8	0	0

Banana	Value addition	8	0	0
Banana	Mechanization of Banana production activities	15	0	0
Banana	Business Management	8	0	0
Banana	Agricultural Policy Options	0	0	4
Overall Total		63	4	40

1.3. SUMMARY OF STATUS OF TIMPS IN BANANA VALUE CHAIN

The inventory process resulted in a total of 71 TIMPs that are ready for up scaling, 26 TIMPs that require validation and 10 TIMPs that require further research (resulting to a total of 107) in the sub-themes, as indicated in Table 2.

Table 2: Number of TIMPs ready for upscaling, require validation or further research

Commodity/VC	Sub-Theme	Ready for upscaling	Require validation	Further Research
Banana	Improved varieties	13	0	0
Banana	Seed Systems	5	0	0
Banana	Good Agricultural Practices (GAP) and Food Safety Management Systems (FSMS)	2	0	0
Banana	Agronomic practices	6	0	0
Banana	Soil fertility and water management	6	6	1
Banana	Crop health	17	6	2
Banana	Mechanization of Banana production activities	13	2	0
Banana	Post-harvest and	5	3	0
Banana	Value addition	0	1	7
Banana	Banana business and marketing	1	7	0
Banana	Agricultural policy	3	1	0
Overall Total		71	26	10

Table 3: Inventory of Banana TIMPs by Category and Status

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
2.0 Suitability map	Suitability map for banana growing areas in Kenya	Management practice	Validation
2.1 Banana Improved Varieties	2.1.1 Grand Nain	Technology	Ready for up-scaling
	2.1.2 Giant Cavendish	Technology	Ready for up-scaling
	2.1.3 Valery	Technology	Ready for up-scaling
	2.1.4 FHIA 17	Technology	Ready for up-scaling
	2.1.5 FHIA 23	Technology	Ready for up-scaling
	2.1.6 Ngombe	Technology	Ready for up-scaling
	2.1.7 Uganda Green	Technology	Ready for up-scaling
	2.1.8 Mkono Tembo	Technology	Ready for up-scaling
	2.1.9 Dwarf Cavendish	Technology	Ready for up-scaling
	2.1.10 Drought tolerant banana varieties	Technology	Ready for up-scaling
	2.1.11 Medium height varieties resistant to lodging due to wind	Technology	Ready for up-scaling
	2.1.12 Dessert Varieties tolerant to Panama disease (Fusarium Wilt)	Technology	Ready for up-scaling
	2.1.13 Black Sigatoka tolerant varieties	Technology	Ready for up-scaling
2.2 Banana Seed Systems	2.2.1 Sucker selection	Management practice	Ready for up-scaling
	2.2.2 Macropropagation	Innovation	Ready for up-scaling
	2.2.3 Tissue culture	Technology	Ready for up-scaling
	2.2.4 Hardening Nursery	Technology	Ready for up-scaling
	2.2.5 Paring and hot water treatment	Management practice	Ready for up-scaling
2.3 Good Agricultural Practices (GAP) and Food Safety Management Systems (FSMS)	2.3.1 Good Agricultural Practices (GAP)	Management practice	Ready for up-scaling
	2.3.2 Food Safety Management Systems (FSMS)	Management practice	Ready for up-scaling
2.4 Agronomic Management practices	2.4.1 Site selection	Management practice	Ready for up-scaling
	2.4.2 Orchard establishment	Management practice	Ready for up-scaling
	2.4.3 Desuckering	Management practice	Ready for up-scaling
	2.4.4 Propping	Management practice	Ready for up-scaling
	2.4.5 Pruning (Dry leaves removal)	Management practice	Ready for up-scaling
	2.4.6 Male bud removal	Management practice	Ready for up-scaling

2.5 Soil fertility and water management	2.5.1 Integrated Soil and Fertility Management	Management Practice	Requires Validation
	2.5.2 Low-cost composting technology	Technology	Requires Validation
	2.5.3 Rapid Soil Testing service	Innovation	Requires Validation
	2.5.4 Intercropping bananas with legumes for soil fertility management	Management Practice	Ready for upscaling
	2.5.5. Mulching for moisture retention	Management Practice	Ready for upscaling
	2.5.6 Green Manure cover crops	Technology	Ready for upscaling
	2.5.7 Use of green manure on banana orchards	Management Practice	Requires further research
	2.5.8 Zai pits/Planting Pits	Technology	Ready for upscaling
	2.5.9 Bench Terraces	Management Practice	Ready for Upscaling
	2.5.10 Agroforestry for soil fertility management	Management Practice	Requires Validation
	2.5.11 Wind breaks and live hedges	Management Practice	Requires Validation
	2.5.12 Drip irrigation system for banana production	Technology	Requires Validation
	2.5.13 Solar irrigation system for small holders	Innovation	Requires Validation
2.6 Banana Crop Health			
Banana pests management	2.6.1 Integrated Management of Nematodes	Management practice	Ready for up-scaling
	2.6.2 Integrated Management of Banana Weevil	Management practice	Ready for up-scaling
	2.6.3 Integrated Management of Banana Thrips	Management practice	Ready for up-scaling
	2.6.4 Integrated management of moles in bananas	Management practice	Ready for up-scaling
	2.6.5 Integrated Management of banana aphids	Management practice	Ready for up-scaling
Banana diseases management	2.6.6 Integrated Management of Banana Xanthomonas Wilt (BXW)	Management practice	Ready for up-scaling

	2.6.7 Integrated Management of fusarium wilt in bananas	Management practice	Ready for up-scaling
	2.6.8 Integrated Management of black Sigatoka in bananas	Management practice	Ready for up-scaling
	2.6.9 Integrated Management of Yellow Sigatoka	Management practice	Further Research
	2.6.10 Integrated Management of Cigar end rot	Management practice	Ready for up-scaling
	2.6.11 Integrated Management of Banana Streak Virus	Management practice	Further Research
	2.6.12 Integrated Management of Anthracnose in Banana	Management practice	Ready for up-scaling
	2.6.13 Integrated Management of Bunchy top disease in Banana	Management practice	Ready for up-scaling
	2.6.14 Integrated Management of Crown rot disease in Banana	Management practice	Ready for up-scaling
	2.6.15 Integrated Management of Armillaria in Banana	Management practice	Ready for up-scaling
Banana weeds Management	2.6.16 Integrated Weed Management in bananas	Innovation	Requires validation.
	2.6.17 Intercropping system for weed management in bananas	Innovation	Requires validation
	2.6.18 Cover cropping for weed management in bananas	Technology	Requires validation
	2.6.19 Mulching for weed management	Technology	Ready for upscaling
	2.6.20 Solarisation in seedbed for weed control	Technology	Requires validation
	2.6.21 Stale seed bed for weed control in banana	Technology	Requires validation
	2.6.22 Mechanical weed control in banana	Management practice	Ready for up-scaling
	2.6.23 Crop Rotation for weed control in banana	Management practice	Ready for up-scaling
	2.6.24 Chemical (Herbicide) weed control in banana	Technology	Requires validation
	2.6.25 Safe use of herbicides in Banana	Management practice	Ready for up-scaling

2.7 Banana Postharvest	2.7.1 Banana bagging	Technology	Validation
	2.7.2 Banana maturity index	Technology	Ready for up scaling
	2.7.3 Appropriate banana harvesting technique	Technology	Ready for up scaling
	2.7.4 Banana de-handing tool	Technology	Ready for up-scaling
	2.7.5 Use of stackable crates during packaging, transportation and marketing of banana	Technology	Ready for up-scaling
	2.7.6 Charcoal cooler for banana storage	Technology	Ready for up-scaling
	2.7.7 Zero Energy brick cooler	Technology	Validation
	2.7.8 Cool bot™	Technology	Validation
2.8 Banana Value addition	2.8.1 Banana ripening chamber	Technology	Ready for up-scaling
	2.8.2 Banana flour	Technology	Validation
	2.8.3 Fried banana chips	Technology	Validation
	2.8.4 Fried banana crisps	Technology	Validation
	2.8.5 Banana juice	Technology	Validation
	2.8.6 Banana jam	Technology	Validation
	2.8.7 Banana wine	Technology	Validation
2.9. Banana Mechanization	2.9.1 Crawler bulldozer	Technology	Ready for upscaling
	2.9.2 Ranging rod	Technology	Ready for upscaling
	2.9.3 Levelling stuff	Technology	Ready for upscaling
	2.9.4 Line level	Technology	Ready for upscaling
	2.9.5 Total Station Theodolite	Technology	Ready for upscaling
	2.9.6 Tripod stand	Technology	Ready for upscaling
	2.9.7 Plumb Bob	Technology	Ready for upscaling
	2.9.8 Measuring tape	Technology	Ready for upscaling
	2.9.9 Excavator	Technology	Ready for upscaling
	2.9.10 Wheel tractor	Technology	Ready for upscaling
	2.9.11 Mould board plough	Technology	Ready for upscaling
	2.9.12 Disc Harrow	Technology	Ready for upscaling
	2.9.13 Handheld hole drill	Technology	Requires validation
	2.9.14 Tractor hole drill	Technology	Requires validation
	2.9.15 Motorized Sprayer	Technology	Ready for upscaling
2.10 Banana Farming Business and marketing	2.10.1 Transformative graduation model of banana production	Management practice	Requires validation
	2.10.2 Building a business plan for banana production	Management practice	Requires validation
	2.10.3 Collective marketing	Management practice	Requires validation

	2.10.4 Profitability analysis	Management practice	Ready for upscaling
	2.10.5 Market research	Management practice	Requires validation
	2.10.6 Contracted production model	Management practice	Requires validation
	2.10.7 Marketing innovation model	Management practice	Requires validation
	2.10.8 Digital marketing	Management practice	Requires validation
2.11. Policy options	2.11.1 Framing Banana production in the National Agricultural Policy	Management practice	Ready for upscaling
	2.11.2 Participation in County Integrated Development planning	Management practice	Ready for upscaling
	2.11.3 Policy Instruments related to Banana	Management practice	Ready for upscaling
	2.11.4 Policy cycle	Management practice	Requires validation

2.0 DETAILED BANANA VALUE CHAIN TIMPS

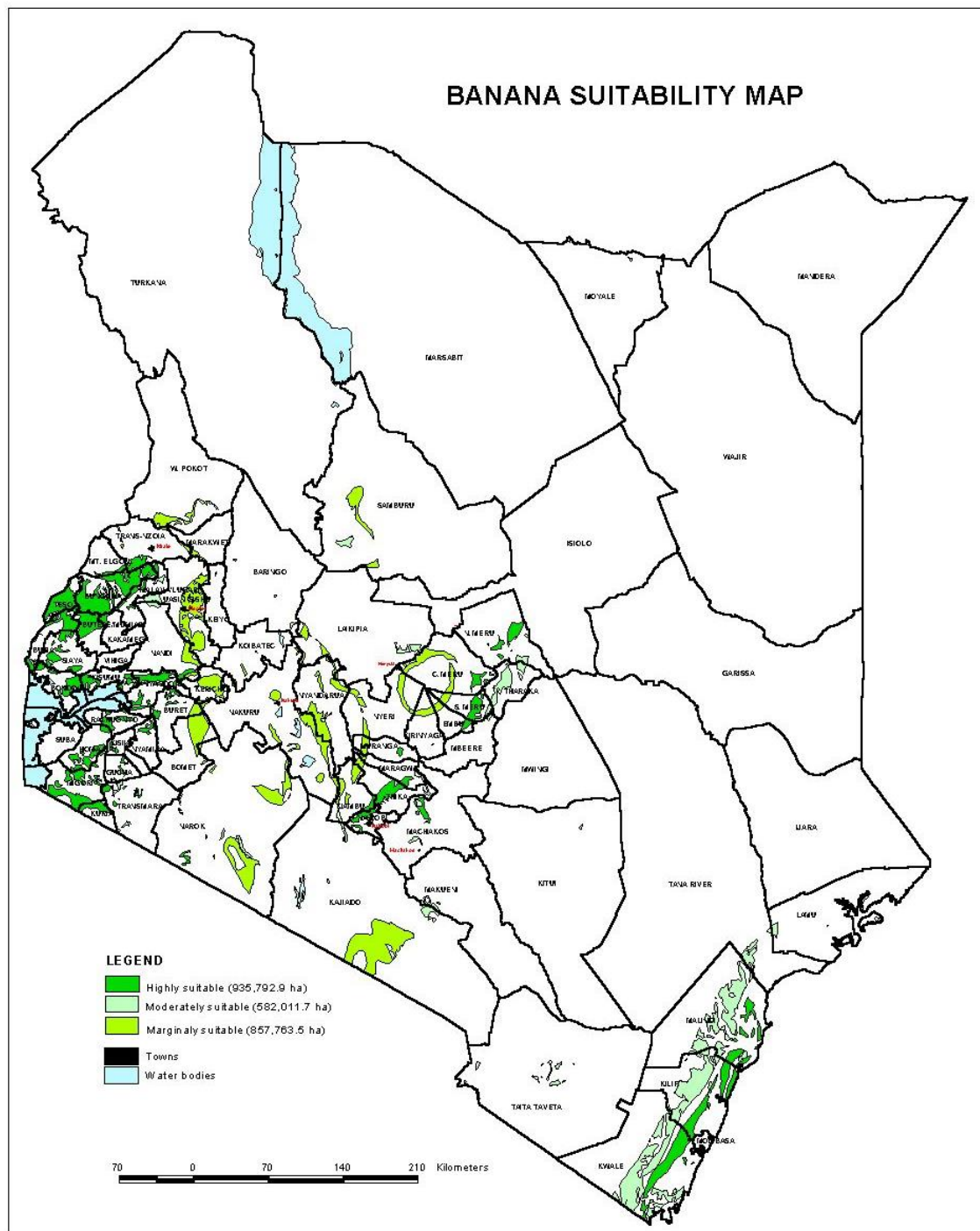



Figure 1: Banana Suitability map of Kenya

2.1 IMPROVED BANANA VARIETIES

2.1.1 Grand Nain (Grande Naine) Variety

2.1.1 TIMP Name	2.1.1 Banana Variety: Grand Nain (or Grande Naine)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addresses	Low productivity of local banana varieties (currently 3-4 tons/acre) coupled with low commercialization and adoption of improved varieties
What is it? (TIMP description)	<p>Grand Nain is a high yielding Cavendish banana variety (dessert type). Has a yield of 440 bunches per acre weighing approximately 30 kg a bunch (about 13 tons/acre). It does well in areas of altitude 0 – 1800 m above sea level and rainfall range of 1000 – 2000 mm. It is early maturing (18 to 22 months), disease tolerant, high yielding with medium to long fingers. It has well-spaced fingers, uniformly yellow when ripe enhancing fruit quality. It has a long shelf life (7 days). It is firm on ripening, has good taste and hence high market demand.</p>  <p style="text-align: center;"><i>Grand Nain banana variety</i></p>
Justification	<p>Increased human population including a more nutritionally aware consumer base has resulted in increased demand for dessert bananas. On the other hand, low productivity of local banana varieties and low adoption of improved varieties has led to low banana supplies that cannot meet this increased demand. To meet market demand (and consumer preferences, farmers need to increasingly adopt improved banana varieties with market-responsive traits. Grand Nain is an early-maturing high-yielding (13 tons/acre) dessert banana variety with a sweet flavor with suitability range (0-1800 m asl) and response to irrigation.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers at county and national level and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private


	<ul style="list-style-type: none"> • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure quality • Training of group nurseries Trainers • Good Marketing Models and pathways • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators – JKUAT, Mimea, KALRO – to provide clean planting materials • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training. • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted if any	The technology has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, Kakamega, Vihiga, Bungoma, Meru, Kirinyaga, Muranga, and Siaya
Counties where TIMP will be upscaled	Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga and Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material for Grand Nain variety • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in banana planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen • Weak seed systems leading to mixed varieties, low yields and poor quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials

	<ul style="list-style-type: none"> • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> • The demand for bananas is high and hence the need to upscale production in other suitable areas to meet the demand • Farmers need persistent hands-on training on good agronomic practices • Marketing and value addition is necessary for increased adoption and impact • Perishability of the crop demands proper handling from farm to market
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity • Women often have less access to agricultural information, technology and knowledge • Women, especially in rural areas, may have less access to education, training and extension services

	<ul style="list-style-type: none"> • In some communities banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise • Distance to market may inhibit access by women due to domestic activities
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for banana cultivation • VMGs often have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs required for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	<ul style="list-style-type: none"> • Farmers have benefited in Meru, Kirinyaga, Bomet and other counties
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for upscaling; 2- requires validation; 3-requires further research)	1. Ready for up-scaling
G. Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare,

	Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.2 Giant Cavendish

2.1.2 TIMP Name	Banana variety: Giant Cavendish
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of local banana varieties (currently 3-4 tons/acre), low commercialization and adoption of improved banana varieties
What is it? (TIMP description)	<p>Giant Cavendish is a high-yielding (440 bunches per acre/year @ 30 kg a bunch translating to about 13 tons/acre) dessert banana variety. It is early-maturing (18 to 24 months), tolerant to drought and also to Panama disease (fusarium wilt). The variety has medium to long fingers that are firm on ripening, with long shelf life, good taste hence good marketability. It does well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm).</p>  <p><i>Giant Cavendish banana variety</i></p>
Justification	Low productivity of local banana varieties and low adoption of improved varieties has led to low banana supplies that cannot meet the demand occasioned by the increasing human population driven by a more nutritionally aware consumer base. Short self-life reduces marketability of bananas, as well as farmers ability to access distant markets. The changing climate calls for varieties that are early-maturing, high-yielding with higher adaptability. Market demand for dessert bananas favors the sweeter bananas.
B: Assessment of dissemination and scaling up/out approaches	


Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean planting materials and application of good management practices • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets • Training of group nurseries Trainers • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted if any	Kisii, Nyamira, Migori, Busia, Embu, Kakamega, Vihiga, Bungoma, Muranga, Meru, Tharaka Nithi and Siaya.
Counties where TIMP will be upscaled	Banana-growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material for Giant cavendish • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting

	<ul style="list-style-type: none"> • Unorganized marketing channels, often controlled by exploitative middlemen • Weak seed systems leading to mixed varieties, low yields, and poor-quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Working with partners with comparative advantage will ensure success in dissemination and upscaling • Availing farmers with adaptable and market preferred banana varieties enhances technology uptake • Linking entrepreneurs to credit and market enhances adoption of banana technology • Availability of gross margin information enhances adoption of technology
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre

Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit. • Engagement in value added products • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	N/A
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)

F: Status of TIMP readiness (1-ready for upscaling, 2-requires validation; 3-requires further research)	1 – Ready for up-scaling
G. Contacts	
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.3 Valery

2.1.3 TIMP Name	Banana variety: Valery
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of local banana varieties (currently 3-4 tons/acre), low commercialization and adoption of improved banana varieties
What is it? (TIMP description)	<p>Valery is a high-yielding dessert type banana variety (440 bunches per acre/year @ 30 kg a bunch translating to about 13 tons/acre). It is early maturing (18 to 24 months), tolerant to Panama disease (<i>Fusarium wilt</i>). Its fingers are green and yellow with sweet (good flavour) when it ripens, and a long shelf life. The banana yields big bunches . It does well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm).</p>  <p style="text-align: center;"><i>Valery Banana Variety</i></p>
Justification	Low productivity of local banana varieties and low adoption of improved varieties has led to low banana supplies that cannot meet the demand occasioned by the increasing human population driven by a


	more nutritionally aware consumer base. Short self-life reduces marketability of bananas, as well as farmers ability to access distant markets. The changing climate calls for varieties that are early-maturing, high-yielding with higher adaptability. Market demand for dessert bananas favors the sweeter bananas.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets • Training of Trainers in management of group nurseries • Favourable weather and provision of supplementary irrigation • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted if any	Meru, Laikipia, Embu, Murang'a, Nyeri, Kiambu, Kisii, Bungoma, Narok, Nakuru, Bomet, Kericho
Counties where TIMP will be upscaled	Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi

Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen. • Weak seed systems leading to mixed varieties, low yields and poor-quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Working with partners with comparative advantage will ensure success in dissemination and upscaling • Availing farmers with adaptable and market preferred banana varieties enhances technology uptake • Linking entrepreneurs to credit and market enhances adoption of banana technology • Availability of gross margin information enhances adoption of technology
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time

	<ul style="list-style-type: none"> Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Women and youth may have limited access to land for banana cultivation, which is a perennial crop. Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. Women often have less access to agricultural information, technology and knowledge. Women, especially in rural areas, may have less access to education, training and extension services. In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> Affirmative action opportunities exist for women and youths to acquire the required credit. Engagement in value added products Youth engagement in aggregation and marketing of bananas Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs may have limited access to land for banana cultivation. VMGs often have less access to agricultural information, technology and knowledge. VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. VMGs may have limited access to education, training and extension services. Due to their social status VMGs are often excluded from decision making in development and dissemination activities. There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> Affirmative action opportunities exist for VMGs to acquire the required credit. Value addition activities would provide VMGs opportunities to actively participate in the value chain. Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Molo (Nakuru county), Nyeri, Meru, Kirinyaga, Bomet and other counties have benefited from Valery variety

Application guidelines for users	Reference: <ul style="list-style-type: none"> Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1. Ready for up-scaling
G. Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.4 FHIA 17

2.1.4 TIMP Name	Banana variety: FHIA 17
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of local banana varieties (currently 3-4 tons/acre), low commercialization and adoption of improved banana varieties
What is it? (TIMP description)	<p>FHIA 17 is an early maturing (18 to 24 months), banana variety suitable as both dessert and cooking type. The variety is high-yielding (60 kg / bunch translating to about (18 -24) tons/acre and is tolerant to sigatoka and Panama (fusarium wilt) diseases, and nematodes. It does well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm). The bunch has medium to long fingers that are firm after ripening with good taste and a long shelf life..</p> 

	<i>FHIA 17 Banana Variety</i>
Justification	Low productivity of local banana varieties and low adoption of improved varieties has led to low banana supplies that cannot meet the demand occasioned by the increasing human population driven by a more nutritionally aware consumer base. Short self-life reduces marketability of bananas, as well as farmers ability to access distant markets. The changing climate calls for varieties that are early-maturing, high-yielding with higher adaptability. Market demand for dessert bananas favors the sweeter bananas.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets and adherence to good management practices • Training of Trainers in management of group nurseries • Favourable weather and provision of supplementary irrigation • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their role	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors – to provide market for ready bananas
C: Current situation and future scaling up	


Counties where already promoted if any	Meru, Laikipia, Embu, Murang'a, Nyeri, Kiambu, Nyandarua, Kisii, Bungoma, Narok, Nakuru, Bomet, Kericho
Counties where TIMP will be up scaled	Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen. • Weak seed systems leading to mixed varieties, low yields and poor-quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • The demand for bananas is high and hence the need to upscale research and production in other suitable areas to satisfy the demand • Farmers need persistent hands-on training in proper agronomic practices, • Marketing and value addition for proper impact • Perishability of the crop demands proper handling from farm to market
Social, environmental, policy and market conditions	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety.

necessary for development and up scaling	<ul style="list-style-type: none"> • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	333 seedlings/acre x KES.130/seedling = KES.43,000/acre
Estimated returns	333 bunches x 60 kg/bunch x KES.20/kg = KES.400,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit. • Engagement in value added products • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.

E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Molo (Nakuru county), Nyeri, Meru, Kirinyaga, Bomet and other counties have benefited from FHIA 17 variety
Application guidelines for users	Reference: <ul style="list-style-type: none"> Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1. Ready for up-scaling
G. Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.5 FHIA 23

2.1.5 TIMP Name	Banana variety: FHIA 23
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of local banana varieties (approximately 3-4 tons/acre), low commercialization and adoption of improved varieties
What is it? (TIMP description)	FHIA 23 is a high-yielding dessert banana variety (18 to 24 tons/acre with good management), which is tolerant to foliar diseases, e.g. sigatoka. The variety has a big stout stem of medium height, which does not easily break. It has the shortest flowering-to-harvest period (96 days) among the FHIA cultivars. The bunch has many hands with big fingers per bunch, weighing about 40-60 kg. The fruit is sweet with soft pulp making it good for dessert, whether raw or processed. The variety does well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm.


	 <p><i>FHIA 23 banana variety</i></p>
Justification	<p>Low productivity of local banana varieties and low adoption of improved varieties has led to low banana supplies that cannot meet the demand occasioned by the increasing human population driven by a more nutritionally aware consumer base. Short self-life reduces marketability of bananas, as well as farmers ability to access distant markets. The changing climate calls for varieties that are early-maturing, high-yielding with higher adaptability. Market demand for dessert bananas favors the sweeter bananas.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers</p>
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm, on-station, seedling nurseries • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets and adherence to good management practices • Training of Trainers in management of group nurseries • Favourable weather and provision of supplementary irrigation • Good Marketing Models and pathways

	<ul style="list-style-type: none"> • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their role	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted if any	Meru, Laikipia, Embu, Muranga, Nyeri, Kiambu, Nyandarua, Kisii, Bungoma, Narok, Nakuru, Bomet, Kericho
Counties where TIMP will be upscaled	Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Erratic weather patterns affecting establishment and productivity of the bananas • Inadequate funds to purchase clean planting materials • Labour intensity especially during planting and weeding • Unorganized marketing channels, often controlled by exploitative middlemen • Weak seed systems leading to mixed varieties, low yields and poor-quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices

	<ul style="list-style-type: none"> • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • The demand for bananas is high and hence the need to upscale production in other suitable areas to satisfy the demand • Farmers need persistent hands-on training on proper agronomic practices in banana production • Access to market, and knowledge on marketing and value addition will enhance adoption and impact • Perishability of the crop demands proper handling from farm to market
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	333 seedlings/acre x KES.130/seedling = KES.43,000/acre
Estimated returns	333 bunches x 60 kg/bunch x KES.20/kg = KES.400,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit. • Engagement in value added products • Youth engagement in mechanization of banana production and marketing to increase participation along the value chain • Youth engagement in aggregation and marketing of bananas

	<ul style="list-style-type: none"> • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge. • Limited involvement of VMGs along the banana value chain • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Opportunities for VMG involvement along the banana value chain • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Molo (Nakuru county), Nyeri, Meru, Kirinyaga, Bomet and other counties have benefited from FHIA 17 variety
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1. Ready for up-scaling
G. Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.6 Ngombe variety


2.1.6 TIMP Name	Banana variety: Ngombe
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of local banana varieties (approximately 3-4 tons/acre), low commercialization and adoption of improved varieties
What is it? (TIMP description)	<p>Ngombe is a dual-purpose early maturing banana variety (cooking & dessert type). It is high yielding (18 tons/acre). It is uniform in growth and has long fingers. The outer skin is partially green and turns yellow when it ripens. The variety is good for chips and crisps, which develops appealing golden yellow color when deep fried, and is excellent for making flour.</p>  <p><i>Ngombe Banana Variety</i></p>
Justification	Low productivity of local banana varieties and low adoption of improved varieties has led to low banana supplies that cannot meet the demand occasioned by the increasing human population driven by a more nutritionally aware consumer base. Early maturing varieties enhance resilience in light of uncertain weather patterns, contributing to increased adoption and participation in markets.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm, on-station, seedling nurseries • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms

Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets • Training of Trainers in management of group nurseries • Favourable weather and provision of supplementary irrigation • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors – to provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted if any	Meru, Nyeri, Nyandarua, Kirinyaga, Nakuru, Bomet, Kisii, Tharaka-Nithi, Embu, Meru, Kiambu
Counties where TIMP will be up scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen. • Weak seed systems leading to mixed varieties, low yields and poor-quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers

	<ul style="list-style-type: none"> • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • The demand for bananas is high and hence the need to upscale research and production in other suitable areas to satisfy the demand • Farmers need persistent hands-on training in proper agronomic practices, • Marketing and value addition for proper impact • Perishability of the crop demands proper handling from farm to market
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity • Women often have less access to agricultural information, technology and knowledge • Women, especially in rural areas, may have less access to education, training and extension services • In some communities banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise • Distance to market may inhibit access by women due to domestic activities
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Engagement in value added products

	<ul style="list-style-type: none"> • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Laikipia Meru, Nyeri, Nakuru Embu and other counties have benefited from growing the crop using clean planting material
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for up scaling, 2-requires validation; 3-requires further research)	1 ready for up scaling
G: Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.7 Uganda Green

2.1.7 TIMPs name	Banana variety: Uganda Green
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity of local banana varieties (currently 3-4 tons/acre), low commercialization and adoption of improved varieties and management practices
What is it? (TIMP description)	<p>Uganda Green banana variety is an early-maturing and high yielding (12 tons/acre) cooking type variety. The variety is tolerant to diseases, e.g. Panama and Cigar end rot. The fruit is harvested green, carefully peeled and then cooked and often mashed or pounded into a meal or Matoke a staple food in East Africa.</p>  <p><i>Uganda Green Banana Variety</i></p>
Justification	Increased demand for cooking varieties of banana, requires increased supply through availability and adoption of clean, high-yielding, early maturing varieties.. Uganda Green is a cooking variety that is suitable for use in most of the banana recipes in East Africa.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print

	<ul style="list-style-type: none"> • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets and adherence to good management practices • Training of Trainers in management of group nurseries • Favourable weather and provision of supplementary irrigation • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors – to provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted, if any	Already promoted in Meru, Embu, Nyeri, Nyandarua, Murang'a, Embu, Kirinyaga, Kisii, Uasin Gishu, Nakuru, Kericho, Bomet and other banana growing counties
Counties where TIMP will be upscaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen.


	<ul style="list-style-type: none"> • Weak seed systems leading to mixed varieties, low yields and poor-quality banana bunches. • Limited knowledge and access to information on diseases and pests control measures
Recommendations for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • The demand for bananas is high and hence the need to upscale research and production to other suitable areas in order to increase supply • Consistent and persistent hands-on training in proper agronomic practices should be conducted at production level to ensure increased productivity and minimize pest and disease buildup • Good post harvest handling practices will enhance the quality of the cooking banana availed to the market
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review from time to time • Good post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop

	<ul style="list-style-type: none"> • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity • Women often have less access to agricultural information, technology and knowledge • Women, especially in rural areas, may have less access to education, training and extension services • In some communities banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise • Distance to market may inhibit access by women due to domestic activities
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Uganda green is a cooking variety hence important for women and households • Collective action (gender groups) that enhance access to markets (input and output) • Increased demand for cooking banana variety provides opportunities for involvement of youth and women along the value chain
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for banana cultivation • VMGs often have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs required for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	-

Application guidelines for users	Reference: <ul style="list-style-type: none"> Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1. Ready for upselling; 2. Requires validation; 3. Requires further research)	1. Ready for up scaling
G: Contacts	
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations and their roles	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.8 Mkono Tembo

2.1.8 TIMP Name	Banana variety: Mkono Tembo (Plantain)
Category (i.e. technology, Innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity of local plantain varieties (currently 3-4 tons/acre) coupled by limited availability of clean planting material for plantain, low commercialization of the available improved varieties
What is it? (TIMP description)	Mkono Tembo is a high-yielding (up to 10 tons/acre) plantain variety, that is very good for roasting. It is early-maturing (18 to 24 months) and does well at altitude of 0 – 1800 m above sea level with rainfall range 1000 – 2000 mm. Under good management, a bunch will have many hands, attaining a weight of 25 kg with up to 119 fingers, each measuring on average 25 cm in length.



		
Justification	Low productivity of local plantain varieties and increased market demand as well as diversified recipes calls for increased supply in quantity and quality. The variety, characterized by lengthy, big fleshy fingers enhances farmers involvement in markets as well by meeting market demand.	
B: Assessment of dissemination and scaling up/out approaches		
Users of TIMP	Plantain growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers	
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms 	
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean planting materials and application of good management practices • Favourable weather and provision of supplementary irrigation • Awareness on household utilization of plantains • Good banana seed system to ensure availability of quality plantlets • Training of group nurseries Trainers • Good Marketing Models and value addition pathways • Well organized farmer groups and networks • County and central government support 	
Partners/stakeholders for scaling up and their respective roles.	<ul style="list-style-type: none"> • Tissue culture laboratorie/banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. 	

	<ul style="list-style-type: none"> • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted if any	Not yet promoted in any county of Kenya
Counties where TIMPs will be upscaled	All banana-growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in development and Dissemination	<ul style="list-style-type: none"> • Inadequate availability of clean planting material for plantains • Plantain production is a new venture hence need for awareness creation on production as well as available markets • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • The plantain market channel is not well established but growing • Limited plantain utilization, processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with research, county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers, service providers and consumers along the plantain value chain on market, benefits and utilization • Training packages on establishment and good management practices of plantain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing, as well as build capacity on benefits and utilization of plantains • Capacity building on cottage industry establishment, utilization of plantain at household level

	<ul style="list-style-type: none"> • Training of producers on good disease and pest control and management practices
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> • The demand for plantains is increasing and hence the need to upscale production in other suitable areas to satisfy the growing demand • Farmers need persistent hands-on training in proper agronomic practices, • Marketing and value addition for proper impact • Perishability of the crop demands proper handling from farm to market • Need for training on utilization of plantain to increase market
Social, environmental, policy, and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review to support plantain value chain • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for plantain cultivation, being a relatively new perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • Plantain utilization is still low at household level • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit, knowledge and inputs for plantain production. • Increased engagement in value addition and utilization of plantain especially by women • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)

VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for and awareness of plantain cultivation. • VMGs often have less access to agricultural information, technology and knowledge on plantain production, especially being a new value chain. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness of plantain.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
○ E: Case studies/profiles of success stories	
Success stories	N/A
Application guidelines for users	Njuguna JK, Gathambiri C et al. 2022. valuation of plantain varieties on yield parameters in Murang'a County, Kenya <i>East African Journal of Science, Technology and Innovation</i> , 3. https://doi.org/10.37425/eajsti.v3i.442
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1. Ready for up scaling;
○ G: Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.9 Dwarf Cavendish

2.1.9 TIMP Name	Banana variety Dwarf Cavendish
Category (i.e. technology innovation, or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity dessert type banana varieties (currently 3-4 tons/acre), coupled by low commercialization and adoption of improved varieties
What is it? (TIMP description)	<p>Dwarf Cavendish is a high-yielding (30 kg/bunch translating to about 13 tons/acre) dessert-type banana varieties that is short in height (2 m) that can perform well under unreliable rainfall. Its characteristic features include resistance to Fusarium wilt, resistant to wind damage and high market preference. The variety is early-maturing (18 to 24 months). It does well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm). The fruit is firm after ripening, with good taste and a long shelf life, hence good marketability firm after ripening, good taste hence high market demand.</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div>
Justification	Banana production has been characterized with decreasing yields and susceptibility to intense winds etc. Introducing varieties that are high yielding but also able to withstand production challenges while meeting market preferences/demand is important to the growth of the value chain.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print


	<ul style="list-style-type: none"> • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean planting materials and application of good management practices • Provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets for short varieties • Training of group nurseries trainers • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training. • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted	Meru, Laikipia, Embu, Muranga, Nyeri, Kiambu, Nyandarua, Kisii, Bungoma, Narok, Nakuru, Bomet, Kericho
Counties where TIMP will be promoted	Banana growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Poor management practices affecting establishment and productivity in light of erratic weather problems • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials

	<ul style="list-style-type: none"> • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in scaling up	<ul style="list-style-type: none"> • The demand for bananas is high while changing weather patterns have affected production and productivity, hence the need to upscale production of early maturing varieties to other suitable areas to satisfy the demand • Farmers need persistent hands-on training in proper agronomic practices, especially in the changing climate • Linkage to markets and value addition enhance adoption and impact
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the varieties. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review to facilitate increased functionality of drought tolerant banana value chains • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise.

	<ul style="list-style-type: none"> Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> Affirmative action opportunities exist for women and youths to acquire the required credit. Engagement in value added products Youth engagement in aggregation and marketing of bananas Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs may have limited access to land for banana cultivation. VMGs often have less access to agricultural information, technology and knowledge. VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. VMGs may have limited access to education, training and extension services. Due to their social status VMGs are often excluded from decision making in development and dissemination activities. There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> Affirmative action opportunities exist for VMGs to acquire the required credit. Value addition activities would provide VMGs opportunities to actively participate in the value chain. Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories	Farmers have benefited in Meru, Kirinyaga, Bomet and other counties
Application guidelines for users	Reference: <ul style="list-style-type: none"> Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1=Ready for up-scaling; 2=Requires validation; 3=Requires further research)	1 – Ready for up-scaling
G: Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and Scientists	KALRO

	Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.10 Drought tolerant banana varieties (Williams and Chinese Cavendish)

2.1.10 TIMPs name	Drought-tolerant banana varieties (Williams and Chinese Cavendish)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to erratic rainfall occasioned by changing climatic patterns
What is it? (TIMP description)	<p>Williams and Chinese Cavendish are dessert type banana varieties that are early-maturing (18 to 24 months), disease tolerant, high-yielding (approximately 30 kg/bunch translating to 13 tons/acre). The varieties are relatively drought tolerant, performing well under unreliable rainfall. In addition, a key characteristic feature for the two varieties includes resistance to Fusarium race 1 and 2. The varieties do well at altitude of 0 – 1800 m above sea level with rainfall range 100 – 2000 mm.</p>  <p><i>Williams</i></p>
Justification	Changing climate patterns coupled by low productivity of local banana varieties and low adoption of improved varieties has led to low banana supply that cannot meet the demand occasioned by the increasing human population driven by a more nutritionally aware consumer base. Improved varieties hence not only need to meet market demand, but also be resilient in changing climate. Williams and Chinese Cavendish are drought-tolerant varieties that have medium to long fingers that are firm after ripening, with a good taste. The bunches have a long shelf life hence good marketability. These characteristics complement well with the drought-tolerance hence encouraging increased yields, resilience, increased market participation and hence increased incomes.
B: Assessment of dissemination and scaling up/out approaches	

Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean planting materials and application of good management practices • Provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets • Training of group nurseries trainers • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted, if any	Meru, Nyeri, Nyandarua, Kirinyaga, Kisii Nakuru, Bomet, Kisii, Tharaka-Nithi, Embu, Meru, Kiambu


Counties where TIMP will be upscaled	Banana growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material • Poor management practices affecting establishment and productivity in light of erratic weather problems • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Recommendations for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> • The demand for bananas is high while changing weather patterns have affected production and productivity, hence the need to upscale production of drought-tolerant varieties to other suitable areas to satisfy the demand • Farmers need persistent hands-on training in proper agronomic practices, especially in the changing climate • Linkage to markets and value addition enhance adoption and impact
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the drought-tolerant varieties. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety.

	<ul style="list-style-type: none"> • Enabling policy and policy review to facilitate increased functionality of drought tolerant banana value chains • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit. • Engagement in value added products • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge on drought-tolerant varieties. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.

VMG related opportunities	<ul style="list-style-type: none"> Affirmative action opportunities exist for VMGs to acquire the required credit. Value addition activities would provide VMGs opportunities to actively participate in the value chain. Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Laikipia Meru, Nyeri, Nakuru, Embu and other counties have benefited from growing the drought tolerant banana varieties
Application guidelines for users	Reference: <ul style="list-style-type: none"> Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for up scaling; 2-requires validation; 3-requires further research)	1-ready for up scaling
G: Contacts	
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.11 Medium height varieties resistant to lodging

2.1.11 TIMPs name	Medium height banana varieties resistant to lodging due to wind (Pelipita, Gros Michel and Chinese Cavendish)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity of local banana varieties coupled by high incidence of banana stem breakage due to strong winds

What is it? (TIMP description)	<p>Pelipita, Gros Michel and Chinese Cavendish are dessert type banana varieties that are able to withstand strong winds without breaking. They are of medium height (2m to 2.5 m) and mature early (18 to 24 months). The varieties are high-yielding (approximately 30 kg/bunch translating to appx 13 tons/acre). They have long fingers which are firm on ripening, with good taste and a long shelf life. They do well at altitude of 0 – 1800 m above sea level and rainfall range 100 – 2000 mm).</p>  <p><i>Pelipita dessert banana</i></p>
Justification	<p>High yielding new banana varieties that are susceptible to breakage due to strong winds imply an additional cost of staking and protection against wind. Further, damage of the plant by wind results reduces the quality of the banana bunches and hence market value. Pelipita, Gros Michel and Chinese Cavendish are early-maturing, high-yielding (13 tons/acre) and able to withstand strong winds, making them attractive for production and marketing.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers</p>
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of planting materials, • Favourable weather and provision of supplementary irrigation • Good banana seed system to ensure quality • Training of Trainers group nurseries


	<ul style="list-style-type: none"> • Favourable weather and provision of supplementary irrigation • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted, if any	Meru, Nyeri, Nyandarua, Kirinyaga, Nakuru, Bomet, Kisii, Tharaka-Nithi, Embu, Meru, Kiambu
Counties where TIMP will be upscaled	Banana growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material for the wind tolerant varieties • Erratic weather patterns affecting establishment and productivity • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen • Weak seed systems leading to mixed varieties, low yields and poor-quality banana bunches. • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Recommendations for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers

	<ul style="list-style-type: none"> • Promote marketing models that encourage collective production and marketing • Training and information dissemination on seed systems and good production practices • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> • The demand for bananas is high and hence the need to upscale production in other suitable areas to satisfy the demand • Farmers need persistent hands-on training in proper agronomic practices, • Marketing and value addition for proper impact • Perishability of the crop demands proper handling from farm to market
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana varieties. • Enabling policy and policy review from time to time • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit.

	<ul style="list-style-type: none"> • The reduced need for staking and reduced destruction by wind provides an opportunity for women and youth to engage in banana production • Engagement in value added products • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Reduced labour and costs for staking and protecting against wind provides opportunity for VMGs to engage in banana production • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Laikipia Meru, Nyeri, Nakuru Embu and other counties where wind is a challenge to banana production
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for up scaling; 2-requires validation; 3-requires further research)	1 - Ready for upscaling
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.12 Dessert banana varieties tolerant to Panama disease (Gerald Tucker and Cavendish)

2.1.12 TIMPs name	Dessert banana varieties tolerant to Panama disease (Gerald Tucker and Cavendish)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity and yield losses due to high incidences of Panama disease (Fusarium wilt)
What is it? (TIMP description)	<p>Gerald Tucker and Cavendish banana varieties are dessert types that perform well in Panama disease hotspot areas. The varieties are early-maturing (18 to 24 months), with medium to long fingers that are firm after ripening, with a good taste and a long shelf life. They do well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm). They are able to yield of 25 - 30 kg/bunch (translating to approximately 13 tons/acre).</p> 
Justification	Panama is a common disease in banana growing areas in Kenya. Climate change has influenced the occurrence of the disease leading to poor performance of banana crops and significant yield losses. The disease cannot be controlled by fungicides therefore growing tolerant varieties is the most viable solution.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business Schools (FFBS) Demonstrations – On-farm and on-station


	<ul style="list-style-type: none"> • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean planting materials and application of good management practices • Provision of supplementary irrigation • Good banana seed system to ensure availability of quality plantlets • Training of group nurseries trainers • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Tissue culture laboratories / banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties where already promoted, if any	Meru, Nyeri, Kirinyaga, Nakuru, Bomet, Kisii, Tharaka-Nithi, Embu, Meru, Kiambu
Counties where TIMP will be upscaled	Banana growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material for Giant cavendish • Poor management practices affecting establishment and productivity in light of erratic weather problems • Inadequate funds to purchase clean planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen • Limited processing technologies and consumption diversity at the household level

	<ul style="list-style-type: none"> • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Recommendations for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Working with partners with comparative advantage will ensure success of the project. • Availing farmers with adaptable and market preferred banana varieties enhances technology uptake. • Linking entrepreneurs to credit and market enhances adoption of banana technology. • Availability of gross margin information enhances adoption of technology.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review to support value chains for Panama disease tolerant banana varieties • Value addition and improved post-harvest handling management to improve market quality
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	444 seedlings/acre x KES.130/seedling = KES.57,720 /acre
Estimated returns	440 bunches x 30 kg/bunch x KES.20/kg = KES.264,000 income in the first year of harvesting
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity.

	<ul style="list-style-type: none"> • Women often have less access to agricultural information, technology and knowledge on disease management. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit. • Engagement in value added products. • Disease tolerant dessert varieties reduce cost as well as labour requirement for disease management hence increasing income • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge on drought-tolerant varieties. • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers in Laikipia Meru, Nyeri, Nakuru Embu and other Panama disease hotspot counties have benefited from growing the crop with improved seeds
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)
F: Status of TIMP readiness (1-ready for up scaling; 2-requires validation; 3-requires further research)	1 - Ready for upscaling
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.1.13 Black sigatoka tolerant banana varieties (FHIA 23, FHIA 01—Gold finger)

2.1.13 TIMP name	Black <i>sigatoka</i> tolerant banana varieties (FHIA 23, FHIA 01—Gold finger)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low banana productivity due to high incidences of Black Sigatoka disease.
What is it? (TIMP description)	<p>FHIA 23, FHIA 01—Gold finger are high-yielding dessert varieties (18 to 24 tons/acre with good management), that are tolerant to Black Sigatoka disease. The varieties have big stout stem that do not break easily, and do well at altitude of 0 – 1800 m above sea level and rainfall range 1000 – 2000 mm). The bunch has many hands with big fingers and weighs between 40 and 60 kg. The fruits are sweet with soft pulp, making it good for dessert, whether raw or processed.</p>  <p><i>FHIA 23 banana variety</i></p>
Justification	Black Sigatoka is a common disease in banana growing areas in Kenya where it is known to cause losses of up to 50%. Climate change has influenced the risk and spread of the disease in tropical areas leading to poor performance of banana crops. Growing varieties tolerant to the disease will reduce production cost and result in varieties meeting market preferences in terms of quantity and quality

Region promoted	Kisii, Nyamira, Migori, Busia, Embu, Bomet, Kericho, Nyeri, Tharaka Nithi and Siaya,
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean planting materials and application of good management practices • Provision of supplementary irrigation • Good banana seed system to ensure availability of quality disease tolerant plantlets • Training of group nurseries trainers • Good Marketing Models and pathways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up their roles and stage of involvement	<ul style="list-style-type: none"> • County government and private Extension service providers - to train farmers on banana production either collectively or through farm-to-farm visits. They will also offer advice and collect information on the uptake and practice in banana production. • Tissue culture laboratories/banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide clean planting materials. • Community farmer groups – to provide land for demonstration of banana production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as clean planting materials and inorganic fertilizer at no cost or through affordable credit systems. • KALRO – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties already promoted if any	The varieties have been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Kiambu, Tharaka Nithii, Busia, Embu, Kakamega, Vihiga, Bungoma, Muranga, and Siaya.

Counties where TIMP will be upscaled	Banana growing counties in Kenya, especially those prone to Black sigatoka disease including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate/unavailability of clean planting material for Giant cavendish • Poor management practices affecting establishment and productivity in light of erratic weather problems • Inadequate funds to purchase disease-tolerant planting materials • Labour intensity in planting, weeding and harvesting • Unorganized marketing channels, often controlled by exploitative middlemen • Limited processing technologies and consumption diversity at the household level • Limited knowledge and access to information on diseases and pests control measures • High perishability and poor post-harvest handling skill
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Collaboration with county government and other players in the private sector in supply of clean planting materials and provision of extension services • Capacity building of farmers and service providers in banana value chain • Link to financial service providers with favourable and flexible credit options • Initiation of large-scale production where mechanization can be employed as well as mechanization solutions for small scale producers • Promote marketing models that encourage collective production and marketing • Training on household level and cottage industry value addition using bananas • Training of producers on good disease and pest control and management practices • Development and dissemination of good post-harvest management practices
Lessons learned in up-scaling if any	<ul style="list-style-type: none"> • Working with partners with comparative advantage will ensures success of the project. • Availing farmers with adaptable and market preferred banana varieties enhances technology uptake. • Linking entrepreneurs to credit and market enhances adoption of banana technology. • Availability of gross margin information enhances adoption of technology.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing.


	<ul style="list-style-type: none"> • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review to support value chains for Panama disease tolerant banana varieties • Value addition and improved post-harvest handling management to improve market quality
Basic costs	333 seedlings/acre x KES.130/seedling = KES.43,000/acre
Estimated returns	333 bunches x 60 kg/bunch x KES.20/kg = KES.400,000 income in the first year of harvesting
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth may have limited access to land for banana cultivation, which is a perennial crop. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure hence resulting in reduced productivity. • Women often have less access to agricultural information, technology and knowledge. • Women, especially in rural areas, may have less access to education, training and extension services. • In some communities, banana is regarded as a woman's crop while at subsistence level. However, after it has gained commercial value, men have taken over the enterprise. • Distance to market may inhibit access by women due to domestic activities.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit. • Engagement in value added products • Disease resistant varieties reduce cost of production and specialized labour for disease management hence encourage different gender groups in participating in the banana value chain • Youth engagement in mechanization of banana production and marketing to increase participation along the value chain • Youth engagement in aggregation and marketing of bananas • Collective action (gender groups) that enhance access to markets (input and output)
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have limited access to land for banana cultivation. • VMGs often have less access to agricultural information, technology and knowledge. • Limited involvement of VMGs along the banana value chain • VMGs may also have limited access to finances to buy the required inputs needed for good banana plot management such as quality planting materials and manure. • VMGs may have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.

VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Disease resistant varieties reduce cost of production and specialized labour for disease management hence encourage VMGs in participating in the banana value chain • Opportunities for VMG involvement along the banana value chain • Value addition activities would provide VMGs opportunities to actively participate in the value chain. • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories	Available in KALRO centers and some farmers
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 – Ready for upscaling
Application guidelines for users	Reference: <ul style="list-style-type: none"> • Njuguna et.al, 2008. Introduction and evaluation of improved banana cultivars for agronomic and yield characteristics in Kenya. <i>African Crop Science Journal</i>, Vol. 16, No. 1, pp. 35 – 40 • SHEP, 2019. Banana Production, (version 6)
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.2 BANANA SEED SYSTEMS

2.2.1 Banana Sucker Selection

2.2.1 TIMP name	Banana Sucker Selection
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity (reduced by up to 20%) of banana mats due to wrong

	selection of sucker type both for production and for propagation
What is it? (TIMP description)	<p>This is a technique for identifying and selecting sword suckers for onward bearing and for use in both micro- and macro-propagation.</p>  <p><i>Sword Suckers (L) compared to water suckers (R)</i></p>
Justification	Use of water suckers, as opposed to the sword suckers results in low vigour and low adaptation of the resultant crop leading to low yields, high disease susceptibility, poorly adapted plants and low-quality banana bunches.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers and policy makers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Availability and accessibility of clean (pest- and disease-free) plants to harvest sword suckers from • Good seed system to ensure quality the market demands • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up their roles and stage of involvement	<ul style="list-style-type: none"> • County government and private extension service providers – To train farmer groups and nursery operators on selection of the right suckers for banana propagation either collectively or through farm-to-farm visits. They will also offer advice and collect information on the uptake and practice of the technique • Tissue culture laboratories/banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide initial clean planting materials.

	<ul style="list-style-type: none"> • Community farmer groups – to provide land for demonstration of banana sucker selection for increased production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as at no cost or through affordable credit systems. • KALRO and researchers – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties already promoted if any	Adopted by some farmers in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be upscaled	Banana growing counties in Kenya including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Limited knowledge on good agronomic practices among producers • Unavailability of sufficient water for irrigation where required. • Diseased orchards that promote the spread of diseases particularly when sourcing planting materials • Lack of strong farmers grower organizations & CBOs including engagement of youth
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Hand-on training, sensitization and demonstrations on good agronomic practices and gross margins indicating cost effectiveness of the technology • Training on water harvesting and moisture retention techniques • Establishment and maintenance of mother blocks to provide clean material for propagation, in collaboration with county government • Access to funds for mentoring university graduates to start agribusiness such as macro propagation units
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • This is a potential of the management practice in addressing the gap in the management of banana orchards. • There is demand for affordable clean banana planting material • Farmers need to appreciate the benefits of desuckered mats where correct suckers are promoted
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Creation of awareness on nutritive and commercial importance of the variety. • Harmonious gender consideration in research, consumption and marketing. • Suitable bio-physical environments in target counties for production of the banana variety. • Enabling policy and policy review to support value chains for Panama disease tolerant banana varieties • Value addition and improved post-harvest handling management to improve market quality
Basic costs	<ul style="list-style-type: none"> • Basic costs include labour costs for desuckering
Estimated returns	<ul style="list-style-type: none"> • Good banana sucker selection saves losses of 20%, translating to


	KES.52,800 per acre.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Gender inequalities in regard to access and control over the land resources may hinder women from adopting the technology.. • Women may not have time and mobility to attend extension activities far from home or held at times when they have other roles
Gender related opportunities	<ul style="list-style-type: none"> • The technology requires less land to establish and run therefore it can easily be taken up by land resource constrained women and youth • Youths and women groups will benefit from setting up and running macro propagation units through sale of planting materials. They will also have enough material for Banana orchard establishment and expansion.
VMG issues and concerns in development, dissemination adoption and scaling up	<ul style="list-style-type: none"> • Due to their social status VMGs are often excluded from decision-making in development, dissemination and benefits of the technology as well as information regarding the technology • VMGs face the barrier of accessing source of clean propagating material of the required varieties due to inadequate resources such as land and credit
VMG related opportunities	<ul style="list-style-type: none"> • Increased production will lead to improved food nutrition and security in the household to the benefit of the VMGs; • Changing consumer behavior leading to increased demand hence improved incomes for VMGs • VMGs can benefit from setting up multiplication of banana plantlets using sword suckers for their own farms or for sale.
E: Case studies/profiles of success stories	
Success stories	<p>The technology has been successfully piloted in Meru and Kirinyaga. The protocol is available and has been practiced in West Africa (Nigeria) and East Africa (Uganda).</p> <p>In Burundi, over ten NGOs have adopted the concept of macro propagation and have reduced the gap between Farmers and access to affordable clean quality planting material.</p>
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 - Ready for upscaling
Application guidelines for Users	<p>Reference:</p> <ul style="list-style-type: none"> • Njukwe, E., Tenkouano, A. et al. 2006. Training Manual Macro-Propagation of Banana and Plantain. IITA • Staver C and Lescot T. Propagating quality planting material to improve plant health and crop performance: Key practices for dessert banana, plantain and cooking banana (Illustrated Guide). (ISBN: 978-92-9255-014-1)
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

GAPS

- Evaluate use of different media on production of plantlets
- Evaluate performance of plantains
- Evaluate the performance of macro propagation units under different AEZs

2.2.2 Macro propagation method

2.2.2 TIMP name	Macro propagation method
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of conventional and locally sourced planting materials even following initial establishment using clean tissue culture materials
What is it? (TIMP description)	<p>This a propagation technique for multiplying true-to-type banana planting materials from identified disease and pest free selected banana plants. Material for multiplication is obtained from sword suckers, corms, and maiden suckers.</p> 
Justification	Banana is an important crop in Kenya used for food and income generation. However, there is inadequate clean planting material and tissue culture bananas are costly to most small scale farmers. Further, after establishing a banana plantation from clean material, farmers would want to expand a particular variety through the farm, without having to purchase new planting materials, yet there exist plants within the farms. Most farmers use locally sourced planting material, with little knowledge on how to select those that are not diseased and infested by pests. Without the right information, multiplication will be done using any local materials, which are not of uniform size and age and may lead to reduced yields and low-quality bananas. Macro-propagation is a low-cost propagation technique which would avail affordable and clean planting material.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and

	researchers and policy makers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Timely availability of clean suckers, • Training of trainers, • Favorable weather and provision of supplementary irrigation • Quality media • Evidence for market demand of planting material
Partners/stakeholders for scaling up their roles and stage of involvement	<ul style="list-style-type: none"> • County government and private Extension service providers will train farmer groups and Nursery operators on Banana macro propagation technique either collectively or through farm-to-farm visits. They will also offer advice and collect information on the uptake and practice of the technique • Tissue culture laboratories/banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide initial clean planting materials. • Community farmer groups – to provide land for demonstration of banana sucker selection for increased production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as at no cost or through affordable credit systems. • KALRO and researchers – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors will provide market for ready bananas
C: Current situation and future scaling up	
Counties already promoted if any	Kirinyaga, Meru, Kiambu
Counties where TIMP will be upscaled	Banana growing counties in Kenya including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Understanding and acceptance of the technology by the farmers • Sustainable availability of healthy mother plants • Increased demand for macro propagated planting material
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization, creating awareness, demonstrations, including demonstration of gross margin calculations indicating cost effectiveness of the technology

	<ul style="list-style-type: none"> Establishment and maintenance of mother blocks to provide clean material for macro propagation, working in collaboration with County Government to enhance supply of the clean planting material Build capacity and create incentive for private sector, university graduates, farmers etc to set up macro propagation units
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> This is a potential technology in addressing the gap in provision of clean planting material as well as an agribusiness enterprise for women and youth groups. There is demand for affordable clean banana planting material Farmers should be able to distinguish TC from Macro propagated material
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> Creation of awareness on nutritive and commercial importance of the variety. Harmonious gender consideration in research, consumption and marketing. Suitable bio-physical environments in target counties for production of the banana variety. Enabling policy and policy review to support value chains for Panama disease tolerant banana varieties Value addition and improved post-harvest handling management to improve market quality
Basic costs	Establishing the micropropagation unit for xxx banana plants would cost approximately KES.230,000
Estimated returns	Sale of planting materials @ KES.xxx would give returns of KES.600,000 every 4 months
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Gender inequalities in regard to access and control for banana production may hinder women and youth from engaging in banana production Women may not have time and mobility to attend extension activities far from home or held at times when they have other roles
Gender related opportunities	<ul style="list-style-type: none"> The technology requires less land to establish and run therefore it can easily be taken up by land resource constrained women and youth. Youths and women groups will benefit from setting up and running macro propagation units through sale of planting materials. They will also have enough material for Banana orchard establishment and expansion.
VMG issues and concerns in development, dissemination adoption and scaling up	<ul style="list-style-type: none"> Due to their social status VMGs are often excluded from decision making in development, dissemination and benefits of the technology as well as information regarding the technology VMGs face the barrier of accessing source of clean propagating material of the required varieties due to inadequate resources such as land and credit
VMG related opportunities	<ul style="list-style-type: none"> Increased production will lead to improved food nutrition and security in the household to the benefit of the VMGs;

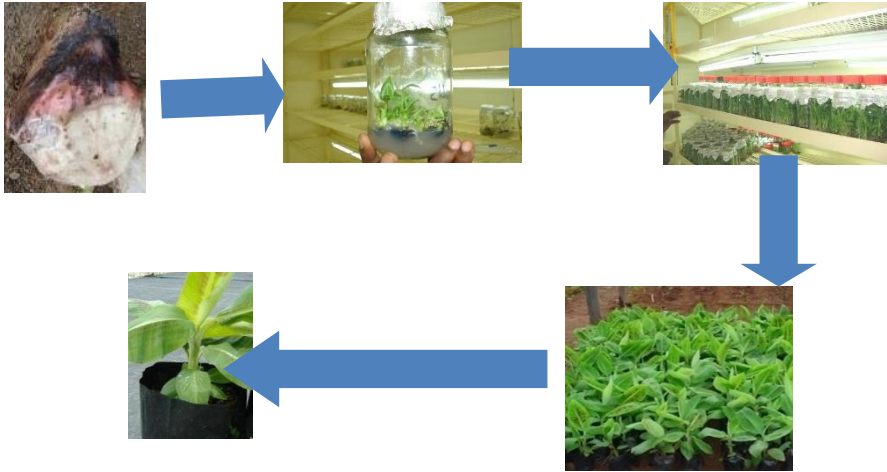
	<ul style="list-style-type: none"> Changing consumer behavior leading to increased demand hence improved incomes for VMGs
E: Case studies/profiles of success stories	
Success stories	<p>The technology has been successfully piloted in Meru and Kirinyaga. The protocol is available and has been practiced in West Africa (Nigeria) and East Africa (Uganda).</p> <p>In Burundi, over ten NGOs have adopted the concept of macro propagation and have reduced the gap between Farmers and access to affordable clean quality planting material.</p>
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 – Ready for upscaling
Application guidelines for users	<p>Reference:</p> <ul style="list-style-type: none"> Njukwe, E., Tenkouano, A. et al. 2006. Training Manual Macro-Propagation of Banana and Plantain. IITA
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Lead organization and scientists	<p>KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino</p>
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

GAPS

- Evaluate use of different media on production of plantlets
- Evaluate performance of plantains
- Evaluate the performance of macro propagation units under different AEZs

2.2.3 Tissue culture

2.2.3 TIMP name	Tissue culture
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low banana yields due to unavailability of enough clean planting materials and lack of uniformity in field establishment and maturity.

<p>What is it? (TIMP description)</p>	<p>Tissue culture is a rapid propagation method for the production of clean (pest and disease free) planting material. In banana production, the materials have uniform flowering and maturity.</p> 
<p>Justification</p>	<p>Banana is an important crop in Kenya used for food and income generation. Pests and disease are a major challenge to banana production, causing significant losses in yields and quality. This is occasioned by inadequate clean planting material and a high genetic variability of available planting materials. Most farmers recycle their own planting materials which are mostly diseased and pest infested thus have low vigour for good planting material. These materials are also not of uniform size and age. Tissue culture provides a method of rapidly multiplying clean uniform planting material with high vigour and good chances of high survival rates after establishment. The even multiplication and maturity of bananas under tissue culture is suitable for contract marketing.</p>
<p>B: Assessment of dissemination and scaling up/out approaches</p>	
<p>Users of TIMP</p>	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers and policy makers</p>
<p>Approaches used in dissemination</p>	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
<p>Critical/essential factors for successful promotion</p>	<ul style="list-style-type: none"> • Timely availability of planting materials, • Good banana seed system to ensure quality • Training of Trainers group nurseries

	<ul style="list-style-type: none"> • Favourable weather and provision of supplementary irrigation • Good Marketing Models and path ways • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up their roles and stage of involvement	<p>Roles of partners</p> <ul style="list-style-type: none"> • County government and private Extension service providers will train farmers on banana production either collectively or through farm to farm visits. They will also offer advice and collect information on the uptake and practice in banana production. • Tissue culture laboratories/banana hardening nursery operators - JKUAT, Mimea, KALRO Kandara- will provide the importance of tissue culture planting materials • KU-Will provide backstopping on plant health issues and low cost tissue culture protocol • Community farmer groups will provide land for demonstration on banana production and enhance the spread of knowledge through farmer-to-farmer training. • NGOs such as World Vision, Africa Harvest will provide inputs to farmers such as clean planting materials and inorganic fertilizer for free or through affordable credit systems. • KALRO – will train trainers and provide technical backstopping on dissemination of tissue technology for bananas and related technologies • Traders and processors such as -Nyanngorora processors – will provide market for ready tissue-cultured bananas
C: Current situation and future scaling up	
Counties already promoted if any	The technology has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya.
Counties where TIMP will be upscaled	Banana growing counties in Kenya including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Inadequate tissue culture laboratories • Lack of funds to purchase the clean materials by farmers • High cost and inadequate funds to purchase planting materials • Centralized TC laboratories without an effective distribution network
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Create incentive for private sector to set up labs in western and eastern Kenya • Innovations that reduce cost of TC hence lowering the cost of seedlings • Collaboration with county government in supply of planting materials • Capacity building of farmers and service providers in banana value chain
Lessons learned in up-scaling if any	<ul style="list-style-type: none"> • Working with partners with comparative advantage ensures success of the project e.g. subsidizing cost of seedling production • Availing farmers with adaptable and market preferred banana varieties enhances technology uptake • Linking entrepreneurs to credit and market enhances adoption of banana technology • Availability of gross margin information enhances adoption of technology • Create effective linkages within the value chain to the end consumer

Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> Banana is socially acceptable and any technology to increase its production will be readily adopted. adoption of the TIMP in place Awareness of the benefits/advantages/management of the technology to enhance acceptability for increased up take. Existence of suitable bio-physical environments in target counties. Availability of domestic and international markets for the commodity. Enabling policy frameworks, e.g. Big 4 Agenda that requires the blending of high nutritive value food products.
Basic costs	Purchase of material at KES.60 per seedling
Estimated returns	Sale of TC seedlings at KES.130 per seedling
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Gender issues and concerns in development, dissemination adoption and scaling up	<ul style="list-style-type: none"> Gender inequalities in regard to access and control over the resources such as land and capital Existing cultural practices that limit any gender categories to participate in the value chain which allow men alone to plant bananas Perceptions in regard to banana as a snack food The technology may not be adopted if the gender targeted especially women is overburdened Women may not have time and mobility to attend extension activities far from home or held at times when they have other roles
Gender related opportunities	<ul style="list-style-type: none"> Develop capacity for women and youth in banana hardening nursery activities to improve profitability of their business., The technology is acceptable and easy to upscale by males, females and the youth Develop capacity for women and youth to set up banana processing units and ripening chambers for value addition and profits It offers opportunities in enhancing food security with the rural households and as source of income
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Due to their social status VMGs are often excluded from decision making in development and dissemination VMGs face the barrier of accessing clean planting materials of the varieties due to inadequate resources such as land and credit Due to prejudices associated with their social status, VMGs are excluded from access to and benefits from improved technologies. Thus the technology is not easily adoptable by the VMGs
VMG related opportunities	<ul style="list-style-type: none"> Affirmative action, capacity building and practical support to be provided The technology is acceptable and easy to upscale by VMGs Increased production will lead to increased consumption of nutritious bananas hence improved health of VMGs; Changing consumer behavior leading to increased demand hence improved incomes for VMGs
E: Case studies/profiles of success stories	
Success stories	More than Twelve million TC bananas have been distributed to farmers in the past ten years. This has led to increased production, improved income and food security in major producing areas such as Kisii, Meru, Nyeri and Taita Taveta.


	The increased production has provided raw material for value addition and processing banana products
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 – Ready for upscaling
Application guidelines for users	www.agrifarming.in/banana-tissue-culture-information www.africenter.isaaa.org/wp-content/uploads/2015/12/TC-Banana-Booklet.pdf
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

APS

- Validation of Fusarium resistant varieties
- Need to fine-tune TC protocol for cooking bananas and plantains
- Study on demand of TC material for sustainable production and supply
- Social economic study on profitability, market demand of tissue culture bananas

2.2.4 Hardening nursery

2.2.4 TIMP name	Hardening Nursery
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed.	Low banana productivity due to poor plant establishment attributed to low adaptability of TC seedlings to local conditions. TC seedlings to reach transplanting size.
What is it? (TIMP description)	This is a structure with at least 55% netting roof to reduce sunlight and temperature, with insect proof net to protect plants from pest attack. It uses sterilized potting media to enhance root formation and vigorous growth before transplanting. Plants remain in the structure for at least two to three months.

	 <p>Banana Hardening nursery</p>
Justification	<p>Banana is an important crop in Kenya used for food and income generation. However, there is inadequate clean planting material and guarantee of true to type. In addition to this the distribution of clean planting material is poor thus farmers and producer groups cannot access these materials from TC Labs and Macro propagation units. Establishment of hardening nurseries will ensure availability of quality planting material to farmers and producer groups.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers and policy makers</p>
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms •
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good security • Availability of clean water • Establishment of hardening nursery a region where bananas are grown • Timely availability of planting materials, • Training of trainers, • Favorable weather and provision of supplementary irrigation • Evidence for market demand

Partners/stakeholders for scaling up their roles and stage of involvement	<ul style="list-style-type: none"> • County government and private Extension service providers will train farmer groups and Nursery operators on Banana macro propagation technique either collectively or through farm-to-farm visits. They will also offer advice and collect information on the uptake and practice of the technique • Tissue culture laboratories/banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide initial clean planting materials. • Community farmer groups – to provide land for demonstration of banana sucker selection for increased production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as at no cost or through affordable credit systems. • KALRO and researchers – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors – to provide market for ready bananas
C: Current situation and future scaling up	
Counties already promoted if any	The technology has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, Muranga, Kiambu, Nyeri and Siaya. Homabay
Counties where TIMP will be up scaled	Banana growing counties in Kenya including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Mixing of varieties before taking to hardening nursery • High mortality if plantlets are too young at hardening stage • Centralized TC laboratories without an effective distribution network • Lack of acceptance of materials obtained from hardening nursery within community
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Capacity building on importance of clear labeling of plantlets during the TC lab process • Build capacity and create incentive for private sector to set up hardening nurseries • Collaboration with county government in financing community hardening nurseries • Capacity building of farmers and service providers in banana value chain
Lessons learned in up-scaling if any	<ul style="list-style-type: none"> • Working with partners with comparative advantage will ensure success of the project e.g. subsidizing cost of seedling production • Availing farmers with adaptable and market preferred banana varieties enhances technology uptake • Linking entrepreneurs to laboratories, farmer groups, credit and market enhances adoption of banana technology • Availability of gross margin information enhances adoption of technology • Create effective linkages within the value chain to the end consumer



Social, environmental, policy, and market conditions necessary	<ul style="list-style-type: none"> • Sensitization, creating awareness, demonstrations, including demonstration of gross margin calculations indicating cost-effectiveness of the technology • Establishment and maintenance of mother blocks to provide clean material for macro propagation, working in collaboration with the County Government to enhance supply of the clean planting material • Build capacity and create incentives for the private sector, university graduates, farmers, etc to set up hardening nurseries •
Basic costs	KES.70,000 per Unit
Estimated returns	10,000 seedlings x KES.40 per seedling = KES.400,000
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Gender issues and concerns in development, dissemination adoption and scaling up	<ul style="list-style-type: none"> • Gender inequalities in regard to access and control for banana production may hinder women and youth from engaging in banana production • Women may not have time and mobility to attend extension activities far from home or held at times when they have other roles •
Gender related opportunities	<ul style="list-style-type: none"> • The TIMP provides an opportunity for Youths and women to benefit from setting up of hardening nurseries through groups • Improved productivity will enhance food security and incomes with the rural households.
VMG issues and concerns in development and dissemination adoption and scaling up	<ul style="list-style-type: none"> • Due to their social status VMGs are often excluded from decision making in development and dissemination, thus the technology is not easily adoptable by the VMGs • VMGs face the barrier of accessing resources such as land and credit therefore may not benefit from access to clean planting materials
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action, capacity building and practical support to be provided • Increased production will lead to enhanced food and nutrition security in the household including VMGs. • Changing consumer behavior leading to increased demand hence improved incomes for VMGs
E: Case studies/profiles of success stories	
Success stories	Farmers in Kisii region can access clean and high yielding varieties from hardening nurseries at KALRO Kisii and Okosambu Nursery. As a result they have been able to establish new orchards and expand existing ones and realized increased production.
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 – Ready for upscaling
Application guidelines for users	References

	<ul style="list-style-type: none"> How to Establish a Tissue Culture Banana Hardening Nursery (Africenter 2008) TC banana plantlets establishment management in nursery (KALRO Kisii, 2017)
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Lead organization and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

GAPS

- Validation of the technology hence requires further research
- Development of production guide

2.2.5 Paring and hotwater treatment

2.2.5 TIMP name	Paring and hot water treatment
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low productivity of local planting materials, high incidence of pests and diseases in seedlings and high cost of clean Tissue Culture planting materials.
What is it? (TIMP description)	<p>This is a management practice of producing pest and disease-free planting materials through paring and hot water treatment</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p><i>Paring and hot water treatment</i></p>
Justification	Banana is an important crop in Kenya used for food and income generation. In most regions, farmers rely on locally sourced planting materials, which are diseased and infested by pests. Additionally, in establishing and expanding banana plantation, most small holder farmers rely on locally sourced suckers and corms for planting. This technology is key in ensuring locally sourced

	planting materials are pest and disease free thereby promoting a healthy banana orchard.
Region promoted	Kisii, Nyamira, Homabay, Migori, Siaya,
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good security • Availability of clean water • Establishment of hardening nursery a region where bananas are grown • Timely availability of planting materials, • Training of trainers, • Favorable weather and provision of supplementary irrigation • Evidence for market demand
Partners/stakeholders for scaling up their roles and stage of involvement	<ul style="list-style-type: none"> • County government and private Extension service providers will train farmer groups and Nursery operators on Banana macro propagation technique either collectively or through farm-to-farm visits. They will also offer advice and collect information on the uptake and practice of the technique • Tissue culture laboratories/banana hardening nursery operators (e.g. JKUAT, Mimea, KALRO) – to provide initial clean planting materials. • Community farmer groups – to provide land for demonstration of banana sucker selection for increased production and enhance spread of knowledge through farmer-to-farmer training • NGOs such as World Vision, Africa Harvest – may provide/avail inputs to farmers such as at no cost or through affordable credit systems. • KALRO and researchers – to train trainers and provide technical backstopping on dissemination of banana varieties and related technologies. • Traders and processors – to provide market for ready bananas
C: Current situation and future scaling up	
Counties already promoted if any	Kisii, Nyamira, Homabay, Migori, Siaya, Busia

Counties where TIMP will be up-scaled	Banana growing counties in Kenya including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Understanding and acceptance of the technology by the farmers • Sustainable availability of healthy mother plants • High demand for clean suckers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitize and create awareness of the management practice through hands-on training and demonstrations among farmers and other users • Create sustainable supply network through establishment of mother blocks • Collaboration with county government in extension and private service providers to increase supply
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • This is a low-cost technology that promotes clean locally sourced planting material. • Farmers should not be completely discouraged from using planting materials sourced locally instead promote options of cleaning such material
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Banana is socially acceptable and any technology to increase its production will be readily adopted. • Awareness of the benefits/advantages/management of the technology to enhance acceptability for increased up take. • Policy options to support multiplication of clean (disease and pest-free) banana planting materials at community level • Existence of suitable bio-physical environments in target counties.
Basic costs	Purchase suckers at KES.20 per sucker
Estimated returns	Sale of clean suckers at KES.50 per sucker
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Gender inequalities in regard to access and control over resources such as land and household finances • Perceptions in regard to banana as a snack food • Women may not have time and mobility to attend extension activities far from home or held at times when they have other roles •
Gender related opportunities	<ul style="list-style-type: none"> • The management practice provides a solution to acquire clean planting material for different gender groups involved in banana production • The technology is acceptable and easy to upscale by males, females and the youth as it utilizes locally available material • It offers opportunities in enhancing food security with the rural households through orchard establishment and expansion.
VMG issues and concerns in development and dissemination	<ul style="list-style-type: none"> • Due to their social status VMGs are often excluded from decision making in development and dissemination • VMGs face the barrier of accessing information regarding this technology as they may not attend trainings and other dissemination platforms

VMG issues and concerns in adoption and scaling up	<ul style="list-style-type: none"> • VMGs may not have enough resources such as land and capital to utilize this technology effectively in expanding banana production.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action, capacity building and practical support to be provided • The management practice provides an income generation opportunity for VMGs in banana growing areas • Increased production will lead to increased consumption of nutritious bananas hence improved health of VMGs; • Changing consumer behavior leading to increased demand hence improved incomes for VMGs
E: Case studies/profiles of success stories	
Success stories	<p>The technology has been successfully piloted in Busia, Siaya, Kisii and Nyamira Counties.</p> <p>The protocol is available and has been practiced in West and East Africa.</p>
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 – Ready for upscaling
Application guidelines for users	<ul style="list-style-type: none"> • Njukwe, E., Tenkouano, A. et al. 2006. Training Manual Macro-Propagation of Banana and Plantain. IITA • Murphy, Kayode. Rapid multiplication of plantain and banana using macro propagation techniques. Dynamic Kay agro allied/IITA Ibadan
G: Contacts	
Contacts	<p>Director, KALRO Seeds E-mail: kalro.seeds@kalro.org;</p> <p>Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org;</p> <p>The Institute Director, HRI Thika; E-mail: director.hri@kalro.org</p>
Lead organization and scientists	<p>KALRO</p> <p>Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino</p>
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

GAPS

- Evaluate effectiveness in eliminating pests and pathogens

2.3 GOOD AGRICULTURAL PRACTICES (GAP) AND FOOD SAFETY MANAGEMENT SYSTEMS (FSMS)

2.3.1 Good Agricultural Practices (GAP)

2.3.1 TIMPs name	Good Agricultural Practices (GAP)
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Detection of food contaminants in fresh produce, including Banana, has been rampant. This results in declining food safety and quality, therefore frustrating sustainable farming of these crops for both food and income generation. These food contaminants also impact negatively on the environment, worker safety and health; consequently making it difficult to implement traceability, as most producers do not give accurate information on inputs and processes used during production, to avoid commercial losses and even prosecution
What is it? (TIMP description)	It is a systematic process of implementing a standardized production system globally designed to reassure consumers about how food is produced on the farm, pre-farm gate or on-farm standards (It is not about a specific crop production, but the process through which production takes). The four 'pillars' of GAP (economic viability, environmental sustainability, social acceptability and food safety and quality) are included in most private and public sector standards, but the scope which they cover varies widely. Commercialization of Banana on the domestic and future export level highly depends on compliance to these market standards
Justification	Most markets continue to impose more stringent measures (to ensure the safety of consumers) for those wishing to access the said markets. There is therefore need to arrest the rampant detection of food contaminants in Banana. Good Agricultural Practice(s) (GAP) is based on the principals of risk prevention, risk analysis, sustainable agriculture [by means of Integrated Pest Management (IPM) and Integrated Crop Management (ICM)] to continuously improve farming systems. GAP is of utmost importance in protecting consumer health by ensuring safety throughout the food chain. It needs to be enforced and transparent, not only from the table but also upstream to include suppliers (e.g. quality of fertilizers and plant protection products) and all the value chain players including providers of logistics and farm equipment
B: Assessment of dissemination and scaling up/out approaches	

Users of TIMP	All value chain players including researchers, producers, extension staff, agripreneurs, processors, consumers, transporters and market outlet operators including wholesale and retail chains, domestic markets and farm gate handlers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	Policy support from government particularly in the enforcement of KS1758 (a domestic scope standard that has been passed after undergoing public participation stage).
Partners/stakeholders for scaling up and their roles	Producer organizations (FPEAK, FPC, KFC, AGAK etc), NGO's, MoALD, Private extension providers, CoG, and other value chain players
C: Current situation and future scaling up	
Counties where already promoted, if any	Already promoted in Meru, Embu, Nyeri, Nyandarua, Muranga, Embu, Kirinyaga, Kisii, Uasin Gishu, Nakuru, Kericho, Bomet and other horticultural hot spots
Counties where TIMP will be upscaled	All counties in Kenya particularly where Banana is grown
Challenges in dissemination	<ul style="list-style-type: none"> • Lack/inadequate knowledge on the benefits GAPs • Lack of legislative mechanisms to support the GAP, in particular the domestic scope • The perception that GAP is oppressive rather than supportive
Recommendations for addressing the challenges	Continuous training of farmers, extension staff and other value chain players
Lessons learned in up scaling, if any	The low number of stakeholders aware of GAP
Social, environmental, policy and market conditions necessary	Supportive policy of national and county governments to promote adaption of GAP's.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Difficult to put monetary gains figures as most involves social and welfare issues in addition than markets lost due to non-compliance
Estimated returns	Benefits are mostly social welfare issues in addition to additional markets accessed

Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have less access to factors of production like land and credit • In most households, it is the men who make decision on what to do and how it is done • Women may not have time and mobility to attend trainings and other extension activities far from home or held at times when they are performing other domestic roles • Women have limited access to markets as they sometimes cannot travel to far markets due to their domestic roles • Women might not be aware of GAPs due to their low level of education and the social economic status
Gender related opportunities	<ul style="list-style-type: none"> • Agro-enterprise development by youth, females and males based on GAPs • There is need for all the stakeholders to be sensitized in GAPs to achieve good profits from their Banana products • Increased income as a result of using GAPs by the youth, females and males
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to GAPs as they are not given chances to participate in agricultural trainings and workshops • VMGs have less access to farmer organization • VMGs have less access to farm implements and other inputs necessary for implementing GAPs • VMGs have limited access credit to implement GAPs • VMGs have limited access to extension services and training on GAPs • Due to their social status VMGs are often excluded from decision making in development and dissemination of GAPs
VMG related opportunities	<ul style="list-style-type: none"> • Agro-enterprise development by VMGs based on GAPs • Increased income due to improved yield hence better market access as a result of implementing GAPs • Increased employment for VMGs and improved food security
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Smallholders in groups in the counties of Kirinyaga, Nyeri, Meru, Nakuru and other counties have been able to produce and export produce from horticultural crops that are certified after adopting and complying with GAP's.
Application guidelines for users	<ul style="list-style-type: none"> • Global GAP Version 6 (Global GAP Version 6 (Code Ref: IFA V5.2_Feb19/Edition Update Register Page: 45 of 45) - https://www.globalgap.org/content/.galleries/documents • KALRO-USAID Training and Extension Manual on Good Agricultural Practices (GAP) - Nov. 2017
F: Status of TIMP readiness (1. Ready for upselling; 2. Requires validation; 3. Requires further research	1 – Ready for up scaling
G: Contacts	

Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO: Nyaga A., Ndungu J., Gatambia E., Kambo C., Kuria, S Musyoki R. Wasilwa, L., Kirigua, V., Muriuki SJN.
Partner organizations and their roles	MoALD, AFA, FPEAK, FPC, PCPB, AAK, KEPHIS, County governments, NGOs, Universities

2.3.2 FSMS

2.3.2 TIMP Name	Food Safety Management System: Hazard Analysis Critical Control Points (HACCP) Plan for Banana Value Chain in Kenya
Category(i.e. technology, Innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem addressed	The presence of chemical, biological and physical hazards within the Banana value chain in Kenya have a direct effect on consumer's health. The biological contaminations previously reported on this value chain include presence of <i>Escherichia coli</i> (E. coli), <i>Salmonella</i> spp., <i>Aspergillus flavus</i> and <i>Aspergillus parasiticus</i> . The chemical hazards are mainly due to heavy metal presence such as lead/mercury/cadmium; while exceedance of MRLs have been reported. These hazards are suspected to cause neurological disorders, cancer and birth defects.
What is it? (TIMP description)	Food safety management system (FSMS) through Hazard Analysis and Critical Control Point (HACCP) in Banana value chain is a system of food safety monitoring and control based on the systematic identification and assessment of various hazards. It is a preventive, rather than a reactive, tool that places the protection of the banana supply from biological, chemical and physical hazards into the hands of food management systems. The system is designed to minimize the risk of food safety hazards by identifying the hazards, establishing controls and monitoring these controls.
Justification	There is increasing demand for high quality of the crop and other banana-related products, from consumers and public health departments in the country. The biological contaminations previously reported on this value chain include presence of <i>Escherichia coli</i> (E. coli), <i>Salmonella</i> spp., <i>Aspergillus flavus</i> and <i>Aspergillus parasiticus</i> . The chemical hazards are mainly due to heavy metal presence such as lead/mercury/cadmium, while exceedance of MRLs have been reported. These hazards are suspected to cause neurological disorders, cancer and birth defects.

	There is need to put in place risk analysis and hazard monitoring and management system to ensure that food contaminants are kept at bay along the Banana value chain. The presence of these contaminants not only poses serious risks to human health and trade. Tools like the HACCP are used globally and even adapted by Codex Alimentarius as a global acceptable Food Safety Management System (FSMS). This will set limitation values for monitoring so that action can be taken if the set point values of hazards are out of the defined range as required. Parameters will be quantified for production, harvesting, processing, distribution and value addition
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups , traders, extension service providers , agripreneurs, processors, tissue- culture nursery operators, food vendors, consumers, and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Formation of “experts” team comprising HACCP specialists, food scientists, microbiologists, representative of the banana (and other similar crops) value chain players, public health officers and a quality control and safety specialists from the competent authorities to guide the process • Local and National governments support • Implementation of policies guiding food quality at production and market/trade levels
Partners/stakeholders for scaling up and their respective roles.	<ul style="list-style-type: none"> • Research partners (KALRO, National Agricultural Research Institutes (NARIs) and International research organizations) – to provide research output and training on HACCP • Market players – to ensure implementation of FSMS • Farmers/farmer groups – to ensure food safety is adhered to at farm level • County governments, central governments e.g. Chiefs, Agricultural Extension (Formal and informal) – to develop policies and implementation frameworks, create awareness and enhance dissemination • NGOs – for farmer organizing and mobilization • National competent authorities • Analytical testing services – to provide services for testing food products


	<ul style="list-style-type: none"> Processors and local traders – to implement policy and safety standards
C: Current situation and future scaling up	
Counties where already promoted if any	<ul style="list-style-type: none"> Not yet promoted in any county of Kenya
Counties where TIMPs will be upscaled	<ul style="list-style-type: none"> All banana-growing counties in Kenya, including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in development and dissemination	<ul style="list-style-type: none"> Inadequate funds to reach value chain actors New concept not very well known among the primary stakeholders and market outlets
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Funding of dissemination platforms Training of all stakeholders on food safety
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> None since scaling up has not been done
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> Banana being regarded by stakeholders as a food and commercial crop that requires protection from contamination. Policies to guide and reward use of less toxic crop protection methods in handling crop health issues Establishment of practical and acceptable food handling protocols at both county and National levels
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	To be determined
Estimated returns	To be determined
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Women and youth might not be aware of the existing hazards, as well as their preventive measures and control Women and youth might not be aware of the impact identified hazards could have to their health Women and youth lack finances to ensure food safety of bananas at their level of operation
Gender related opportunities	<ul style="list-style-type: none"> In harvesting and processing Banana to meet the acceptable national standards, women and youth play critical roles. Capacity building of women and youth in the identification of food safety hazards/risks and the control measures along Banana value chain Opportunities exist for women and youth in the marketing and use of Banana and its by-products as an entrepreneurship.

VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to production resources such as land, knowledge, information, extension training, and credit and quality seed. • VMGs have limited participation in decision making at community and County level • Require strategies that target the VMG during scaling up of the Banana value chain.
VMG related opportunities	<ul style="list-style-type: none"> • Identification of critical limits to be defined • Capacity building of VMGs in the identification of food safety hazards/risks and the control measures along Banana value chain • Implementing HACCPs will improve health for VMGs through production and consumption of bananas • HACCPs are important for sustainable environmental management hence an advantage to marginalized groups • Criteria for compliance already clearly defined for adoption
○ E: Case studies/profiles of success stories	
Success stories	N/A
Application guidelines for users	<ul style="list-style-type: none"> • HACCP general guidelines - https://www.fao.org/fao-who-codexalimentarius/codex-texts/codes-of-practice/en/ • General principles of food hygiene - https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%25253A%25252F%25252Fworkspace.fao.org
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1 – Ready for up scaling;
○ G: Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Njoro Email: kalro.njoro@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organization and scientists	KALRO John N. Ndung'u, Antony Nyaga, Francis Wayua, Lusike Wasilwa, Violet Kirigua, Beatrice Wanjiku,
Partner organizations	MoALD, AFA, FPEAK, PCPB, AAK, KEPHIS, KEBS, County governments, NGOs and Universities.

2.4 BANANA AGRONOMIC PRACTICES

2.4.1 Site selection

2.4.1 TIMP Name	Site Selection
Category (i.e. technology, innovation or management practice)	Management Practice

A: Description of the technology, innovation or management practice	
Problem to be addressed	Low yields, high costs or inability to manage banana stand due to poor identification of suitable areas for growing Banana
What is it? (TIMP description)	<p>The suitable areas for Banana growing ranges from 0 - 1,800m above sea level, with an annual rainfall range of 1,000-2,000 mm. These areas must be frost free, with an optimum temperature of 20 - 30°C. The soils must be well drained and rich in organic matter (100 cm depth). The optimum Soil pH range is 6.0 – 7.5. The slope of the land should not exceed 20 degrees (if exceeded, soil conservation measures are required)</p> 
Justification	Banana varieties are specific to agro-ecological zones where they are suitable. Growing a variety in the wrong zone results in poor yields, quality and wastage of resources.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers at national and county levels, and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Availability and accessibility of clean (pest and disease-free) seedlings

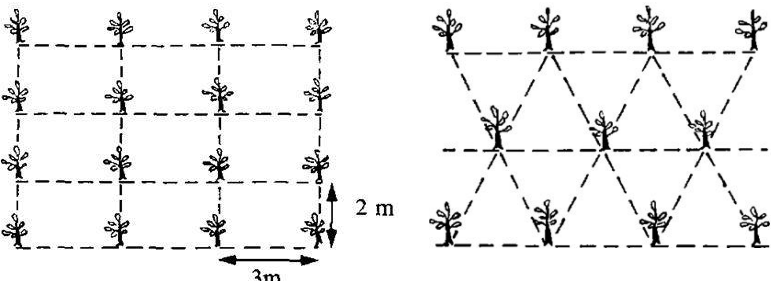
	<ul style="list-style-type: none"> • Good seed system to ensure quality the market demands • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • National government – for promotion, policy formulation and implementation, and allocation of funds • County governments – for funding & promoting the crop and management practices • Researchers – For R&D and training • NGOs – to conduct training & provide funding • CBOs, lead farmers and farmer groups – to implement the recommendations • Public and private extension service providers – to provide training
C: Current situation and future scaling up	
Counties where already promoted if any	Adopted by some farmers in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be upscaled	All counties suitable for banana production including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of adequate quality/clean seedlings • Lack of correct agronomic knowledge by producers • Unavailability of sufficient amount of water for irrigation where required • Lack strong farmers grower organizations & CBO's
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establishment of additional hardening and seedling nurseries • Sensitization on importance planting healthy and vigor seedlings • Digging of bore holes and capacity building on water harvesting techniques for banana production • Regular training of producers •
Lessons learned in up scaling	<ul style="list-style-type: none"> • Growing Banana in the recommended agro-ecological zones enhances both productivity and quality and manages the cost of production
Social, environmental, policy and market conditions necessary for development and up scaling	Sensitization of all stakeholders to ensure production and marketing of demand driven varieties in the appropriate zones. This management practice will enable growing of Banana in the appropriate zones thereby conserving the environment and ensuring maximum profitability

D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	None
Estimated returns	KES 500,000 per acre. Returns =KES 380,000 with good management practices
Gender issues and concerns in development dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth have limited access to information on banana site selection . • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure . • Women have less access to agricultural information, technology and knowledge. • Women have limited access to education, training and extension services. • In some communities, banana is regarded as a woman's crop but after it has gained a commercial value, men have taken over the enterprise
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for banana cultivation • VMGs have less access to agricultural information, technology and knowledge on banana site selection. • VMGs may have limited access to finances to buy the required inputs for banana production through the region is suitable for production of the crop • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Increased production due to good site selection will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	<ul style="list-style-type: none"> • Banana site selection has been used in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia, Taita Taveta and most other counties growing banana. However, uptake is not widespread even within the counties
Application guidelines for users	<ul style="list-style-type: none"> • Production Manuals • Brochures • Banana Production (Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS) – MoALD, JICA

F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1 - Ready for up scaling
G: Contacts	
Contacts	Director, KALRO Seeds E-mail: kalro.seeds@kalro.org ; Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org ; The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organizations and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.4.2 Orchard Establishment

2.4.2 TIMP Name	Orchard Establishment
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low yields due to poorly established banana orchard and use of inappropriate land preparation practices
What is it? (TIMP description)	<p>Knowledge on orchard establishment entails right timing and practices for land preparation, using of right spacing (whether using square, rectangular or triangular plan), ensuring proper drainage as well as the right input management strategies.</p> <p>The initial land preparation is done during the dry season by either ploughing, harrowing, use of herbicides or methods stipulated in conservation agriculture.</p> <p>Before planting, deep soil cultivation by ploughing & harrowing is recommended. The field should be free of trees, bushes and especially perennial weeds.</p> <p>A planting hole measuring 60 cm x 60 cm x 60 cm is recommended although this may vary depending on water availability. In dry & semi-arid areas, it is recommended to use holes measuring 90 cm x 90 cm x 90 cm.</p> <p>Bananas cannot withstand stagnant water hence soil should have good drainage</p> <p>The spacing used depends on the variety. For Short Varieties, a spacing of 3 m x 3 m (444 plants/acre) is recommended, medium</p>

	<p>varieties: 3 m x 4 m (333 plants/acre) and for tall varieties, use 4 m x 4 m (250 plants/acre). During hole preparation, the top and sub soils are separated. Manure (at least 2 debes, approximately 40kgs) is mixed with the top soil and then filled back into the hole. Erosion prevention measures must be put in place at this land preparation stage</p>  <p><i>Different spacing Plans in Bananas</i></p>
Justification	<p>Improper land preparation and orchard establishment leads to poorly established crop as the crop has a poorly established root system, competition and inadequate nutrients hence the need have well tilled land, proper planting holes and correct nutrient regime during initial establishment.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers (county and national level) and researchers</p>
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Certified Seedlings availability and accessibility • Good seed system to ensure quality linked to market preference • Well organized farmer groups and networks • County and central government support •

Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • National government – for promotion, policy formulation and implementation, and allocation of funds • County governments – for funding & promoting the crop and management practices • Researchers – For R&D and training • NGOs – to conduct training & provide funding • CBOs, lead farmers and farmer groups – to implement the recommendations • Public and private extension service providers – to provide training
C: Current situation and future scaling up	
Counties where already promoted if any	Adopted by some farmers in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be up scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of adequate quality seedlings • Limited land size for establishment of a good banana stand • Lack of correct agronomic knowledge by producers • Unavailability of sufficient amount of water for irrigation where required • Lack strong farmers grower organizations & CBO's
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on importance planting healthy and vigor seedlings • Guidance on banana economic unit • Establishment of additional hardening and seedling nurseries • Digging of bore holes and capacity building on water harvesting techniques and utilization for banana production • Regular training of producers
Lessons learned in up scaling	<ul style="list-style-type: none"> • Growing Banana in the recommended agro-ecological zones enhances both productivity and quality
Social, environmental, policy and market conditions necessary for development and up scaling	Sensitization of all stakeholders to ensure production and marketing of demand driven varieties in the appropriate zones. This management practice will enable growing of Banana in the appropriate zones thereby conserving the environment and ensuring maximum profitability
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 120,000 per acre in orchard establishment
Estimated returns	KES 500,000 per acre. Returns =KES 380,000
Gender issues and concerns in development dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth have limited access to land and labour required for establishment of banana orchard .

	<ul style="list-style-type: none"> • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure. • Women have less access to agricultural information, technology and knowledge. • Women have limited access to education, training and extension services.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Opportunities for youth to provide services and training relating to establishment of banana orchard
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for establishment of a banana orchard cultivation . • VMGs have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs such as quality planting materials and manure. • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Applying knowledge on orchard establishment will provide increased income for the VMGs • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Banana orchard establishment has been adopted in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii , Kericho, Bungoma, Busia and Taita Taveta
Application guidelines for users	<ul style="list-style-type: none"> • Production Manuals • Brochures • Banana Production (Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS) – MoALD, JICA
F: Status of TIMP readiness (1-ready for upscaling; 2- requires validation; 3-requires further research)	1 – Ready for up scaling
G: Contacts	
Contacts	<ol style="list-style-type: none"> 1. Director, KALRO Seeds E-mail: kalro.seeds@kalro.org; 2. Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org; 3. The Institute Director, HRI Thika; E-mail: director.hri@kalro.org

Lead organizations and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.4.,3 Banana de-suckering

2.4.3 TIMP Name	Banana De suckering
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Unwanted suckers compete for light, water and nutrients reducing yields. .
What is it? (TIMP description)	<p>De-suckering is the removal of unwanted suckers from a banana mat. The process should start 2 months after planting and should be repeated every 45 days till the plant flowers.</p> <p>At any one time a maximum of five suckers per mat (at different stages) are allowed for big bunches and high yields. The undesired sucker is cut down and a small cavity gorged out in the centre using a knife. 2 ml Paraffin is then poured into this cavity (which is assimilated downwards, killing the meristem and preventing re-growth)</p> <div> </div> <div> </div>
Justification	Banana being a perennial crop with a bearing life of more than 10 years requires proper spacing within the mat to avoid competition of nutrients and light. Too many suckers result in small unhealthy bunches. Unnecessary suckers must be removed regularly and timely before they become too large and unmanageable
B: Assessment of dissemination and scaling up/out approaches	


Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers at county and national level and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Certified Seedlings availability and accessibility • Good seed system to ensure quality linked to market preference • Well organized farmer groups and networks • County and central government support •
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • National government – for promotion, policy formulation and implementation, and allocation of funds • County governments – for funding & promoting the crop and management practices • Researchers – For R&D and training • NGOs – to conduct training & provide funding • CBOs, lead farmers and farmer groups – to implement the recommendations • Public and private extension service providers – to provide training
C: Current situation and future scaling up	
Counties where already promoted if any	Adopted by some farmers in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii , Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be upscaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga and Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of adequate quality seedlings • Lack of correct agronomic knowledge by producers • Unavailability of sufficient amount of water for irrigation where required • Limited labour available for timely de-suckering • Lack strong farmers grower organizations & CBO's

Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on importance planting healthy and vigor seedlings • Establishment of additional hardening and seedling nurseries • Regular training of producers • Digging of bore holes
Lessons learned in up scaling	<ul style="list-style-type: none"> • Growing Banana in the recommended agro-ecological zones enhances both productivity and quality
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Sensitization of all stakeholders to ensure production and marketing of demand driven varieties in the appropriate zones. • This management practice will enable growing of Banana in the appropriate zones thereby conserving the environment and ensuring maximum profitability • Market demand for good quality banana bunches will contribute to increased adoption of the management practice
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Labour cost for de-suckering
Estimated returns	KES.500,000 per acre. Returns =KES 380,000 with good management practices
Gender issues and concerns in development dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth have limited access to labour required for establishment timely desuckering. • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure. • Women have less access to agricultural information, technology and knowledge. • Women have limited access to education, training and extension services.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Opportunities for youth to provide services and training relating to timely desuckering
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to knowledge and required labour for timely desuckering. • VMGs have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs such as quality planting materials and manure. • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Applying knowledge on desuckering will provide increased income for the VMGs • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.

• E: Case studies/profiles of success stories	
Success stories from previous similar projects	Banana desuckering has been adopted in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia, Taita Taveta and other Banana Growing counties of Kenya
Application guidelines for users	<ul style="list-style-type: none"> • Production Manuals • Brochures • Banana Production (Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS) – MoA JICA
F: Status of TIMP readiness (1-ready for upscaling; 2- requires validation; 3-requires further research)	1 - Ready for up scaling
G: Contacts	
Contacts	<ol style="list-style-type: none"> 1. Director, KALRO Seeds E-mail: kalro.seeds@kalro.org; 2. Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org; 3. The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organizations and scientists	<p>KALRO</p> <p>Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino</p>
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.4.5 Banana propping

2.4.5 TIMP Name	Banana Propping
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lodging of bearing banana plants due to large bunches or weak and tall pseudostems resulting in reduced income
What is it? (TIMP description)	Propping is a way of supporting heavy bunches to prevent plant lodging. Large banana bunches cause the pseudo-stem to bend over and become weak. Pseudo-stems bearing heavy bunches of bananas should therefore be propped up and staked with forked poles or string tied to a strong peg to avoid lodging.


	
Justification	There is need to support banana plants mainly from tall and medium varieties bearing heavy bunches, particularly in areas with strong winds, to prevent lodging and therefore resulting to losses from such breaking. Falling over of pseudo stem results in total bunch loss of immature bunches.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers (county and national level) and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Certified Seedlings availability and accessibility • Good seed system to ensure quality linked to market preference • Well organized farmer groups and networks • County and central government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County governments – for funding & promoting the crop and management practices • Researchers – For R&D and training • NGOs – to conduct training & provide funding • CBOs, lead farmers and farmer groups – to implement the recommendations

	<ul style="list-style-type: none"> Public and private extension service providers – to provide training
C: Current situation and future scaling up	
Counties where already promoted if any	Adopted by some farmers in Muranga, Tharaka Nithi, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kirinyaga, Kisii, Nyamira, Bomet, Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be up scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga and Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> Lack of correct agronomic knowledge by producers Limited sources of propping wood particularly due to the conflict of the need to conserve trees High costs of the props
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Sensitization on importance of using props to reduce production losses Use of other alternative pseudo stem support mechanisms such as strings and ropes Use of dwarfing varieties that are less prone to lodging
Lessons learned in up scaling	<ul style="list-style-type: none"> Growing banana in the recommended agro-ecological zones enhances both productivity and quality
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> Sensitization of all stakeholders to ensure production and marketing of demand driven varieties in the appropriate zones. Market demand for good quality banana bunches will contribute to increased adoption of the management practice
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Cost of labour for propping and cost of purchasing the prop
Estimated returns	Savings of
Gender issues and concerns in development dissemination, adoption and scaling up	<ul style="list-style-type: none"> Women and youth have limited access to land for banana cultivation. Women and youth have limited access to labour required for timely propping Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure. Women have less access to agricultural information, technology and knowledge. Women have limited access to education, training and extension services.
Gender related opportunities	<ul style="list-style-type: none"> Affirmative action opportunities exist for women and youths to acquire the required credit

	<ul style="list-style-type: none"> • Opportunities for youth to provide services and training relating to timely propping
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to knowledge and required labour for timely propping and its associated benefits. • VMGs have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs such as quality planting materials and manure. • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Applying knowledge on timely propping will provide healthier crop and increased income for the VMGs • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Banana orchard establishment has been adopted in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia and Taita Taveta
Application guidelines for users	<ol style="list-style-type: none"> 1. Production Manuals 2. Brochures 3. Banana Production (Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS) – MoA JICA
F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1 – Ready for up scaling
G: Contacts	
Contacts	<ol style="list-style-type: none"> 1. Director, KALRO Seeds E-mail: kalro.seeds@kalro.org; 2. Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org; 3. The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organizations and scientists	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,
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2.4.5 Pruning of old dried leaves

2.4.5 TIMP Name	Pruning of Old dried leaves
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Reduced productivity due to low light penetration in the orchard leading to increased incidences of certain leaf diseases and increased bunch injury caused to banana by the dry leaves during windy periods
What is it? (TIMP description)	<p>Leaves are the place where photosynthesis or food manufacture takes place. De-leafing or removal of some leaves is an important operation in banana orchard management but should be done only to remove old, hanging, dried and diseased leaves from the plant, to allow for light penetration for good growth. Green leaves should not be removed as this will reduce the photosynthetic area and final bunch weight.</p> <p>Leaves with sigatoka disease should be removed to slow fungal growth. The diseased leaves are removed regularly and burned to reduce the pathogen burden on the plant.</p> 
Justification	The need to increase light penetration in banana orchards so as to check on the reduced photosynthetic capacity of the plant and reduce diseases build up and to reduce physical injuries on the bunches
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers (county and national level) and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business Schools (FFBS) Demonstrations – On-farm and on-station

	<ul style="list-style-type: none"> • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Certified Seedlings availability and accessibility • Good seed system to ensure quality the market demands • Well organized farmer groups and networks • County and national government support
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • National government – for promotion, policy formulation and implementation, and allocation of funds • County governments – for funding & promoting the crop and management practices • Researchers – For R&D and training • NGOs – to conduct training • CBOs, lead farmers and farmer groups – to implement the recommendations • Public and private extension service providers – to provide training
C: Current situation and future scaling up	
Counties where already promoted if any	Adopted by some farmers in Muranga, Tharaka Nithi, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kirinyaga, Kisii, Nyamira, Bomet, Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be upscaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of correct agronomic knowledge by producers • Lack of access to and affordability of correct tools for pruning
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on importance of pruning banana plants and correct leaf selection • Management of diseases to avoid unnecessary green leaf removal

Lessons learned in up scaling	<ul style="list-style-type: none"> • Farmers use green banana leaves as animal fodder hence leading to reduced foliage on banana plants • Need for demonstrations where producers learn
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Sensitization of all stakeholders to ensure production and marketing of demand driven varieties in the appropriate zones. • Market demand for good quality banana bunches will contribute to increased adoption of the management practice
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Labour cost of pruning; one time cost of the pruning tools
Estimated returns	At least 10% of revenue of KES.500,000 per acre is lost due to lack of proper pruning. With proper and timely pruning, the farmers are able to save KES.50,000.
Gender issues and concerns in development dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth have limited access to land for banana cultivation. • Women and youth have limited access to labour required for timely pruning • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials, pruning implements and manure. • Women have less access to agricultural information, technology and knowledge. • Women have limited access to education, training and extension services.
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Opportunities for youth to provide services and training relating to timely pruning
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to knowledge and required labour for timely pruning. • VMGs have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs such as quality planting materials, pruning implements and manure. • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Applying knowledge on timely pruning will provide healthier crop and increased income for the VMGs

	<ul style="list-style-type: none"> Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Banana orchard establishment has been adopted in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia and Taita Taveta
Application guidelines for users	<ol style="list-style-type: none"> 1. Production Manuals 2. Brochures 3. Banana Production (Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS) – MoA JICA
F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1 - Ready for up scaling
G: Contacts	
Contacts	<ol style="list-style-type: none"> 1. Director, KALRO Seeds E-mail: kalro.seeds@kalro.org; 2. Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org; 3. The Institute Director, HRI Thika; E-mail: director.hri@kalro.org
Lead organizations and scientists	<p>KALRO</p> <p>Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino</p>
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.4.6 Male bud removal

2.4.6 TIMP Name	Male Bud Removal
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Reduced productivity due to increased presence of diseases and pests in the male bud when retained after full bunch differentiation
What is it? (TIMP description)	<p>Male bud is the part of the inflorescence which consists of the male flowers only, also referred to as the heart or navel. The practice involves removal of the male bud after all the female flowers are open; approximately 2 weeks after shooting.</p> <p>The use of a forked stick to remove male buds is recommended</p>

	<p>to avoid spread of BXW and Panama diseases. This is because the stick only touches the male bud that falls off during the removal.</p> <div> </div> <div> </div> <div> <p><i>Male bud</i></p> </div> <div> <p><i>Male bud removal</i></p> </div>
Justification	<p>The removal of male bud results in early bunch filling. In areas where BXW disease is present, removal of the male buds used to manage this disease since bees no longer visit the male flowers for nectar hence cannot spread the bacteria. The advantages of male bud removal include the increase in both length and circumference of the fruit; increased weight of bunches up to 7.5%; reduced attack by banana thrips which attack the fruit and cause unsightly brown freckling on fruits; reduction in the days to harvesting period. In addition, bunches with removed male bud are heavier by 3kgs, and the method is useful in managing Banana Xanthomonas Wilt (BXW) disease</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers (county and national level) and researchers</p>
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business Schools (FFBS) • Demonstrations – On-farm and on-station • Trainings – Workshops, Seminars, Meetings • Extension – Public and private • Farmer to farmer extension models • Mass media – Electronic and print • Publications and promotional material – Posters, brochures, leaflets, manuals etc. • Agricultural shows, field days, exhibitions • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms – Website, dashboards, Apps, social media short message services • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good Marketing Models and pathways • Certified Seedlings availability and accessibility • Good seed system to ensure quality linked to market preference • Well organized farmer groups and networks

Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County and central government support • County governments – for funding & promoting the crop and management practices • Researchers – For R&D and training • NGOs – to conduct training & provide funding • CBOs, lead farmers and farmer groups – to implement the recommendations • Public and private extension service providers – to provide training
C: Current situation and future scaling up	
Counties where already promoted if any	Adopted by some farmers in Muranga, Tharaka Nithi, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kirinyaga, Kisii, Nyamira, Bomet, Kericho, Bungoma, Busia and Taita Taveta
Counties where TIMP will be up scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga and Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of correct agronomic knowledge by producers • Lack of access to correct tools for bud removal
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on importance of bud removal on bearing banana plants • Training on correct stage of bud removal
Lessons learned in up scaling	<ul style="list-style-type: none"> • There are communities that use the male bud as food and hence encourages the removal of the bud • Need for demonstrations where producers learn
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Sensitization of all stakeholders to ensure production and marketing of demand driven varieties in the appropriate zones. • This management practice will enable management of BXW thereby conserving the environment and ensuring maximum profitability
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Labour cost for removing male bud
Estimated returns	Reduced losses from disease infestation as well as increased income from larger banana bunches
Gender issues and concerns in development dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth have limited access to land for banana cultivation. • Women and youth have limited access to labour required for timely male bud removal • Women and youth may also have limited access to finances to buy the required inputs such as quality planting materials and manure. • Women have less access to agricultural information, technology and knowledge. • Women have limited access to education, training and extension services.

Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Use of male bud for food would encourage timely removal • Opportunities for youth to provide services and training relating to timely male bud removal
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to knowledge and required labour for timely removal of male bud and its associated benefits. • VMGs have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs such as quality planting materials, pruning implements and manure. • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by the VMGs due to lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit. • Applying knowledge on timely male bud removal will provide healthier crop and increased income for the VMGs • Increased production will lead to increased consumption and utilization of bananas and hence improved health of VMGs.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	<ul style="list-style-type: none"> • Banana male bud removal has been adopted in Muranga, Kiambu, Nyeri, Nyandarua, Embu, Meru, Machakos, Bungoma, Kisii, Kericho, Bungoma, Busia and Taita Taveta
Application guidelines for users	<ul style="list-style-type: none"> • Production Manuals • Brochures • Banana Production (Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS) – MoA JICA
F: Status of TIMP readiness (1-ready for upscaling; 2-requires validation; 3-requires further research)	1 – Ready for upscaling
G: Contacts	
Contacts	<ul style="list-style-type: none"> • Director, KALRO Seeds E-mail: kalro.seeds@kalro.org; • Centre Director, FCRC Kisii Email: kalro.kisii@kalro.org; • The Institute Director, HRI Thika; E-mail: director.hri@kalro.org

Lead organizations and scientists	KALRO Antony Nyaga, Robert Musyoki, Charity Gathambiri, Eliud Gatambia, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare, Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi and Willis Owino
Partner organizations	Ministry of Agriculture and Livestock Development (MoALD) and County Governments, Africa Harvest, World Vision,

2.5 SOIL FERTILITY MANAGEMENT AND WATER CONSERVATION

2.5.1 Integrated Soil Fertility Management

2.5.1. TIMP name	Integrated Soil Fertility Management (ISFM)
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity due to declining soil fertility, low organic matter, poor soil structure and limited available moisture in banana production.
What is it? (TIMP description)	These are a set of soil fertility management practices that include the use of fertilizers, locally available organic inputs and improved seed and good agronomic practices to adapt to local conditions. ISFM places emphasis on the importance of using often scarce resources like fertilizer and organic inputs in small doses through techniques such as fertilizer banding (field application of fertilizer directly in area of root-zone to increase the potential for uptake) and micro dosing (applying small quantities of fertilizer with the seed at planting time and a few weeks after emergence)
Justification	Soils within the farming system are heterogeneous due to spatial variability in soil fertility. These inherent differences arise from the parent material from which the soil has evolved, and the position in the landscape that influences how soil develops. A large proportion of soils in the NAVCDP target project counties are derived from some of the oldest land surfaces which, due to weathering and cropping, have low soil nutrients. Where younger, volcanic soils occur these are inherently richer in nutrients, but may have other soil fertility problems such as acidity and fixation of some critical nutrients such as phosphorus. Past management of the soil has a major influence on soil fertility which in turn influences productivity. These challenges call for an integrated soil fertility management (ISFM) approach that combines appropriate interventions on soil management that include fertilizer use and crop agronomy. The aim

	of ISFM is therefore to optimize agronomic use efficiency of the applied nutrients for improved crop productivity.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of affordable and quality manure, fertilizers and clean planting materials • Take into account variability between farms, in terms of farming goals and objectives, size, labour availability, ownership of livestock, importance of off-farm income; • Availability of clean/certified seed • Availability of novel crop protection practices, and • Take into account amount of production resources (i.e. land, money, labour, crop residues) that different farming families are able to invest in
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County government extension services - Provide linkage with farmers. • Community farmer groups - play coordination role for ease in problem identification and dissemination.
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Kisii, Busia, Tharaka Nithi Siaya, Kisumu, Kakamega, Tharaka Nithi, Isiolo, Nyeri, Uasin Gishu, Elgeyo Marakwet, Nyamira, Migori, Embu, Meru, Muranga, Kiambu, Nyeri and Siaya. Bomet, Kericho, Kericho.
Current extent of reach	A few counties have now adopted ISFM
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga and Tharaka Nithi

Challenges in dissemination	<ul style="list-style-type: none"> • Change of mindset in some regions/cultures that organic manures cannot be applied on crops • Lack of guidelines on how to combine manures/organic materials with modest amounts of mineral fertilizers. • Misconceptions that chemical fertilizer damage the soils.
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness trainings on role of organic manures in crop cultivation • Training and awareness creation on the usefulness of fertilizer applications to clear the misconceptions about fertilizers
Lessons learned if any	For ISFM to succeed, good germplasm/seed/seedlings, etc is required since farmers tend to re-use previous planted materials. Knowledge of how to combine organic and inorganic fertilizers is required.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Practice is socially acceptable, • Environmentally friendly, • Increased productivity will provide supply to the markets, • Supporting frameworks/policies are available
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	This is a technically demanding technology and high cost are incurred in acquisition of inputs.
Estimated returns	Farmers who have adopted ISFM technologies have more than doubled their agricultural productivity and increased their farm-level incomes by 20 to 50 percent
Gender issues and concerns in development and dissemination	<ul style="list-style-type: none"> • It is labour intensive hence may not be adopted by women who are already overburdened. s • Women and youth have limited access to credit to purchase the required inputs such as such as fertilizers than men. • Women and youth have limited access to land for bananas cultivation • Women have less access to agricultural information, technology and knowledge.
Gender related opportunities	<ul style="list-style-type: none"> • Opportunity exist for women to access the required credit through the women enterprise funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • It is labour intensive hence may not be adopted by VMGs. • VMGs have limited access to credit to purchase the required inputs such as such as fertilizers • VMGs have limited access to land for dry banana cultivation • VMGs have less access to agricultural information, technology and knowledge
VMG related opportunities	<ul style="list-style-type: none"> • Opportunity exist for VMGs to access the required credit through the affirmative action.
E: Case studies/profiles of success stories	
Success stories	ISFM successes have been reported in maize in central and western Kenya highlands. In Machakos farmers have reported high yields of sorghum and millet after adapting ISFM practices.
Application guidelines for users	<ul style="list-style-type: none"> • Always use well-adapted, disease- and pest-resistant germplasm/seed to make efficient use of available nutrients. • Ensure that good agronomic practices are upheld

	<ul style="list-style-type: none"> • Combined use of inorganic and organic fertilizers is recommended. • Adapt the practice to local conditions
F: Status of TIMP readiness (1-Ready for up scaling; 2-Requires validation; 3-Requires further research)	2 - Requires validation
G: Contacts	
Contacts	1. Centre Director, KALRO Kabete P.O. Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org
Lead organization and scientists	KALRO: E. Gikonyo, C. Kibunja, A. Muriuki, D. Kamau, A. Esilaba, J. Ndufa and S. Kimani

GAPS

1. Validation of the ISFM technology in Counties where technology has not been tested.
2. Testing (fertilizer types, rates, frequencies) and combination with manures for different value chains

2.5.2 Low-Cost Composting technology

2.5.2. TIMP name	Low-Cost Composting technology
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to low soil fertility. Organic wastes constitute the highest percentage of waste flow in Kenya leading to big landfills especially near the urban centres. However, there is low awareness on appropriate low cost composting technologies and lack of supporting policies. Moreover, lack of proper composting management and handling leads to increased GHG emissions.
What is it? (TIMP description)	Composting is the biological decomposition of organic waste such as food or plant material by bacteria, fungi, worms and other organisms under controlled aerobic conditions resulting in an accumulation of partially decayed organic matter called humus. Composting is thus one of the most effective process for recycling organic wastes intended for use in agriculture.
Justification	The decline in soil fertility in smallholder system is a major factor inhibiting agricultural development on farms. It is estimated that soils are depleted at annual rate of 22kg/ha for nitrogen, 2.5kg/ha for phosphorous, and 15kg/ha for potassium. Compost contain the nutrients nitrogen, phosphorus and potassium and that are found in most chemical fertilizer and even secondary and trace elements (such as zinc, iron and

	magnesium) that are not, and which are useful to the roots of growing plants. The compost also adds balanced nutrients to soil in an easily assimilated form, and helps improving soil structure by lightening heavy clays and improving water retention properties in porous sands
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings – workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Training on banana nutrition, management and use of manure • Dissemination approach used to reach target farmers • Model demonstration plots using several crops
Partners/stakeholders for scaling up and their roles	Ministry of Agriculture, Livestock, Fisheries & Irrigation (MoALD)-National and County level -extension services CIGs (Common Interest Groups)- co-ordination roles and back stopping at grass root levels NGOs (Non-governmental organizations)-promotion, micro financing etc.
C: Current situation and future scaling up	
Counties where already promoted if any	Tharaka Nithi, Kajiado, Nyeri, Bomet, Uasin Gishu, Kakamega, Busia, Machakos
Current extent of reach	Though small scale farmers in the Counties do composting on their farms, they do not optimize on usage.
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of model demonstration farms • Cultural challenges -Lack of interest in manure management by pastoral communities • Lack of continuity in training of extension and farmers in the skill for manure management • Lack of proper mobilization mechanism for reaching many farmers

Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establishment of many demonstration plots by counties • Capacity building of pastoral communities on manure management and its benefit • Continuous capacity building of demonstration farmers and extension workers • Use of approaches to mobilize farmer to attend demonstration forums
Lessons learned if any	<ul style="list-style-type: none"> • Proper use of manures improves soil fertility • Use of composts enhances crop productivity • Skills in composting, storage and application
Social, environmental, policy and market conditions necessary	<p>Composting requires care when handling wastes that would normally contain heavy loads of pathogens and aim at removing non-biodegradable and hazardous waste and controlling odours and flies. Also compost pits if not well managed can also be a source of contamination through leaching of nutrients.</p> <p>Generally, composting saves on purchase of inorganic fertilizer, increases crop yield and saves water when used on the farm and therefore the technology is socially and environmentally acceptable</p>
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Preparation of composts require labour for building a compost heap, maintaining it and finally transporting and applying it field which take a lot of effort and time
Estimated returns	Returns dependent on crop and crop varieties in the value chain where composting is practised
Gender issues and concerns in development ,dissemination, adoption and scaling up	<ul style="list-style-type: none"> • It is labour intensive hence may not be adopted by women who are already overburdened. • Women and youth have limited access to credit to purchase the required inputs such as such as fertilizers • Women and youth have limited access to land for banana cultivation. • Women have less access to agricultural information, technology and knowledge.
Gender related opportunities	<ul style="list-style-type: none"> • Opportunity exist for women to access the required credit through the women enterprise funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge. • It is labour intensive hence may not be adopted by some VMGs who are elderly. • Women and youth have limited access to to credit to purchase the required inputs such as such as fertilizers.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action in various areas as for instance in the provision of finances to VMGs.
E: Case studies/profiles of success stories	
Success stories	Farmers who use composts in quickly maturing crops have reported 3 to 5 times increased production due to improved soil health and betterincome

Application guidelines for users	<p>The guidelines for users focus on the following areas:-</p> <ul style="list-style-type: none"> • Need to mix the compost with the soil to ensure adequate nutrition in the rooting zone. • Compost storage to preserve nutrient and avoid losses. • Timing of application for maximum utilization by the crop. • Regular analysis of compost to ascertain the quality including contaminants like heavy metals and pathogens. • Type of composts and quality that will determine the application rates. • Materials that cannot be used for composts include, charcoal ash, dog/cat manure, meat/animal fat, leaves or biomass from certain tree species that have toxic compound levels for microbes, e.g. eucalyptus and cassia spp.
F: Status of TIMP readiness (1-Ready for up scaling; 2-Requires validation; 3-Requires further research)	2 - Requires validation
G: Contacts	
Contacts	<p>Director, Environment & Natural Resource Systems KALRO Headquarters P.O. Box 57811-00200 +254 722 206986/8, Ext 2316</p>
Lead organization and scientists	<p>KALRO S. Kimani, B. Mugo, E. Mutuma, D. Kamau, M. Okoti, J. Wamuongo, A.O. Esilaba</p>

GAPS

1. Promote composting technology in counties that have not practised it.
2. Conduct nutrient budget study on selected farms using composts in the 24 Counties
3. Efficiency of composting types available to farmers

2.5.3 Rapid Soil Testing Services

2.5.3. TIMP name	Rapid Soil Testing Services
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	<p>Low banana productivity due to inadequate fertilizer recommendations. Conventional methods for soil testing are expensive for farmers, results take long and are not reproducible.</p> <p>Further, conventional methods have not provided solutions for paired soil and leaf testing to determine health of soil and crop simultaneously.</p>

	<p>Current methods do not provide a framework for large scale assessment of geo-referenced sampled points using standardized protocols.</p> <p>Limited access to soil testing services (centralized soil testing laboratories and cost).</p>
What is it? (TIMP description)	<p>This is a dry spectral method for soil testing using the interaction of electromagnetic radiation with matter to characterize biochemical composition of a soil and/or plant tissue. It does not require the routine laboratory analysis using chemicals.</p> <p>When a sample is run through a scanner, soil testing results are generated with accompanying recommendations instantly.</p> <p>However, the method requires partners involved (ICRAF, iSDA and SoilCares) to work closely with KALRO and county agricultural officers to sensitize farmers to embrace the testing method.</p> <p>This innovation will involve working closely with agronomists to generate specific fertilizer recommendation driven by soil and crop data obtained.</p>
Justification	<p>Soil testing is the basis for good fertilizer management that maintains the productivity of soil and improves the quality of crops. It promotes more efficient fertilizer use and prevents environmental pollution from excess fertilizer application, and cost efficiency. However, limited access to soil testing services is depriving the farmers' ability to make informed decisions with regard to soil management and fertilizer use.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers</p>
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of the necessary equipment (Scanner and accessories) for rapid on-site soil testing. • Established rapport between farmers and the technical personnel involved in soil testing.

	<ul style="list-style-type: none"> • Adequate qualified staff to cover the large number of samples from the target 24 counties before the planting season begins. • A well-designed information storage system for data obtained at farm level including (GPS readings, physical description of the locations, raw measured scanned data, fertilizer recommendation according to crop type suitability). • Farmers must understand, trust, and be willing to act upon the information provided
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County government extension services; Providing the link to farmers. • Soilcares; Provides soil scanners technology and capacity building in collaboration with KALRO and ICRAF, • ICRAF and iSDA; Tests and validate the recommendations obtained in collaboration with SoilCares and KALRO. • Fertilizer companies; To provide fertilizer blends according to soil health status • Agro dealers to stock required fertilizers that is readily available to farmer
C: Current situation and future scaling up	
Counties where already promoted if any	Technology has not been promoted though testing has been ongoing in a few counties
Current extent of reach	Minimal reach in Nyeri County
Counties where TIMP will be promoted	All banana growing counties Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • It requires continuous updating of methods to improve recommendations. • Lack of awareness on the importance of regular testing of soil quality
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation, intensive farmer field training (capacity building) • Make the whole process cost efficient. Use of scanners (spectroscopy) and less wet chemistry analysis. • Automated methods for updating existing recommendations by generating local soil libraries.
Lessons learned if any	Timely affordable soil information will guide on fertilizer use. Farmers have reported frustration when they apply the wrong fertilizers and see no results because they did not take the first step to understand what the soil demand in terms of macro, micro nutrients and trace elements like Zinc and Copper.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Socially acceptable-brings income, increases food production, nutrition security and family cohesion.

	<ul style="list-style-type: none"> • Environmentally friendly; -Recommendations provided ensures that farmers only apply the required amounts of fertilizers. No excess nutrients to contaminate ground and surface water. • Market will absorb the increased productivity • Supporting frameworks/policies are available. • Training of personnel at national and county levels
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	<ul style="list-style-type: none"> • Soil testing equipment and License, sampling and packaging materials (KES 650,000/=), personnel and logistics (will depend on site/location). • Shipping selected soil and plant materials for further testing and results verification in a certified lab. • There are other additional costs on professional consultation.
Estimated returns	At least 30% profit for soil testing business venture using the scanner. Farmers end up getting higher returns on the crops grown and amounts depend on specific value chain. High value crops will give higher returns compared with subsistence crops.
Gender issues and concerns in development and dissemination	<ul style="list-style-type: none"> • Women have less access to credit to pay for the rapid soil testing services. • Women and youth have limited access to land for banana cultivation. • Women have less access to agricultural information, technology and knowledge. • Bringing services closer to the users saves time and resources to the various gender categories using the rapid soil testing.
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youths who can be trained on soil sampling to help the local community in rapid soil testing.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for banana cultivation. • VMGs have less access to agricultural information, technology and knowledge.
VMG related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for VMGs who can be trained on soil sampling to help the local community in rapid soil testing.
E: Case studies/profiles of success stories	
Success stories	Has been tested used successfully by other organizations like ICRAF, SoilCares & former Kenya Sugar Research Foundation. It has been adopted at Kenya cane testing centre for checking maturity level and quality of sugar cane
Application guidelines for users	<ul style="list-style-type: none"> • A handheld scanner to test soils and crops in the field • Community soil sampling champions are identified and trained on good soil sampling procedures. • Soil and crop is analysed and the results including fertilizer recommendation generated on site.

F: Status of TIMP readiness (1-Ready for up scaling; 2-Requires validation; 3-Requires further research)	2 - Requires validation
G: Contacts	
Contacts	Director, Environment & Natural Resource Systems KALRO Headquarters P.O. Box 57811-00200 +254 722 206986/8, Ext 2316
Lead organization and scientists	KALRO; C. Kibunja, E. Gikonyo, Christy van Beek, A. Sila, D. Kamau, A. Esilaba and S. Kimani
Partner organizations	MoALD, County governments, SoilCares, ICRAF and iSDA

GAPS

1. Testing paired soil and crop samples to determine nutrients in the soil and what is available to plant.
2. Determine nutrient deficiency and make recommendation for the type of fertilizer to use and at what rate.
3. Developing a fertilizer recommendation system with options for new blends.
4. Working with fertilizer companies to produce fertilizer blends packaged in smaller quantities as per farmer needs.
5. Using scanners at farm level to undertake fertilizer quality analysis, e.g. quantitative and qualitative analysis, major and trace elemental analysis, and chemical and physical analysis.
6. Updating existing soil maps with newly acquired soil data to provide current soil fertility status in the country

2.5.4 Intercropping bananas with legumes for soil fertility management

2.5.4 TIMP Name	Intercropping bananas with legumes for soil fertility improvement and land use efficiency
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low banana productivity. There is a need for crop diversification, land use efficiency. Declining soil fertility
What is it? (TIMP description)	Intercropping is growing two or more crops on the same piece of land. The most common goal of intercropping is to maximize land use Intercropping Bananas with legumes is the simultaneous cultivation of Bananas with one or more legumes at the same time during the same season on the same piece of land. This system has been demonstrated to be more efficient than sole cropping in utilizing land, increasing production and improving the general ecology. The main goal of intercropping Bananas with legumes is to get improved productivity per unit land area and efficient utilization of land resources and farming inputs including labor.

	 <p><i>Banana alley cropping system</i> Source: Evans Mutuma, KALRO</p>
Justification	Diminishing land sizes especially among smallholder farmers calls for the need to increase production per unit area. The recommended spacing in Bananas coupled with its perennial nature allows for intercropping with food or fodder legumes. This system ensures efficient land use utilization, improves soil fertility through Nitrogen fixation, and provides food through the short duration crops planted as intercrops. In addition legumes act as cover crops further improving soil conditions for increased banana productivity
Region promoted	Busia, Kisumu, Baringo, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Kericho.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Counties where promoted, if any	Kisii, Nyamira, Bungoma
Counties where TIMP will be upscaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of leguminous seed varieties that are compatible with banana • Effective multiplication and distribution schemes for the improved planting materials of these varieties • Agronomic packages for intercropping to include time of planting, fertilizer rates, planting patterns
Partners/stakeholders for	<ul style="list-style-type: none"> • County government and private extension service providers

scaling up and their roles	<p>will train farmers on intercropping system. They will also offer advice and collect information on the level of uptake and practice of intercropping</p> <ul style="list-style-type: none"> • Agrovets and local stockists for provision of different legume seeds • NGOs such as world vision and One Acre Fund may provide inputs to farmers such as fertilizer and seeds for free or through affordable credit systems.
C: Current situation and future scaling up	
Counties already promoted if any	Kisii, Nyamira, Migori
Counties where TIMP will be upscalled	Baringo, Kericho, Bomet, West Pokot, Nyeri and Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Limited access to clean seed of leguminous crops that are compatible with banana • Lack of effective multiplication and distribution seed schemes for the improved seed materials of these varieties • Inadequate agronomic packages for intercropping
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Develop effective legume seed systems • More capacity building is required through on-station and on-farm demonstrations during farmer field schools and field days
Lessons learned	<ul style="list-style-type: none"> • This is a management practice that is adopted widely and is useful in optimizing land productivity in a sustainable manner
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Intercropping bananas with legumes are environmentally friendly agricultural investments. • Intercropping is socially acceptable • Enabling policy frameworks to support development and adoption of the management practice is in place
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	This is a low-cost management practice
Estimated returns	Increased productivity has been reported
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge. • Women have less access to agricultural information, technology and knowledge than men.
Gender related opportunities	<ul style="list-style-type: none"> • Intercropping offers good opportunities for various gender categories e.g. men and women to grow diverse crops for economic gains. • The technology may reduce women work burden when it comes to weeding. • Reduces labor demands across all gender categories
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • . • VMGs have limited access to land for bananas cultivation than men •
VMG related opportunities	<ul style="list-style-type: none"> • Reduces labor demands for the VMGs • Intercropping places emphasis on the importance of using available land space to grow a diversity crops thus increasing

	biodiversity, pest management for VMGs economic and health gains.
E: Case studies/profiles of success stories	
Success stories	Increased production per unit area from intercropping system has greatly benefited small holder farmers especially youths and women who are constrained by land. Other farmers have reported improved Soil conditions under this system, leading to increased banana yields
Application guidelines for users	<ol style="list-style-type: none"> 1. KALRO Factsheets 2. KALRO Brochures 3. KALRO pamphlets – www.kalro.org
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 = Ready for upscaling
G: Contacts	Centre Director, KALRO Kisii: Off Kisii-Sotik Road. P.O Box 523-40200 Kisii Email: kalro.kisii@kalro.org ; Tel: 0202122762
Lead organization and scientists	KALRO: Nasambu Okoko, Catherine Muriithi, Julius Martim, Martin Barare and Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi, Willis Owino
Partner organizations	MoALD and County Governments, One acre fund, World Vision, Private farm input Stockists /Agro-vets.

GAPS

- Evaluate the performance under Zai pits in semi-arid agro ecological zone
- Evaluate the acceptability of the technology by the farmers in the project site

2.5.5 Mulching for moisture retention in bananas

2.5.5 TIMP name	Mulching for moisture retention in banana
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity. Accelerated loss of soil moisture-water stress in the soil, weed infestation, loss of organic matter, and managing salinity in ASALS has led to low crop yields.
What is it? (TIMP description)	<p>The practice of covering the soil/ground with natural materials such as straw, dead leaves and compost to make more favourable conditions for plant growth, development and efficient crop production.</p> <p>Plastics like polythene, and row covers are also used as mulch. Benefits: retain moisture in the soil; suppress weeds; lowers soil temperature; and help improve soil fertility (as the mulches decompose).</p>

	  <p>Organic mulching <i>Source: S. Kimani, KALRO</i></p> <p>Plastic mulching <i>Source: E. Mutuma, KALRO</i></p>
Justification	Mulching facilitates retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops. It minimizes weed problems and nutrient loss. It also improves soil; structure directly by preventing raindrop impact and indirectly by promoting biological activity.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations - On-farm and on station Agricultural shows/exhibitions/field days Trainings - workshops/Seminars/Meetings Public and private Extension Agents Farmer to farmer extension models Mass media – Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Availability of plant or crop residues. Size of the land. Competing uses of crop residues. Type of the crops
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> County government extension services; pProvide link with farmers Community farmer groups; play coordination role for ease in problem identification and dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Baringo, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Machakos.
Current extent of reach	Available and practised in different commodity value chains

Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of enough plant and crop residues due to competing uses • Possibilities of insect build up categorized as pest or disease vectors
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Crop diversification to increase availability of residues. • Establish and follow a good integrated pest control management program for the particular crop. • Adapting alternative mulching materials like high absorbance polymers in fruit trees like mangoes and bananas, as well as plastic mulches and row covers in vegetables
Lessons learned if any	There is need to adapt alternative mulching technologies in addition to use of organic materials like crop, plant residues, and agricultural processing wastes.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Practice is socially acceptable • Environmentally friendly • Increased productivity will provide supply to the markets • Supporting frameworks/policies are available.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Organic mulch is low cost but labour intensive practice during the initial application. Such costs are dependent on value chain and plant spacing. However, plastic mulch is costly and needs to be used for high value crops.
Estimated returns	Dependent on the type of value chain and mulch used
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Mulching is labour intensive hence it may increase the labour burden for the various gender categories. This may lead to the technology not to be adopted especially by women who are already overburdened. • .
Gender related opportunities	<ul style="list-style-type: none"> • The TIMP can offer employment opportunities for the youths. • The TIMP will reduce women's weeding time that can be used performing other productive activities • Material used for mulch is locally available on-farm.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Since the activity is labour intensive it may increase the labour burden for the VMGs. This may lead to the technology not being adopted amongst VMGs. • The TIMP will reduce VMG's weeding time that can be used performing other productive activities.
VMG related opportunities	<ul style="list-style-type: none"> • The TIMP can offer employment opportunities for the VMGs. • The mulch is locally available on-farm.
E: Case studies/profiles of success stories	

Success stories	Farmers in different value chains have reported improved soil conditions, reduced runoff and nutrient loss, soil moisture retention in the soil and generally increased crop production following application of mulching technology.
Application guidelines for users	Esilaba et al. 2021. . KCEP-CRAL Integrated Soil Fertility and Water Management Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya.
F: Status of TIMP readiness (1=Ready for up scaling; 2=Requires validation; 3=Requires further research)	1 - Ready for up scaling (Organic mulch) 2 - Requires validation (plastic mulch) 3 - Requires further research (plastic mulch)
G: Contacts	
Contacts	Centre Director KALRO Food Crops Research Centre, Kabete. P.O. Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org
Lead organization and scientists	KALRO: S.K. Kimani, E. Mutuma, P. Kitiem, J. Mwaura, A. Esilaba and D. Kamau
Partner organizations	MoALD, County governments Public-Private-Partnerships

GAPS

1. Further research on and validation of mulching using plastics, factory/industrial wastes, e.g. mushroom, tea, coffee, etc. in different value chains is required

2.5.6 Green manure cover crop

2.5.6 TIMP name	Green Manure Cover Crops
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity. In general, cover crops reduce nutrient leaching, suppress weeds, have positive effects on soil structure, soil erosion and feed the soil microbiomes. They can increase plant nutrient supply in the soil especially nitrogen through biological nitrogen fixation and thus improve banana yields.
What is it? (TIMP description)	Green manure cover crops are rapidly growing crops that accumulate biomass in a short period and cover the soil surface. They are left on the soil surface as mulch or plowed under to enrich soil organic matter content. Legumes like desmodium are prioritized for their ability to source atmospheric nitrogen.
Justification	With the declining soil fertility, soil moisture stress and soil erosion, green manure cover crops provide perfect solutions with potential benefits like increasing soil organic matter through biomass production, nutrient cycling, biological nitrogen fixation (leguminous crops) adds nitrogen to the soil, improving the

	resilience of the soil through covering the soil as a "living mulch", lowering soil temperature and help to retain soil moisture. In addition, some of the cover crops provide fodder and human food (pulses).
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Awareness creation on the benefits and contribution of the technology to all stakeholders. • Easy access of varieties that are compatible with associated systems. • Technical packages describing appropriate schedules of planting GMMCs. • Linkages with Private sector - to improve production capacity and empowerment • Linkages with credit facilities • Technical skills development for the users • Capacity building on the benefits of GMCCs
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County governments – to provide extension services, farmer mobilization and policy formulation • NGOs – to provide support on capacity building and micro-financing services
C: Current situation and future scaling up	
Counties where already promoted if any	Most Counties in the medium to high rainfall areas & Arid and semi-arid areas
Current extent of reach	Although farmers in these counties practice intercropping, most fall short of using the right seed and agronomic practices, hence do not benefit from the technology
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Unavailability of quality seeds • Lack of good knowledge can have some unpleasant consequences


	<ul style="list-style-type: none"> • Inadequate access to technical materials on the establishment, operations and management of GMCCs by farmers • The increased effects of climate change hindering adoption. • Farmer high poverty levels coupled with illiteracy especially in deep rural areas of Kenya limits know how
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Enhance access to clean planting materials across the counties. Work closely with certified seed merchants, research institutions • Train and sensitize farmers on the basic principles of intercropping, their benefits and types suitable to their contexts. Use farmer field schools and demonstrations • Develop a comprehensive manual on the practice to guide the farmers during the adoption
Lessons learned if any	<ul style="list-style-type: none"> • The technology is very important in soil fertility management. Farmers can use GMCCs to improve soil fertility, feed livestock as well as food. Therefore, farmers can easily adopt this to significantly cut down on input costs • The number of ecological benefits provided by this practice can also accelerate up scaling.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Socially accepted by both male and female gender. • The practice is environmentally friendly as it enhances biodiversity, controls erosion and minimizes use of chemical inputs
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	This is a low cost management practice though technically demanding especially where the objective is to improve soil fertility. The price of quality seeds is also high
Estimated returns	Dependent on the type of GMCCs adopted
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge. • Women and youth have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> • GMCCs offer good opportunities to both men and women to grow diverse crops for economic gains and at the same time offers enhanced biodiversity benefits
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge. • VMGs often have limited access to education, training and extension services
VMG related opportunities	<ul style="list-style-type: none"> • GMCCs places emphasis on the importance of using available land space to grow diverse for increased biodiversity, thus the practice is economically viable and increase's crop production for improved food security for the VMGs
E: Case studies/profiles of success stories	
Success stories	Farmers have reported improved soil conditions, reduced run off and nutrient loss, soil moisture retention in the soil and generally an increased crop production following application of this widely used and readily available practice

Application guidelines for users	1. KALRO Brochures 2. KALRO Pamphlets
F: Status of TIMP readiness (1=Ready for up scaling; 2=Requires validation; 3=Requires further research)	1 - Ready for upscaling
G: Contacts	
Contacts	Director, Environment & Natural Resource Systems KALRO Secretariat P.O. Box 57811-00200 Nairobi Email: info@kalro.org +254 722 206986/8, Ext 2316
Lead organization and scientists	KALRO, G. Ayaga, S. Kimani, C. Kundu
Partner organizations	MOALD, County government, PPPs

GAPS

1. Major information gaps on GMCCs performances in specific areas of Kenya.
2. Little information on the interactions of various crop intercrops especially in the arid and semi-arid areas (ASALs).

2.5.7 Use of green manure on banana orchard

2.5.7 TIMP Name	Use of green manure on banana orchards
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low banana productivity due to declining soil fertility in the highly populated banana growing areas
What is it? (TIMP description)	<p>Green manure is obtained from the decomposition of plant or animal wastes. The farmer can obtain the input materials from plant and animal wastes, dump in pits at open places and allow it to decompose by microbes. The decomposed product is manure.</p>  <p>Top-dressing using green manure. <i>Source: Evans Mutuma, KALRO-Thika</i></p>
Justification	Soil fertility has been declining leading to low orchard productivity.

	Many small scale banana farmers lack resources to purchase chemical fertilizers thus green manure would be a good alternative. Green manuring is an inexpensive way to improve soil health and the nutrition of crops grown. Green manures suppress weeds reducing the labour cost of weeding, protects the soil from erosion by wind and water and direct sunlight.
Region promoted	Farmers in Nyamira, Kisii, Kakamega, Vihiga, Siaya, and Muranga, Counties have been trained and are practicing green manuring on their banana orchards. All banana growing counties.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, agricultural colleges, agripreneurs and universities
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of suitable green manure • Availability of quality seed and other planting material
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Public and private (County government extension services, community farmer groups. • County government and private Extension service providers will train farmers on green manuring and conduct demonstrations either collectively or through farm-to-farm visits. • Community farmer groups will determine suitable green manure and implement the technology on their farms
C: Current situation and future scaling up	
Counties already promoted	Nyamira, Vihiga, Kisumu, Siaya, Kakamega and Kisii.
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • High cost of seed and availability • Erratic weather condition-drought • Acceptance by farmers to incorporate green manure legume at the right time
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Provide quality green manure seed • Carry out cost benefit analysis
Lessons learned	<ul style="list-style-type: none"> • There is need to integrate green manuring with use, plant residues, and agricultural processing wastes
Social, environmental,	<ul style="list-style-type: none"> • Green manure use is socially acceptable

policy and market conditions necessary	<ul style="list-style-type: none"> • Green manure is an environmentally safe practice and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Need to create awareness of the benefits/ advantages/ management of the TIMP to enhance acceptability for increased up take • Increased productivity will provide commodity for the market.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	This is low cost but labour intensive practice especially during the initial application (cost to be determined)
Estimated returns	>100% of the initial investments (calculate)
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge. • Women and youth have limited access to education, training and extension services • Green manuring may increase the workload for women
Gender related opportunities	<ul style="list-style-type: none"> • Green manure offers good opportunities to both men and women to grow diverse crops for economic gains and at the same time offers enhanced biodiversity benefits
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge. • VMGs and youth have limited access to education, training and extension services
VMG related opportunities	<ul style="list-style-type: none"> • Green manure increases production leading to increased consumption of nutritious bananas hence improved health of VMGs
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • Farmers have reported reduced cost of production per banana with green manuring • There is increased yields and income.
Application guidelines for users	<ul style="list-style-type: none"> • KALRO Factsheets • Brochures
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	3 - Requires further research
G: Contacts	
Contacts	Centre Director, KALRO FCRC Kisii Off Kisii-Sotik Road. P.O Box 523-40200 Kisii Email: kalro.kisii@kalro.org Tel: 0202122762
Lead organization and scientists	KALRO, Nasambu Okoko, Catherine Muriithi, Julius Maritim, Martin Barare and Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi, Willis Owino


Partner organizations	MoALD and County Governments, One acre fund, World Vision, Private farm input Stockists /Agro-vets.
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GAPs

1. Need to evaluate the suitable green manuring crops for banana
2. Establish the best timing for incorporating the green manure into the soil
3. Carry out cost/benefit analysis

Soil and water Management TIMPS

2.5.8 Zai pits/Planting pits


2.5.8 TMP name	Zai Pits /Planting pits
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana yields due to unreliable water to sustain a crop cycle due to increasing dry spells within a growing season.
What is it? (TIMP description)	<p><i>In-situ</i> water conservation method. <i>Zai Pits</i> are small planting pits typically measuring 60-90 cm in width, 60-80 cm deep and spaced 300 cm for bananas.</p> <p>The pits store water for crop use. Banana planting materials (TC and sucker) are planted into the pits after filling with two debes (20 kg) of organic material such as manure, compost, or dry plant biomass. The technology is suitable for areas with unpredictable rains especially the drought-prone areas in the ASALs. Due to the current erratic rainfall the technology can be used to store water even in high potential areas.</p>  <p>Zai pits for banana Source: Evans Mutuma/Kathiani/Machakos County</p>
Justification	Climate change and variability induced risks like low and erratic rainfall are exacerbating agricultural droughts in banana growing areas. <i>Zai Pits</i> technology offers a solution to harvest and store water at the root zone of the banana plant. The technology helps to reduce soil moisture loss, prevents soil erosion and it has been found to improve soil health and increased biodiversity especially when integrated with organic manure application.
Region promoted	Kisii, Nyamira, Migori, Busia, Embu, Meru Muranga, Kiambu, Nyeri

	and Siaya. Homabay Busia, Kisumu, Baringo, Bomet, Kericho Tharaka Nithi, Kericho. And all the banana growing counties. All banana growing areas.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, researchers, NGOs, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Training - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Equipment for establishing Zai pits, timely availability of planting material
Partners/stakeholders for scaling up	<ul style="list-style-type: none"> • Public/Private partners - County governments and NGOs • (Kenya Red Cross (KRC), Action Aid, World Vision, and OXFAM). • County government and private extension service providers will train farmers on intercropping system. They will also offer advice and collect information on the level of uptake and practice of intercropping. • Agro-vets and local stockists for provision of different legume seeds. • NGOs such as Kenya Red Cross (KRC), Action Aid, World Vision, and OXFAM may provide inputs to farmers such as fertilizer and seeds for free or through affordable credit systems.
C: Current situation and future scaling up	
Counties where already promoted if any	Practiced in Machakos, Makueni, Tharaka Nithi, Meru, Embu, Tana River, Garissa, Makueni) and have increased farmer's resilience to food and nutritional security.
Counties where TIMPs will be up-scaled	All counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	The technology is Labour intensive and many farmers find it difficult to implement due to their poverty levels.
Recommendations for addressing the challenges	Supporting farmers with equipment for preparing Zai pits Intensive training on the technology
Lessons learned	Huge potential to increase farmers' resilience especially in ASALs
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • <i>Zai Pits</i> are environmentally friendly agricultural investments • They conserve water and soil erosion and generally boost biodiversity • Enabling policy frameworks to support the development and adoption of the <i>Zai Pits</i> are in place • The technology has Available markets

D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Labour for Zai pit preparation is estimated at KES 80 to 100 per pit
Estimated returns	450 bunches after two years KES168,900
Gender issues and concerns in development and dissemination	<ul style="list-style-type: none"> It is labour intensive in terms of preparation and application hence may not be adopted by women who are already overburdened. Women and youth have limited access to land for banana cultivation. Women have less access to agricultural information, technology and knowledge.
Gender related opportunities	<ul style="list-style-type: none"> Opportunities for youths males employment exist in the task of zai pits
Gender VMGs issues and concerns in development and dissemination	<ul style="list-style-type: none"> It is labour intensive in terms of preparation and application hence may not be adopted by VMGs who are incapacitated. VMGs have limited access to land for banana cultivation VMGs have less access to agricultural information, technology and knowledge.
VMGs related opportunities	<ul style="list-style-type: none"> The practice is economically viable and increase's crop production for improved food security for the VMGs.
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> Has been used successfully in Makueni, Kilifi, Tana River with reports of yield increase, One farmer in Kathonziweni, Makueni County has already dug 170 pits and targeted 500 pits for production of sorghum. The farmer expects to harvest an average of 40-50 bags (90 Kgs) from one acre for crop production.
Application guidelines for users	1. Refer to Zai pit Manual
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1. Ready for upscaling
Contacts	
Lead organization and scientists	KALRO, S. Kimani, E. Mutuma; J. Wamuongo; M. Wairimu; P. Kitiem, J. Mwaura; and D. Kamau

2.5.9 Bench Terraces


2.5.9. TIMP name	Bench terraces for soil and water conservation
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana yields due to soil erosion and low soil water retention due to high accelerated run off in medium to steep slopes in some banana production areas.
What is it? (TIMP description)	A terrace is an earth-embankment, constructed across the slope, to control runoff and minimize soil erosion. A terrace acts as an intercept to land slope, and divides the sloping land surface into strips.

	<p>Bench terraces consist of a series of flat or almost flat beds running across a slope at vertical intervals, supported by steep banks or risers (walls or bunds). The flat beds created by bench terraces enable planting of crops on medium to steep slopes.</p> <p>The technology is highly suitable for Semi-arid to humid regions of rainfall, 700 mm or more; medium to steep slopes (12-47%).</p>  <p>Bench terraces in Mbooni, Makueni County Kenya Source: S. Kimani-</p>
Justification	<p>Agricultural production is threatened in many parts of the Kenya by soil erosion and limited soil moisture. Bench terraces offer a solution by arresting soil erosion by water, the flat beds enhance water infiltration therefore improves soil moisture retention and therefore reducing soil moisture stress. Since bananas require adequate soil moisture, the technology is a perfect intervention for soil erosion control and soil moisture retention in banana production areas under medium to steep slopes.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, private service providers, county agricultural extension service providers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of labour as the technology is labour intensive. • Farmers and extension service with skills to design and construct contour bunds. • Land tenure systems that allows individual ownership

Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> County government extension service providers – delivery of information to farmers, technology access, capacity building Community farmer groups – Provide on farm demonstration plots to hold farmer field schools. External service providers – capacity building and access to technology
C: Current situation and future scaling up	
Counties where already promoted if any	Makueni, Machakos, Tharaka Nithi, Kakamega, Nyeri, Meru
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> Increased risk of soil erosion if terraces are improperly laid out Labour intensive during construction and maintenance and many farmers may find it difficult to implement at large scale Land tenure systems – communal land ownership, or in places where individuals don't have land title deeds
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Farmers need to be supported with appropriate equipment for preparation of Bench terrace for efficiency and increased output per man hour. Training youthful farmers to be champions of making bench terraces construction at the Ward level/village level. Training on site specific designs and construction of bench terraces Fast track land registration
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> Terracing is popular due largely to the rapid benefits it gives in terms of improved crop performance. Existence of well-developed self-help groups can lead to successful soil and water conservation activities. Conducting publicity campaigns has been found to add to the success of soil and water conservation. Similarly, when the farmers are adequately trained and sensitized on the technology, many of them would be willing to invest.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> Enforce policies on soil and water conservation at the County level Create awareness on the importance of soil and water conservation Avail low-cost technologies for soil and water conservation Policies that support individual land tenure systems
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The main input cost is the labour for <i>Bench terrace</i> preparation. The cost will depend on the land size, labour costs and the landscape terrain/slope

Estimated returns	Bench terraces broadly provide ecosystem services, through conservation of soil and water. Economic returns depend on the value chain being addressed.
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • It is labour intensive in terms of preparation and application hence may not be adopted by women who are already overburdened. • Women have less access to agricultural information, technology and knowledge.
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths males employment exist in performing the task of bench terraces.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for bananas cultivation • Women have less access to agricultural information, technology and knowledge. • The technology is labour intensive and may be difficult for the VMG to implement in the field.
VMG related opportunities	<ul style="list-style-type: none"> • The practice is economically viable and increase's crop production for improved food security for the VMGs
E: Case studies/profiles of success stories	
Success stories	Mukethe Mbithi is a member of the Kyungu Mwethya group in Machakos <i>"Before making the bench terraces we didn't have good harvests because the soil was eroded. When we applied fertilizer the water washed it into the river and the maize grew short. But when we made terraces the soil erosion stopped and we got good crops"</i> .
Application guidelines for users	<ol style="list-style-type: none"> 1. KALRO brochures 2. KALRO pamphlets
F: Status of TIMP readiness (1=Ready for up scaling; 2=Requires validation; 3=Requires further research)	1 - Ready for up scaling
G: Contacts	
Contacts	Centre Director KALRO FCRC Kabete. P.O. Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org
Lead organization and scientists	KALRO, E. Mutuma; J. Wamuongo; M. Wairimu; P. Kitiem, J. Mwaura; D. Kamau and S. Kimani
Partner organizations	MoALD, County Governments extension offices.

2.5.10 Agroforestry for Soil Fertility

2.5.10. TIMP name	Agroforestry for Soil Fertility
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to land degradation characterized by the declining soil fertility, increased soil moisture stress, increased soil erosion and loss of biodiversity
What is it? (TIMP description)	<p>Agroforestry is a collective term for land use systems and practices where woody perennials are deliberately integrated with crops and/or animals on the same land management unit. It is a land use management system in which trees or shrubs grown in or among crops or pasture land for the purpose of improving soil fertility and rehabilitation of degraded lands. These systems include:</p> <ul style="list-style-type: none"> • Improved fallows; Leguminous trees planted in natural fallows. • Multi-strata; an agroforestry system whose components (crops, trees, shrubs, livestock) occupy distinct layers of the vertical structure of the community.  <p><i>Banana agroforestry</i> Source: Evans Mutuma</p>
Justification	Farmers who grow bananas according to an agroforestry system, not only minimize adverse climatic factors, but they also provide a better yield for bananas. Bananas require a constant supply of moisture which is easily achieved with perennial high trees that provide shadow and preserve water in the soil. Agroforestry with leguminous trees has potential to increase the productivity of bananas by stabilizing the soil, improving soil fertility through nutrient cycling, erosion control and enhanced biodiversity that provide perfect condition for high banana yield. Conserve soil water.
B: Assessment of dissemination and scaling up/out approaches	

Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers at county and national level and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Training on principles and benefits of agroforestry legumes for green manure • Model demonstration plots using cereal crops
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County governments extension services – to mobilize community and provide support as well as develop and implement supporting frameworks/policies at the local level • Researchers (KALRO & KEFRI) - To provide further research and disseminate knowledge and information on agroforestry
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Siaya, Kisumu, Kakamega, Busia, Tharaka Nithi
Counties where TIMP will be promoted	All banana growing Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Limited species appropriate for agroforestry in banana in different agro-ecological zones • Shortage of seeds and seedlings for agroforestry • Many farmers lack knowledge and skills needed to grow and maintain them • Change of mindset • Competing interests • land tenure (farmers reluctant to invest in agroforestry technologies where they do not have clear land rights)
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Enhance Public Private Partnerships to support increased production and market access • Improve county government capacity to train and re-tool technical team so as to enhance uptake of the technology • Availing inputs and credit • Allocation of more funds for continued research and dissemination of this technology would aid increased uptake agroforestry for soil fertility
Lessons learned if any	<ul style="list-style-type: none"> • Mind sets of local farmers' negative about agroforestry for soil fertility improvement.

	<ul style="list-style-type: none"> Inadequate skills in the technology and its management practices
Social, environmental, policy and market conditions necessary	Reliable technology adoption and suitable price and market access for produce grown under the improved agroforestry system
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Dependent on the technology being promoted, though minimal focusing on labour costs
Estimated returns	Returns dependent on the technology and value chain
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Women have less access to agricultural information, technology and knowledge. Women and youth have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> There are opportunities for the rural women and unemployed youths in tree nursery management and seedlings sales Women can easily get access to the products of the practice, e.g. fuel wood
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs have less access to agricultural information, technology and knowledge. VMGs have limited access to education, training and extension services.
VMG related opportunities	<ul style="list-style-type: none"> There are opportunities for the VMGs in tree nursery management and seedlings sales VMGs can easily get access to the products of the practice, e.g. fuel wood .
E: Case studies/profiles of success stories	
Success stories	Farmers who adopt the technology have reported increased and sustainable source of income
Application guidelines for users	Adopters of agroforestry for soil fertility will need training for informed decisions on appropriate tree species to plant
F: Status of TIMP readiness (1=Ready for up scaling; 2=Requires validation; 3=Requires further research)	2 - Requires validation
G: Contacts	
Contacts	Kenya Forestry Research Institute, P.O. Box 20412, Nairobi director@kefri.org +254 722 157 414
Lead organization and scientists	KEFRI and KALRO, J. Ndufa, M. Okoti; E. Odoyo, B. Mugo, S. Kimani, C. Kundu and D. Kamau
Partner organizations	MoALD, County government, Private Public Partnerships

GAPS

1. Validation of existing technologies in different agro-ecological zones/Counties

2.5.11 Windbreaks and live hedges

2.5.11. TIMP name	Windbreaks and Live hedges
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	<p>Low banana productivity due to increased land degradation and loss of biological and economic productivity caused by overexploitation of the vegetation which cause wind and water erosion in most of landscapes. This is characterised by declining soil fertility, increased soil moisture stress, increased soil erosion from water and wind and loss of biodiversity; shortages of poles, timber, fuelwood and charcoal; shortages of medicine, fruit and fodder; increased emission of GHGs (Carbon) responsible for the climatic change</p>
What is it? (TIMP description)	<p>Windbreak/shelterbelts/live hedges is the planting of one or two rows of trees or shrubs along the edge of the farm, boundary and around the homestead in such manner as to provide shelter from the wind by reducing wind velocity and to protect soil from soil erosion and to provide other tree products</p> <div> </div> <p>Live hedges Source: S., Kimani, KALRO</p>
Justification	<p>A windbreak (also called a hedge, hedgerow, shelter belt, vegetative barrier, or wind barrier) is a row planted with trees that prevents or reduces the speed of the strong wind coming through it. The use of trees for windbreaks serves multiple purposes. Belts of trees as windbreaks can be of considerable practical value because they decrease soil erosion, reduce mechanical damage to plants, increase crop yield, and improve cover and increase food supply for wildlife Windbreaks often are used to protect young trees in plantations and forest nurseries. Trees can be planted</p>

	around the homestead and the edge of the farms can also provide medicine, fruits, timber, poles, fuelwood and fodder. Trees and shrubs planted along boundaries of fields can also provide demarcation for boundaries and provide other ecosystem service
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers, agripreneurs, processors, tissue-culture nursery operators, policy makers at county and national level and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Training on principles and benefits of windbreak/shelterbelts/live hedges for wind and water erosion control and provision of other tree products and ecosystem services
Partners/stakeholders for scaling up and their roles	County governments - Provide extension services, farmer mobilization and policy formulation KEFRI and KFS – capacity building, provide tree; policy implementation NGOs – capacity building
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Laikipia, Nyeri, Tana river, Isiolo, Wajir, Garissa, Taita Taveta, Tharaka Nithi, Kericho, Bomet, Busia, Kakamega, Uasin Gishu, Elgeyo Marakwet, Nyandarua, Siaya, Kisumu, Siaya, Lamu, Baringo
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Limited species appropriate to different agro-ecological zones • Shortage of seed • Tree and tenure issues when trees are planted along the common boundary • Lack of proper management plans as provided for under the Forests Act of 2005 can affect sustainable feedstock management. • The arid and semi-arid areas of Kenya where

	<p>windbreaks have potential of adoption are water deficient environments that experience challenges in vegetation growth and tree regeneration. This highlights the need for proper agronomic planning.</p> <ul style="list-style-type: none"> • Many farmers lack knowledge and skills needed to grow them • Competing interests
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Improve county government capacity to train and re-tool technical team so as to enhance uptake of the technology • Allocation of more funds for continued research and dissemination of this technology would aid increased uptake • Provide training of seed collection, nursery management and tree establishment and management • Promoted windbreak trees/shrubs which provide multiple e.g. medicine, fruits, timber, poles, fuelwood and fodder • Enhancing implementation of land use regulations and guidelines, especially where changes in land use occur
Lessons learned if any	<ul style="list-style-type: none"> • Inadequate skills in the technology and its management practices
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Mindset change of local farmers about windbreak practices. • Reliable technology adoption will provide easy access to multiple tree products and income , and mitigation of climate of change
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Initial cost of establishment is high but there is the benefit of good returns if well managed. Farmers will also save on time spent on firewood collection
Estimated returns	Returns dependent on type of tree species used and value chain but no economic costs have been done
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge. • Women and youth have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> • There are opportunities for the rural women and unemployed youths in tree nursery management-seedlings sales • Women can easily get access to the products of the practice, e.g. fuel wood. The time saved from firewood collection can be used for other economic activities
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge. • Women and youth have limited access to education, training and extension services .

VMG related opportunities	<ul style="list-style-type: none"> There are opportunities for the VMGs in tree nursery management- seedlings sales VMGs can easily get access to the products of the practice, e.g. fuel wood. The time saved from firewood collection can be used for other economic activities
E: Case studies/profiles of success stories	
Success stories	Farmers who adopt the technology have reported increased and sustainable source of income and increased resilience and have sufficient fuelwood for home consumption
Application guidelines for users	Adopters of windbreaks will need training to decide appropriate tree species
F: Status of TIMP readiness (1=Ready for up scaling; 2=Requires validation; 3=Requires further research)	2 - Requires validation
G: Contacts	
Contacts	Kenya Forestry Research Institute, P.O. Box 20412, Nairobi director@kefri.org +254 722 157 414
Lead organization and scientists	KEFRI, KALRO and ICRAF: James Ndufa, E. Odoyo, D. Kamau and S. Kimani
Partner organizations	County government, Private Public Partnerships


GAPS

1. Validation of existing windbreak and live hedges species in different agro-ecological zones/counties
2. Further species selection for different agro-ecological zones/counties

Irrigation TIMPS

2.5.12 Drip irrigation

2.5.12 TIMP name	Drip irrigation systems for Banana production
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low banana productivity. Specific temperature ranges and high water demand throughout all stages of its growth limit the range and growth of banana. Increased crop water stress caused by seasonal rainfall variability in rain fed production leads to low banana yields.
What is it? (TIMP description)	It is a type of micro-irrigation system that allows optimal usage of limited water resource by controlled delivery of the water to the plant root zone at low pressure using drip lines and emitters to minimise water loss. The layout is above surface and is easy to

	<p>design and operate. It can be used to apply fertilise efficiently through fertigation. It provides the opportunity for farmers to increase crop yields.</p>  <p><i>Drip irrigation system</i> Source: Evans Mutuma</p>
Justification	Kenya is generally a water-deficient country yet almost all crop production is rain fed. The impacts of climate change (seasonal rainfall variability and drought) to crop production is a real threat to food security. The drip irrigation offers an opportunity to produce food with limited water. Mainstreaming drip irrigation systems into crop production therefore provides the opportunity for farmers to enhance crop resilience, increase yields and incomes.
Region promoted	Busia, Kisumu, Baringo, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Kericho. All banana growing counties.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, private hardening nursery operators, researchers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of clean quality water • Access to finances to procure the system • Awareness of the benefits of the systems • Correct field design (system installation) of the drip system to minimize water inefficiencies • Training of farmers and extension workers • Drip system management skills
Partners/stakeholders for	<ul style="list-style-type: none"> • County Governments can sponsor purchase of irrigation

scaling up	<p>kits for farmer groups or model farms</p> <ul style="list-style-type: none"> • County government and private extension service providers will train trainers of trainers (TOTs and farmers on management of irrigation systems. • NGOs such as World Vision, One Acre Fund, Kenya Red Cross, Action Aid, World Vision, OXFAM and Micro finance institutions (MFIs) may offer extension services, train trainers and credit facilities for purchase irrigation kits
	<ul style="list-style-type: none"> • AMIRAN Kenya, HortiPro, Agro-Irrigation, Aqua-Valley Services Ltd are suppliers of drip irrigation kits • Davis & Shirliff are suppliers of water pumps, • NGOs (Kenya Red Cross, Action Aid, World Vision, OXFAM etc) – offer extension services and train trainers • KALRO - technical backstopping
C: Current situation and future scaling up	
Counties where promoted, if any	Used widely for high value horticultural vegetable crops such as tomatoes, capsicums in greenhouses and outdoor in Kiambu, Muranga, Meru, Kajiado, Marsabit Makueni
Counties where TIMP will be upscaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Relatively high cost of drip kits for majority of poor resource farmers in Kenya • High temperatures experienced in ASALs cause water salinity challenges • Drip poly tubing also tend to collapse causing inadequate water conveyance along the tube. • Limited awareness of the benefits of the TIMP • Water scarcity • lack of knowledge and skills in irrigation constrain management of the system
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Model farmer demonstration would create awareness and willingness to invest in the system • Modification of drip system tubes in ASAL areas is required (use of PVC pipes) to manage clogging and allow free flow of water • Regular maintenance of the system especially the drip filters is required to flush out accumulated salts that tend to clog emitters • Awareness creation and farmer training is required on the management of drip irrigation system. • Build capacity on water harvesting, Storage and management of drip irrigation system • Regular maintenance of the system especially the drip filters is required to flush out accumulated salts that tend to clog emitters • Use PVC pipes ASALs to manage clogging
Lessons learned	<ul style="list-style-type: none"> • Drip system increases yield, incomes and food security. • Linking farmers to markets is critical for enhancing


	<p>sustainability.</p> <ul style="list-style-type: none"> • Soil mulching (crop residue or green manures) in a drip systems help preserve moisture and add nutrients to the soil • Linking farmers to financial institutions enables them to purchase drip irrigation systems. • There are many successful farmers who have implemented drip irrigation system for up scaling.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Drip systems are environmentally friendly agricultural investments. They are water-saving • Enabling policy frameworks to support development and adoption of the TIMP in place • Availability of markets
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Inputs materials include water source, drip lines, drippers, pumping unit, filtering and fertilizing systems, ¼ acre costs between KES.50, 000 to 100,000
Estimated returns	Income from drip system rises by as much as 35% above that from conventional production systems
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youths have less access to credit required to install drip irrigation. • Women have less access to technology and information on the TIMP. • Women have less access to education, training and extension services.
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youths in installing the drip irrigation kits. • Opportunity exist for women to access the required credit through the women enterprise funds for installing drip irrigation kits
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to credit required to install drip irrigation. • VMGs have less access to technology and information on the TIMP. • VMGs have less access to education, training and extension services.
VMG related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for VMGs in installing the drip irrigation kits.
E: Case studies/profiles of success stories	
Success stories	Drip technology has been successfully applied in many parts of the country over a considerable period of time. For example, James Mwenda from South Imenti, Meru County earns more than 130,000 per month from the sale of eggplants grown under Ithitwe Iraru irrigation project.
Application guidelines for users	1. Sijali, IV. 2001. Drip Irrigation: Options for smallholder farmers in eastern and southern Africa. Technical Handbook No. 24, RELMA.
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further	2 – Requires validation

research	
G: Contacts	
Contacts	Centre Director, KALRO FCRC Kisii Off Kisii-Sotik Road. P.O Box 523-40200 Kisii Email: kalro.kisii@kalro.org Telephone: +254 20 2122762
Lead organization and scientists	KALRO: Nasambu Okoko, Catherine Muriithi, Julius Martim, Martin Barare and Josiah Mogaka, Francis Wayua, Joseph Njuguna, Maina Mwangi, Willis Owino
Partner organizations	MoALD, AMIRAN Kenya, HortiPro, Agro-Irrigation, Aqua- Valley Services Ltd, Davis & Shirtliff, and Microfinance institutions (MFIs)

GAPS

1. Water requirement for banana under different AEZs
2. Evaluation of different irrigation systems

2.5.13 Solar Irrigation Systems for smallholder farmers

2.5.13. TIMP name	Solar Irrigation Systems for smallholder farmers
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity. High cost of pumping water for irrigation, using electricity or fossil fuel powered pumps; reduction of greenhouse gas emissions
What is it? (TIMP description) Source: E. Mutuma	This is a technology that uses solar power in the pumping of irrigation water and running of the irrigation systems 
Justification	There has been general increase in prices of diesel and electricity making pumping of irrigation water to be a costly operation. Though Solar panels have been used successfully to light houses and in small businesses in the rural areas, they have hardly been used in the

	irrigation systems despite their potential. Solar power would be a good source of power for addressing climate smart agriculture focusing on renewable and green energy. It also has the advantage of low cost and sustainability.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications – posters, brochures, leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Documentation of available solar irrigation systems • Access to solar irrigation performance data. • Improving solar irrigation systems efficiencies in irrigation schemes • Creating local support for solar irrigation technologies
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • County Governments can sponsor purchase of irrigation kits for farmer groups or model farms • County government and private extension service providers will train trainers of trainers (TOTs and farmers on management of irrigation systems. • NGOs such as World Vision, One Acre Fund, Kenya Red Cross, Action Aid, World Vision, OXFAM and Micro finance institutions (MFIs) may offer extension services, train trainers and credit facilities for purchase irrigation kits
C: Current situation and future scaling up	
Counties where already promoted if any	Various Counties including Marsabit, Garissa, Machakos, Nyeri, Kajiado, Siaya, Bomet, Kericho and Uasin Gishu
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Farmers lack knowledge on the potential of solar as a power source for irrigation systems

	<ul style="list-style-type: none"> • High-cost of the innovation
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness trainings on and the advantages of different solar irrigation systems to governments, extension service providers, farmers and development agencies. • Creating solar irrigation systems network
Lessons learned if any	<ul style="list-style-type: none"> • Solar irrigation systems should be well designed in water delivery, storage and application to the field.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Practice is socially acceptable • Environmentally friendly, • Policies are friendly to the technology • Capable of increasing marketable products
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The TIMP has high investment costs but low operation costs. Costs depend on the energy required and size of irrigated area.
Estimated returns	To be determined
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth have limited access to land for bananas cultivation than men. • Women and youth may also have limited access to finances to implement and operationalize the solar irrigation system. • Women have less access to agricultural information, technology and knowledge than men.
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth in installing the solar irrigation systems.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land for bananas cultivation than men. • VMGs may also have limited access to finances to implement and operationalize the solar irrigation system. • VMGs have less access to agricultural information, technology and knowledge than men.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action in various areas as for instance in the provision of finances to VMGs. • Employment opportunities exist for youth in installing the solar irrigation systems.
E: Case studies/profiles of success stories	
Success stories	Solar irrigation systems success stories have been reported in Counties such as Kajiado on high value crops
Application guidelines for users	
F: Status of TIMP readiness (1=Ready for up scaling:	2 - Requires validation

2=Requires validation; 3=Requires further research)	
G: Contacts	
Contacts	Centre Director KALRO FCRC Kabete, off Waiyaki Way, P.O. Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org
Lead organization and scientists	KALRO: I. V. Sijali, M. P. O. Radiro, F. Karanja, F. Kaburu, E.Mutuma
Partner organizations	Solar irrigation systems suppliers, County governments, National Irrigation Acceleration Programme (NIAP)


GAPSs

1. Validation of the solar irrigation systems in the different counties.
2. Up scaling of the technology to smallholder community schemes
3. Solar irrigation systems that maximize crop water productivity

2.6 BANANA CROP HEALTH

Management of Banana Pests

2.6.1 Integrated management of nematodes in bananas

2.6.1 TIMP Name	Integrated management of nematodes in bananas
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Yield losses of up to 50% attributed to banana nematodes including the root lesion nematode (<i>Pratylenchus</i> spp), root knot nematodes (<i>Meloidogyne</i> spp.); burrowing nematodes (<i>Radopholus similis</i>) and spiral nematodes (<i>Helicotylenchus</i> spp.).</p> <div>  </div> <p>Necrosis of main & feeder roots due to feeding of nematodes <i>Source: KALRO</i></p>
What is it? (TIMP description)	This TIMP includes an integrated management package with cultural and biological options:

	<p>Cultural management</p> <ul style="list-style-type: none"> • Use of clean/nematode free banana seedlings from reliable dealers • Planting seedlings in nematode free fields-test the soil to ensure it is free from nematodes • Paring of banana corms and hot water treatment of corm at 55°C • Crop rotation when establishing new banana orchards • Ploughing the land during hot weather and exposing it to the hot sun for a month (solarization) • Prevent surface run off as it transmits soilborne pathogens • Clean farm tools and footwear using disinfectant (eg Jik 50mls per 1 litre of water) to remove adhering soil that could be contaminated <p>Biological management</p> <ul style="list-style-type: none"> • Use neem based biopesticides (e.g Achook, Nimbecidine, Neemraj Super) according to manufacturer's instructions
Justification	Banana nematodes especially the root lesion, burrowing nematode and root knot are major pathogens of bananas. They cause major losses of up to 50% in the crop since they destroy the roots during feeding and compromise the plants anchorage hence causing toppling over of bananas. They also open up the plant, exposing it to fungal and bacterial pathogens that cause Panama and Banana Xanthomonas wilt diseases.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers (public and private), agripreneurs, tissue-culture nursery operators and research organizations (including CGIAR and universities)
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Support Agro chemical companies to sell biological controls products • Create awareness of the benefits of the IPM management practices • Willingness of stakeholders to participate • Carry out Applied and adaptive research to validate IPM on nematodes • Create a platform for interaction of banana value chain stakeholders

	<ul style="list-style-type: none"> • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes • A strong partnership between technical personnel /Extension/companies producing biological control and bio-pesticides products and farmers would enhance promotion.
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Extension agents (both private and public)-mobilization/sensitization of farmers and extension of the management practice • Farmers/CBO: participate in trainings and adoption of the management practice • KALRO to continually undertake research in nematode management • PCPB to promote registration of biopesticides for nematode management • Universities to develop management practice and conduct ToTs. • Farmers/farmer groups to adopt the management practices • County governments, central governments for development of enabling policies and create awareness. • CGIAR/NGOs to link farmers to the market and lobby for changes in agriculture policies to favor the farmer. • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Kisii and Nyamira
Counties where TIMP will be upscaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on nematodes infesting bananas and losses attributed to them • Poor linkages among stakeholders in banana value chain • Nematodes cannot be seen with the naked eye hence, difficult to convince farmers that they are a problem and are responsible for the yellowing and stunted banana crops • Several other factors cause yellowing of leaves and stunting (e.g. Fusarium wilt, poor nutrition) hence difficult to confirm problem unless soils are tested
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Dissemination of integrated pest management practices and safe use of biopesticides • PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish banana innovation platforms for technology disseminations • Promote appropriate marketing channels e.g. contract farming, collective production and marketing • Sensitization on the pest and its effect



Lessons learned	<ul style="list-style-type: none"> • Sensitization is necessary for people to appreciate the use of IPM in nematode management • Adoption of good agricultural practices by farmers is key in management of the pest. • Chances of successful scaling are higher when many value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Scouting is important for early detection of nematode symptoms so as to employ timely control measures
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Willingness of stakeholders to participate • Regulatory bodies e.g. PCPB, KBS to ensure biopesticides sold to farmers are genuine and of high quality • Producers willing to adopt the nematode management practices • Producers are organized in groups to ensure that management practices are effectively up-scaled • Farm input costs are within the reach of farmers • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	(Pesticide+labour+cultural practices) KES 23,200 per acre / per year
Estimated returns	<p>Approximately 440 plants x 30kg x KES20 = KES 264,000 per acre / per year</p> <p>If IPM of nematodes in banana is not applied the yield will be reduced by 50%. Therefore, the estimated net returns will be 264,000-132,000= KES 132,000 per acre / per year</p>
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to productive resources such as credit to purchase the required inputs such as chemicals • Women have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in spraying the crop • Affirmative action funds exist for youths and women to access the required funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for unemployed exists in spraying the crop.

	<ul style="list-style-type: none"> Affirmative action funds exist for VMGs to access the required funds.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	<ol style="list-style-type: none"> Banana production-JICA www.jica.go.jp www.fruitrop.com/en/Articles-by-subject/Agronomy/2016/Banana-diseases-and-pests plantvillage.psu.edu/topics/banana/infos infonet-biovision.org/PlantHealth/Crops/Bananas
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for up-scaling
G: Contacts	
Contacts	<p>Centre Director, KALRO Food Crops Research Centre Kabete P.O Box 14733 – 00800 Nairobi email: cdnarl@kalro.org Tel: 0727624471</p> <p>Director - KALRO Seeds; P.O. Box 6223 01000 Thika: Email: kalro.seeds@kalro.org; Telephone: +254-0727615868</p> <p>The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075</p>
Lead organization and scientists	<p>KALRO Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo and Harun Odhiambo</p>
Partner organizations	CABI, ICIPE, KEPHIS, Real IPM, Koppert, Universities, County governments, Farmer Groups, Service provider agencies e.g. financial institutions, traders and private sector Agrovets

GAPs

1. Validate and promote the use of bio-pesticides for management of nematodes
2. Explore the efficacy of ITKs in management of nematodes under high pressure

2.6.2 Integrated management of banana weevil

2.6.2 TIMP Name	Integrated management of banana weevil
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Yield losses of up to 50% attributed to banana weevil. These create avenues for pathogen entry, hence exposing the plant to pathogens and compromise the plants stability/anchorage hence leading to toppling over disease of bananas</p>  <p>Tunneling of banana weevils into the rhizome <i>Source: SJN Muriuki-KALRO</i></p>  <p>Adult weevils on a trap <i>Source: SJN Muriuki-KALRO</i></p>
What is it? (TIMP description)	<p>This TIMP includes an integrated management package with cultural and biological management options:</p> <p>Cultural management</p> <ul style="list-style-type: none"> • Practice crop rotation when establishing new banana orchards • Practice field hygiene by cutting and burying old stems or cutting them and exposing them to the sun to dry up then bury them • Banana stems may also be used to trap weevils following which they are physically destroyed. Old pseudostems can be cut into lengths of 20 to 60 cm and split each length and placed on the ground near the corm bases with the cut surface downwards. Adult weevils are attracted to the cut stems or corms for shelter, to feed and to lay eggs. When the eggs hatch the life cycle cannot

	<p>continue as the cut pieces dry out and the grubs die from desiccation.</p> <ul style="list-style-type: none"> • Dig out and remove old corms and trash, where weevils breed, and bury them. • Spread mulch away from banana stool leaving a clear ring of about 60 cm from the base of the stool to keep the roots from growing towards the surface, and to avoid moist conditions near the stool, which attracts banana weevils. • Use of clean banana seedlings; planting banana seedlings in fields free from the pest. • Paring of banana corm and hot water treatment at 55°C to kill weevils and destroy eggs • prevent surface run off as it transmits soilborne pests • Clean farm tools and footwear using disinfectant (eg Jik 50mls per 1 litre of water) to remove adhering soil that could be contaminated • Keep the plantation free from weeds • Ensure proper fertilization to produce vigorous banana plants that are able to tolerate weevil damage. <p>Biological management</p> <ul style="list-style-type: none"> • Use neem based biopesticides (e.g Achook 0.15% EC3, Neemraj Super and Nimbecidine)
Justification	<p>Banana weevils create tunnels in the corm and roots exposing the plant to fungal and bacterial pathogens that cause Panama and Banana Xanthomonas wilt diseases. They interfere with water uptake and root development resulting to weak wilting plants whose anchorage is compromised, hence causing toppling over of bananas. They also open up the plant, exposing it to fungal and bacterial pathogens that cause rotting of the corm. The use of the IPM package for weevils reduces offers options for the control of the pest hence leading to increased productivity, incomes and food security for farmers</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, farmer producer groups, traders, extension service providers (public and private), agripreneurs, tissue-culture nursery operators and research organizations (including CGIAR and universities)</p>
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals

	<ul style="list-style-type: none"> Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Support Agro chemical companies to sell biological controls products Create awareness of the benefits of the IPM management practices Willingness of stakeholders to participate Carry out applied and adaptive research to validate IPM on banana weevils Create a platform for interaction of banana value chain stakeholders Farmers adopt appropriate agronomic practices Form well organized farmer groups and networks Formation of spray service providers (teams) to manage banana weevil A strong partnership between technical personnel /Extension/companies producing biological control and bio-pesticides products and farmers would enhance promotion.
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> Extension agents (both private and public)-mobilization/sensitization of farmers and extension on the management practice Farmers/CBO: participate in trainings and adoption of the management practice KALRO to continually undertake research in banana weevil management PCPB to promote registration of biopesticides for banana weevil management Universities to develop management practice and conduct ToTs. Farmers/farmer groups to adopt the management practices County governments and MoALD to develop enabling policies and create awareness. CGIAR/NGOs to link farmers to the market and lobby for changes in agriculture policies to favor the farmer. Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Kisii and Nyamira
Counties where TIMP will be up-scaled	All banana growing Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> Unwillingness of farmers to adopt IPM In adequate knowledge on IPM strategies on banana weevils infesting bananas and losses attributed to them Poor linkages among stakeholders in banana value chain
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Dissemination of integrated pest management practices and safe use of biopesticides PCPB enhance registration of crop protection products Training of stakeholders in IPM options



	<ul style="list-style-type: none"> • Establish banana innovation platforms for technology disseminations • Sensitization on the pest and its effect
Lessons learned	<ul style="list-style-type: none"> • Sensitization is necessary for people to appreciate the use of IPM in banana weevil management • Adoption of good agricultural practices by farmers is key in management of the pest. • Chances of successful scaling are higher when many value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Scouting is important for early detection of banana weevils so as to employ timely control measures
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Willingness of stakeholders to use IPM of banana weevil • Regulatory bodies e.g. PCPB, KBS to ensure biopesticides sold to farmers are genuine and of high quality • Producers willing to adopt the banana weevil management practices • Producers are organized in groups to ensure that management practices are effectively up-scaled • Farm input costs are within the reach of farmers • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	(Pesticide+ labour+ cultural practices) KES 25,200 per acre / per year
Estimated returns	<p>Approximately 440 plants x 30 kg x KES 20 = KES 264,000 per acre / per year</p> <p>If IPM of weevils in banana is not applied the yield will be reduced by 50%. Therefore, the estimated net returns will be 264,000-132,000= KES 132,000 per acre / per year</p>
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to productive resources such as credit to purchase the required inputs such as chemicals than men • Women have limited access to education, training and extension services than men • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in spraying the crop • Affirmative action funds exist for youths and women to access the required funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services

	<ul style="list-style-type: none"> • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for unemployed exists in spraying the crop. • Affirmative action funds exist for youths and women to access the required funds.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	www.jica.go.jp Banana production-JICA www.fruitrop.com/en/Articles-by-subject/Agronomy/2016/Banana-diseases-and-pests plantvillage.psu.edu/topics/banana/infos infonet-biovision.org/PlantHealth/Crops/Bananas
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for up-scaling
G: Contacts	
Contacts	<p>Centre Director, Food Crops Research Centre, Kabete P.O Box 14733 – 00800 Nairobi Email: cdnarl@kalro.org Tel: 0727624471</p> <p>Director - KALRO Seeds; P.O. Box 6223 01000 Thika: Email: kalro.seeds@kalro.org; Telephone: +254-0727615868</p> <p>The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075</p>
Lead organization and scientists	KALRO Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo and Harun Odhiambo
Partner organizations	CABI, ICIPE, KEPHIS, Real IPM, Koppert, Universities, County governments, Farmer Groups, Service provider agencies e.g. financial institutions, traders and private sector Agrovets

GAPs

1. Validate and promote the use of bio-pesticides for management of banana weevils

2.6.3 Integrated management of banana thrips

2.6.3 TIMP Name	Integrated management of banana thrips
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Yield losses of up to 40% attributed to thrips in banana production. These contribute to poor quality fingers. Thrips suck water from plants sometimes leading to splitting of fingers and creates avenues for pathogen entry, hence compromising the plants quality</p> <div>  </div> <div>  </div> <div> <p>Damage caused by banana rusty thrips (<i>Chaetanaphothrips signipennis</i>) <i>Source: Lusike Wasilwa, KALRO</i></p> </div> <div> <p>Thrips <i>(Source: Infonet biovision)</i></p> </div>
What is it? (TIMP description)	<p>This TIMP includes an integrated management package with cultural, biological and chemical control options;</p> <p>Cultural management</p> <ul style="list-style-type: none"> • Use healthy/pest free planting materials from certified dealers • Weed orchards as these may serve as alternative hosts to thrips • Clear abandoned plantations as these serve as sources for pest breeding and spreading. • Cover or bag banana bunches just after the floral parts have fallen off to prevent damage <p>Biological /management</p> <ul style="list-style-type: none"> • Spray plants with neem based biopesticides e.g Achook 0.15% EC and Nimbecidine to target pupae. Spray plant and fruits with the same biopesticides to target the adults <p>Chemical control:</p> <ul style="list-style-type: none"> • Spray plants with Atom 2.5EC, Battallion 2.5EC, or Amazing Top based on manufacturers recommendations
Justification	<p>Banana thrips suck sap from plants and cause occurrence of silver and bronze/ brown scars on fruits which lower the quality of fruits. Rusty-red to dark brown-black discolouration are also produced by banana rust thrips. These lower the quality of bananas leading to farmers receiving lower prices from their bananas. Where the feeding</p>

	is severe, fingers may split open leading to fungal infections. The pest causes losses of up to 40%
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension Agents (Public and Private), agripreneurs, research organizations and universities, as well as CGIAR's
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Support Agro chemical companies to sell biological controls products • Create awareness of the benefits of the IPM management practices • Willingness of stakeholders to use IPM for banana thrips • Carry out applied and adaptive research to validate IPM on banana thrips • Create a platform for interaction of banana value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage banana thrips • A strong partnership between technical personnel /Extension/companies producing biological control and bio-pesticides products and farmers would enhance promotion.
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Extension agents (both private and public)-mobilization/sensitization of farmers and extension of the management practice • Farmers/CBO: participate in trainings and adoption of the management practice • KALRO to continually undertake research in banana thrip management • PCPB to promote registration of biopesticides for banana thrip management • Universities to develop management practice and conduct ToTs. • Farmers/farmer groups to adopt the management practices • County governments, MoALD to develop enabling policies and create awareness. • CGIAR/NGOs to link farmers to the market and lobby for changes in agriculture policies to favor the farmer. • Financial institutions to provide credit facilities

C: Current situation and future scaling up	
Counties already promoted	Kisii and Nyamira
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Unwillingness of farmers to adopt IPM • In adequate knowledge on IPM strategies on banana thrips infesting bananas and losses attributed to them • Poor linkages among stakeholders in banana value chain • Thrips are tiny insects and may not be seen easily by farmers without the help of a magnifying glass hence, difficult to convince farmers that they are a problem and are responsible for the silverfish and browning symptoms on the fruits
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Dissemination of integrated pest management practices and safe use of biopesticides • PCPB enhances the registration of crop protection products • Training of stakeholders in IPM options • Establish banana innovation platforms for technology dissemination • Sensitization of the pest and its effect
Lessons learned	<ul style="list-style-type: none"> • Sensitization is necessary for people to appreciate the use of IPM in banana thrip management • Adoption of good agricultural practices by farmers is key in management of the pest. • Chances of successful scaling are higher when many value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Scouting is important for early detection of banana thrips so as to employ timely control measures
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Willingness of stakeholders to use IPM of banana thrips • Regulatory bodies e.g. PCPB, KBS to ensure biopesticides sold to farmers are genuine and of high quality • Producers willing to adopt the banana thrip management practices • Producers are organized in groups to ensure that management practices are effectively upscaled • Farm input costs are within the reach of farmers • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take

D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	(Pesticide+ labour+ field sanitation) KES 22,400 per acre / per year
Estimated returns	Approximately 440 plants x 30 kg x KES 20 = KES 264,000 per acre / per year If IPM of thrips in banana is not applied the yield will be reduced by 40%. Therefore, the estimated net returns will be 264,000-105,600= KES 158,400 per acre / per year
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to productive resources such as credit to purchase the required inputs such as chemicals • Women have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in spraying the crop • Affirmative action funds exist for youths and women to access the required funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for unemployed exists in spraying the crop. • Affirmative action funds exist for VMGs to access the required funds.
E: Case studies/profiles of success stories	
Success stories	
Application guidelines for users	www.jica.go.jp Banana production-JICA www.fruitrop.com/en/Articles-by-subject/Agronomy/2016/Banana-diseases-and-pests plantvillage.psu.edu/topics/banana/infos infonet-biovision.org/PlantHealth/Crops/Bananas
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for up-scaling
G: Contacts	
Contacts	<p>Centre Director, Food Crops Research Centre, Kabete P.O Box 14733 – 00800 Nairobi email: cdnarl@kalro.org Tel: +254 727624471</p> <p>Director - KALRO Seeds; P.O. Box 6223 01000 Thika: Email: kalro.seeds@kalro.org Telephone: +254-0727615868</p>

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Lead Organization and scientist	KALRO Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo and Harun Odhiambo
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GAPs

1. Validate and promote the use of bio-pesticides in management of banana thrips
2. Validate and promote the use of ITK's for management of banana thrips

2.6.4 Integrated management of moles in bananas

2.6.4 TIMP Name	Integrated management of moles in bananas
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Yield losses of up to 50% attributed to mole rats in banana production.
What is it? (TIMP description)	This TIMP includes an integrated management package with cultural and chemical options: Cultural management <ul style="list-style-type: none"> • Use of ITK's including trapping of the moles • Use of slurry poured into the mole hole • Pouring rabbit urine into the mole hole • Burning eucalyptus leaves in the holes to suffocate the mole rats • Planting tephrosia. Roots of tephrosia emit a poisonous substance that repels the moles Chemical management <ul style="list-style-type: none"> • Use rat poison
Justification	The moles feed on roots leading to poor anchorage of the plants which later fall hence contributing to yield losses.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers (public and private), agripreneurs, tissue-culture nursery operators and research organizations (including CGIAR and universities)
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings

	<ul style="list-style-type: none"> • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Create awareness of the benefits of the IPM management practices • Willingness of stakeholders to use IPM for mole rats in banana • Carry out Applied and adaptive research to validate IPM on mole rat • Create a platform for interaction of banana value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Extension agents (both private and public)-mobilization/sensitization of farmers and extension of the management practice • Farmers/CBO: participate in trainings and adoption of the management practice • KALRO to continually undertake research in mole rat management • PCPB to promote registration of pesticides for banana mole rat management • Universities to develop management practice and conduct ToTs. • Farmers/farmer groups to adopt the management practices • County governments, central governments for development of enabling policies and create awareness. • CGIAR/NGOs to link farmers to the market and lobby for changes in agriculture policies to favor the farmer. • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Kisii and Nyamira
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Unwillingness of farmers to adopt IPM • In adequate knowledge on IPM strategies on banana mole rat infesting bananas and losses attributed to them • Poor linkages among stakeholders in banana value chain
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Dissemination of integrated pest management practices • Training of stakeholders in IPM options • Establish banana innovation platforms for technology dissemination • Sensitization on the pest and its effect
Lessons learned	<ul style="list-style-type: none"> • Sensitization is necessary for people to appreciate the use of IPM in banana mole rat management

	<ul style="list-style-type: none"> • Adoption of good agricultural practices by farmers is key in management of the pest. • Chances of successful scaling are higher when many value chain stakeholders collaborate in an innovation platform • Partnership is important in management practice dissemination and adoption and this can be facilitated through innovation platforms • Scouting is important for early detection of banana mole rat so as to employ timely control measures
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Willingness of stakeholders to use IPM of banana mole rat • Producers willing to adopt the banana mole rat management practices • Producers are organized in groups to ensure that management practices are effectively up-scaled • Farm input costs are within the reach of farmers • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	(Pesticide+ labour) KES 3,000 per acre / per year
Estimated returns	<p>Approximately 440 plants x 30 kg x KES 20 = KES 264,000 per acre / per year</p> <p>If IPM of mole rats in banana is not applied the yield will be reduced by 30%. Therefore, the estimated net returns will be 264,000-79,200= KES 184,800 per acre / per year</p>
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to productive resources such as credit to purchase the required inputs such as chemicals • Women have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in spraying the crop and trapping the moles • Affirmative action funds exist for youths and women to access the required funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for unemployed exists in spraying the crop and trapping the moles.

	<ul style="list-style-type: none"> Affirmative action funds exist for youths and women to access the required funds.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	www.jica.go.jp Banana production-JICA www.fruitrop.com/en/Articles-by-subject/Agronomy/2016/Banana-diseases-and-pests plantvillage.psu.edu/topics/banana/infos infonet-biovision.org/PlantHealth/Crops/Bananas
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Requires Validation
G: Contacts	
Contacts	<p>Centre Director, KALRO FCRC Kabete P.O Box 14733 – 00800 Nairobi email: cdnarl@kalro.org Telephone: 0727624471</p> <p>Director - KALRO Seeds; P.O. Box 6223 01000 Thika: Email: kalro.seeds@kalro.org; Telephone: +254-0727615868</p> <p>The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075</p>
Lead Organization and scientist	<p>KALRO Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo and Harun Odhiambo</p>
Partner organizations	CABI, ICIPE, KEPHIS, Real IPM, Koppert, Universities, County governments, Farmer Groups, Service provider agencies e.g. financial institutions, traders and private sector Agrovets

GAPS

1. Identify and validate ITK methods /strategies for mole rat control

2.6.5 Integrated management of banana aphids

2.6.5 TIMP Name	Integrated management of banana aphids
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Yield losses of up to 30-40 % may be attributed to aphids in banana production as vectors of Banana bunchy top virus
What is it? (TIMP description)	<p>This TIMP includes an integrated management package with cultural, biological and chemical management options;</p> <p>Cultural management</p> <ul style="list-style-type: none"> • Conserve natural enemies (e.g. flower bugs, lady bird beetles, praying mantis, hover flies, green lace wing, long horned grass hoppers and spiders) by planting lantana hedges to act as breeding grounds for predators • Rotate with non-host crops e.g. maize, upland rice, sorghum, okra, sugarcane, and sunflower to prevent build-up of population. • Remove heavily infested plant parts and destroy by burying <p>Biological management</p> <ul style="list-style-type: none"> • Apply neem based products (e.g. neem oil 40 ml/20lts of water and Achook, Nimbecidine, Neemraj Super) according to manufacturers' recommendations <p>Indigenous Technical knowledge</p> <ul style="list-style-type: none"> • Spray with soapy water solution (mix 1 tablespoon of teepol detergent with 4 lts of water or use strong jet of water to wash off aphids) <p>Chemical management</p> <p>Use only pest control products recommended by Pest Control Products Board (PCPB) such as:</p> <ul style="list-style-type: none"> • Use Danadim Blue 40 EC (Dimethoate 400 g/L) • Duthrin 1.75 EC (<i>Lambdacyhalothrin</i> 17.5 g/L) • Spray using 10 - 15 mls/20lts of Atom or Decis at the rate of 10-15mls/20lts of water
Justification	Aphids cause considerable losses in banana when in large colonies of hundreds of individuals covering all parts of plant and cause culling of fruits and transmit banana bunchy top virus. Losses of up to 30-40% are attributed to aphids especially where they transmit the bunchy Top virus. They secrete honey dew which causes discolorations and invite ants for more quality deterioration. The ants make nests nearby plants canopy and therefore make habitat unsuitable for natural enemies. The honeydew is colonized by disfiguring sooty-mold fungi and cause further degradation in quality and quantity of the produce

B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, farmer producer groups, traders, extension service providers (public and private), agripreneurs, tissue-culture nursery operators and research organizations (including CGIAR and universities)
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Support Agro chemical companies to sell biological controls products • Create awareness of the benefits of the IPM management practices • Willingness of stakeholders to use IPM for banana aphids • Carry out applied and adaptive research to validate IPM on banana aphids • Create a platform for interaction of banana value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage banana aphids • A strong partnership between technical personnel /Extension/companies producing biological control and bio-pesticides products and farmers would enhance promotion.
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Extension agents (both private and public)-mobilization/sensitization of farmers and extension of the management practice • Farmers/CBO: participate in trainings and adoption of the management practice • KALRO to continually undertake research in banana aphid management • PCPB to promote registration of biopesticides for banana aphid management • Universities to develop management practice and conduct ToTs. • Farmers/farmer groups to adopt the management practices • County governments, central governments for development of enabling policies and create awareness. • CGIAR/NGOs to link farmers to the market and lobby for changes in agriculture policies to favor the farmer. • Financial institutions to provide credit facilities
C: Current situation and future scaling up	

Counties already promoted	Kisii and Nyamira
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Unwillingness of farmers to adopt IPM • In adequate knowledge on IPM strategies on banana aphids infesting bananas and losses attributed to them • Poor linkages among stakeholders in banana value chain
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Dissemination of integrated pest management practices and safe use of biopesticides/pesticides • PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish banana innovation platforms for technology disseminations • Sensitization on the pest and its effect
Lessons learned	<ul style="list-style-type: none"> • Sensitization is necessary for people to appreciate the use of IPM in banana aphid management • Adoption of good agricultural practices by farmers is key in management of the pest. • Chances of successful scaling are higher when many value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Scouting is important for early detection of banana aphids so as to employ timely control measures
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Willingness of stakeholders to use IPM of banana aphids • Regulatory bodies e.g. PCPB, KBS to ensure biopesticides sold to farmers are genuine and of high quality • Producers willing to adopt the banana aphid management practices • Producers are organized in groups to ensure that management practices are effectively upscaled • Farm input costs are within the reach of farmers • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	(Pesticide+ labour) KES 27,000 per acre / per year
Estimated returns	Approximately 440 plants x 30 kg x KES.20=KES 264,000 per acre / per year

	If IPM of aphids in banana is not applied the yield will be reduced by 80%. Therefore, the estimated net returns will be 264,000-211,200= KES 52,800 per acre / per year
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to productive resources such as credit to purchase the required inputs such as chemicals than men • Women have limited access to education, training and extension services than men • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in spraying the crop • Affirmative action funds exist for youths and women to access the required funds.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for unemployed exists in spraying the crop. • Affirmative action funds exist for youths and women to access the required funds.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	www.jica.go.jp Banana production-JICA www.fruitrop.com/en/Articles-by-subject/Agronomy/2016/Banana-diseases-and-pests plantvillage.psu.edu/topics/banana/infos infonet-biovision.org/PlantHealth/Crops/Bananas
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for upscaling
G: Contacts	
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Lead Organization and scientist	KALRO Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo and Harun odhiambo
Partner organizations	CABI, ICIPE, KEPHIS, Real IPM, Koppert, Universities, County governments, Farmer Groups, Service provider agencies e.g. financial institutions, traders and private sector Agrovets

GAPS

1. Capacity building on aphids' identification and management
2. Validation of biopesticides and synthetic pesticides in the management of banana aphids
3. Determine the effects of aphids on yield, quality and implication on economic returns for the farmer

Management of Banana Diseases

2.6.6 Integrated Management of Banana Xanthomonas Wilt

2.6.6 TIMP Name	Integrated Management of Banana Xanthomonas Wilt (BXW)
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Losses of up to 70 - 100% attributed to Banana Xanthomonas Wilt disease
What is it? (TIMP description)	<p>Integrated management of Banana Xanthomonas wilt involves the combination of exclusion and cultural control options. The options under each strategy are:</p> <p>Quarantine/Exclusion methods:</p> <ul style="list-style-type: none"> • Exclusion of the disease from areas where it has not been reported through regional quarantine (ie avoid disease introduction) • It involves scouting for the disease and sensitizing farmers and other stakeholders on importance of using planting materials that are certified to be free of diseases <p>Cultural control:</p> <ul style="list-style-type: none"> • Scouting 2-3 times a week for presence of the disease • Break male buds once fingers have stopped forming, to prevent transmission by insects • Cut down diseased plants, carry them in a bag ensuring that infected plant parts are not scattered and bury 1m deep to prevent spread • Disinfect farm tools with 50ml of Jik per litre of water

	 <p>Symptoms of banana Xanthomonas wilt Source: Promusa.org</p>
Justification	<p>In East Africa, incidences of BXW disease were first reported in Uganda. Thereafter the disease was reported in Busia and Bungoma Counties in Western Kenya. Where Integrated Management of BXW is not implemented timely, losses of upto 100% have been reported. Integrated Management of BXW includes excluding the disease from non-infected areas, use of disease free planting materials, field hygiene and removing the male bud to prevent insect transmission. This is a very devastating disease with no cure thus the need to take the necessary protective and surveillance measures promptly.</p>
Region promoted	Busia, Siaya, Kisumu and Bungoma Counties
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, Researchers, KEPHIS, HCD, Extension providers, Seedling producing companies, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Involvement of communities and awareness creation • Continuous surveillance for disease • Availability of funds • Willingness of farmers to participate • Form organized farmer groups that can be trained • Create a platform for banana stakeholders that allows sharing
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Extension agents (both private and public): • Mobilization/sensitization of farmers and extension on the IDM • Farmers/CBO: participate in trainings and adoption of the management practices • KALRO to continually undertake research in management • Universities to promote the IDM package • Farmers/farmer groups to adopt the technologies

	<ul style="list-style-type: none"> • County governments, MoALD to develop enabling policies and create awareness • CGIAR/NGOs to link farmers to the market and lobby for changes in agriculture policies to favour the farmer to enhance production • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Nyamira, Migori, Siaya, Kakamega, Bungoma and Kisii.
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • High cost of labour for removing affected plants • Not all community members will agree to uproot and burn plants in affected mats • Challenges in restricting movement of planting materials from affected areas to non affected areas especially at the borders where communities are related • Unwillingness of farmers to adopt the IDM options
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Farmers should put in place measures to lock out the disease to avoid high costs of removing affected plants • Farmer sensitization on the disease and implications • Provide subsidies that enhance exclusion and where crop is affected give some form of compensation • Limit movement of affected material • Provide credit facilities to support farmers to start off in disease free areas
Lessons learned	<ul style="list-style-type: none"> • Exclusion / prevention is the best control measure for this disease • Involvement of whole community in control is critical • Collaboration between government and communities is important in combating the disease and excluding it where it has not been reported • Scouting for diseases is key in controlling the disease
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The technology is an environmentally safe practice and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	7,000-10,000 per acre/per year (mainly costs for labor for scouting, de-budding, uprooting affected plants and burying)
Estimated returns	$440 \times 30\text{kg per plant} = 13,200\text{kg} \times \text{KES } 20 = 264,000$ Estimated returns = 264,000 – 10,000= 254,000
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge

	<ul style="list-style-type: none"> • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for VMGs exists in affirmative action
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • The disease has been brought under control in Uganda. • It has also been successfully controlled in Western Kenya especially in Busia, Bungoma and Siaya Counties • Some successful farmers Josephine Owino and George Otieno in Siaya County are currently trainers of other farmers besides producing macro propagated bananas
Application guidelines for users	<ol style="list-style-type: none"> 1. Integrated Management of banana diseases. (2020). Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. KALRO Fact sheets produced under KCSAP 2020 How to recognize Banana Xanthomonas wilt. Plantwise Knowledge Bank Important Banana Diseases. 2017. 2. T.K. Kwambai, L.J. Kwach, H. Okwaro., A.A. Masinde and H.N. Wambani. KALRO Information brochure series No. 2017/092
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for up-scaling
G: Contacts	
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Lead organization and scientists	KALRO, Ruth Amata, Anthony Nyaga, Nasambu Okoko, Mercyline Orayo, Josiah Mogaka, Eliud Gatambia
Partner organizations	MoALD, County Governments, One acre fund, World Vision, Farm input Stockists /Agro-vets

GAPS

1. Continuous surveillance to ensure no new outbreaks
2. Quarantine to check the spread to new non infected areas

2.6.7 Integrated management of Fusarium wilt of bananas

2.6.7 TIMP Name	Integrated management of Fusarium wilt of bananas
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Yield losses of 70-100% attributed to Fusarium wilt disease</p> <div> </div> <div> </div> <p>Left: Fusarium wilt disease (Caused by <i>Fusarium oxysporum</i> fsp. <i>cubense</i>) Right: Browning of vascular system of banana affected by Fusarium wilt disease (Source: Ruth Amata, KALRO)</p>
What is it? (TIMP description)	<p>Integrated management of Fusarium wilt involves the combination of cultural, biological and chemical control options. These are:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Practice soil solarization for 2-3 months during hot weather & test the soil and irrigation water to confirm absence of the pathogen before planting • Consider crop rotation when establishing new orchards • Plant Cavendish varieties such as Grand Nain & Williams (These are tolerant to race 1 & 2 of the Fusarium wilt pathogen) • Plant tolerant varieties e.g Gerald Tucker • Scout for the disease for timely control • Uproot affected plants and bury 1m deep • Disinfect farm tools (use 50 ml Jik in 1 Litre of water) • Avoid injuring roots as this creates pathogen entry points to eliminate pathogen entry • Control surface run off by digging trenches since water spreads the pathogen <p>Biological control:</p>

	<ul style="list-style-type: none"> • Apply Trichoderma based biopesticides (Trianum P, Trichotech and Rootgard) <p>Chemical control:</p> <ul style="list-style-type: none"> • Drench soil /spray plants with Previcur N, Saaf WP or Sherrif 75WP before disease becomes severe
Justification	Incidences of Fusarium wilt disease have been reported in all banana growing areas in Kenya. This is a very devastating disease which is capable of remaining in the soil for up to 4 years since it produces resting spores which infect once the host is grown. It causes losses of 70-100%. Where management strategies are not employed the disease is capable of wiping out entire banana orchards since it can be spread through any means that can transfer infected soil (including surface runoff water, farm tools, boots / animal hooves) and tools. There is need to take the necessary preventive measures through use of the IDM package to prevent its spread into non-infected farms / mats and increase productivity and yield
Region promoted	Farmers from Kisii, Nyamira, Tharaka Nithi, Kericho and Bomet Counties have received training on management of this disease
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, HCD, MoALD, KALRO, Extension agents (Public and Private), Research Organizations and Universities, Pesticides companies and CGIAR's, Seedling producers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Willingness of farmers to adopt • Involvement of community and awareness creation • Continuous surveillance for early detection • Availability of funds to conduct the options
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • KALRO to build capacity of trainers. Public and private (County government extension services, community farmer groups, • County government and private Extension service providers will train farmers on the disease and conduct demonstrations either collectively or through farm to farm visits. • Researchers to be involved in fine tuning control techniques

C: Current situation and future scaling up	
Counties already promoted	A few regions in Kisii and Nyamira
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • High cost of labour for removing affected plants • Not all community members will agree to remove affected plants • Movement of affected materials(bananas) from an affected area to clean area thus spreading the disease
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Provide subsidy • Sensitization on the disease and its effect • Limit movement of affected material
Lessons learned	<ul style="list-style-type: none"> • Prevention is the best control measure. Excluding the disease from fields where it has not been found. • Involvement of whole community in control is important since the disease can be transmitted through surface runoff from farm to farm. • Awareness creation and support from County governments and community would be useful
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practise is environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	7,000-10,000 per acre, per year (mainly costs for labor for drenching and spraying biopesticides/pesticides, scouting and field sanitation)
Estimated returns	<p>440 x 30kg per plant = 13,200kg x KES 20 = 264,000 per acre/per year</p> <p>Estimated net returns = 264, 000 – 10,000= 254,000</p>
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge • Some women may not be able to uproot the bananas when infected since it is labor intensive • Women and youths have limited access to credit to buy the required inputs such as chemicals
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in managing fields to keep the disease at bay
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness


VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in managing fields to keep the disease at bay
E: Case studies/profiles of success stories	
Success stories	The disease has been brought under control in parts of Tharaka Nithi where farmers have embraced IDM of Fusarium wilt
Application guidelines for users	<ol style="list-style-type: none"> 1. Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. KALRO Integrated Management of banana diseases. (2020) Fact sheets produced under KCSAP 2020 2. Kwambai. T.K., Kwach L.J., Okwaro H., Masinde A.A. and Wambani H.N Important Banana Diseases. 2017. KALRO Information brochure series No. 2017/092 3. . Ram Niwas et al. Fusarium wilt: A destructive disease of bananas and their sustainable management. 2022
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 -00800 email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO, Ruth Amata, Nasambu Okoko, Anthony Nyaga, Eliud Gatambia & Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> • MoALD • County Governments • Farmer CBO's • Private farm input Stockists /Agro-vets

GAPs

1. Validation of the use of biological control agents in Fusarium wilt disease management

2.6.8 Integrated management of Black Sigatoka Disease of bananas

2.6.8 TIMP Name	Integrated management of Black Sigatoka Disease of bananas:
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Yield losses of 40-50% attributed to Black Sigatoka disease in Kenya


	 <p><i>Black Sigatoka disease (Caused by Mycosphaerella fijiensis)</i> Source: Ruth Amata, KALRO</p>
What is it? (TIMP description)	<p>Integrated management of Black Sigatoka disease involves the combination of cultural and chemical control options. These are:</p> <p>Cultural Control:</p> <ul style="list-style-type: none"> • Use of tolerant varieties such as FHIA 23, FHIA 01 -Gold finger; • Use of recommended spacing 3m x 2m for appropriate plant density and good aeration in the orchard • Sterilizing farm tools to prevent spread when pruning • Avoid injuring plants as these serve as pathogen entry points • Destruction of severely infected leaves by cutting and burying them 2 feet deep • Enhance plant vigour by proper plant fertilization • Apply 20 kg of well decomposed manure per hole at planting and 20kg yearly thereafter per mat. Supplement with 100g of CAN per mat per year. The disease is more severe where plants do not receive adequate fertilization. • Reduce relative humidity by pruning off old leaves as these enhance disease spread • Avoid overhead irrigation as this promotes spread through splash • Plant a Tithonia boundary around the farm for continuous nitrogen supply • Scout for initial disease symptoms for timely control <p>Chemical control:</p> <ul style="list-style-type: none"> • Spray plants with copper based fungicides and alternate with AzoxyTop 325 C according to manufacturers' recommendations
Justification	<p>Incidences of Black Sigatoka disease have been reported in all banana growing areas in Kenya. This is a very devastating disease which reduces leaf surface area for photosynthesis hence reducing the plants' capacity to produce higher yields. It causes yield losses of 40-50 %. IDM of Black Sigatoka is an important package that reduces these losses ensuring that the farmer has higher yields and higher incomes</p>
Region promoted	<p>Some farmers in Kisii, and Nyamira Counties have received information on management of this disease</p>

B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, Bio-pesticides companies, CGIAR's, Seedling producing companies and SMEs, Processors, Agro-input dealers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Create awareness of the benefits of the IDM package • Willingness of farmers to adopt IDM package • Willingness of stakeholders to participate • Create a platform for interaction of banana value chain stakeholders • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes • Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices • Establishment of FFBS • Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Ministry of Agriculture & Livestock Development(MoALD) Extension and Capacity Building • ICIPE (International Centre for Insect Physiology and Ecology)– collaborative research on crop protection • FAO (Food and Agricultural Organization)- co-sharing of resources and networking and knowledge management • CIGs (Common Interest Groups)- back stopping the IDM package at grass root level • NGOs (Non-governmental organization), (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management • Financial institutions to provide credit facilities

C: Current situation and future scaling up	
Counties already promoted	Parts of Kisii, Nyamira, Tharaka Nithi, Muranga and Kiambu
Counties where TIMP will be up-scaled	All Counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> Increased cost of labour for removing affected plant parts and burying in 2 feet deep pits Some farmers believe in retention of residues in the field as manure
Suggestions for addressing the challenges	<p>Sensitization on the importance of the disease and its effects</p> <p>Importance of IDM and reduction in losses</p>
Lessons learned	Scouting is important for early detection and timely control
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> The management practices are environmentally safe and can be practiced in any bio-physical environment. Enabling policy frameworks to support development and adoption of the TIMP is in place Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	5,000-7,000 per acre, per year (mainly costs for labor for scouting, removing infected leaves and burying, spraying pesticides and field sanitation)
Estimated returns	<p>440 x 30kg per plant = 13,200kg x KES 20 = 264,000 per acre/year</p> <p>Estimated net returns = 264,000- 7000 = 257,000</p>
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> Women and youth have limited access to education, training and extension services than men Women have less access to agricultural information, technology and knowledge Women and youths have limited access to credit to buy the required inputs such as chemicals Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> Opportunities for youths exists in uprooting the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs have limited access to credit to buy the required inputs such as chemicals VMGs have limited access to training and extension services Due to their social status VMGs are often excluded from decision making in development and dissemination activities There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> Opportunities for youths exists in in uprooting the crop
E: Case studies/profiles of success stories	
Success stories	The disease has been controlled in farms in Tharaka Nithi where farmers prune off infected leaves timely. The farmers are currently trainers of other farmers besides producing macro propagated bananas

Application guidelines for users	<ol style="list-style-type: none"> 1. Luis Pérez-Vicente, FAO. A holistic integrated management approach to control Black Sigatoka disease of banana caused by <i>Mycosphaerella fijiensis</i>. 2012. 2. Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. Integrated Management of banana diseases. (2020). KALRO Fact sheets produced under KCSAP 2020 3. . Kwambai T.KKwach., L.J., Okwaro H., Masinde A.A. and Wambani H.N. KALRO Information brochure series No. 2017/092 Important Banana Diseases. 2017
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	1 – Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka,
Partner organizations	MoALD, County Governments, Farmer CBO's, Private farm input Stockists /Agro-vets

2.6.9 Integrated management of Yellow Sigatoka Disease of bananas

2.6.9 TIMP Name	Integrated management of Yellow Sigatoka Disease of bananas:
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Yield losses of 40-50% attributed to Yellow Sigatoka disease in Kenya</p>  <p><i>Yellow Sigatoka disease (Caused by Mycosphaerella musicola)</i> Source: Lusike Wasilwa, KALRO</p>
What is it? (TIMP description)	Integrated management of Yellow Sigatoka disease involves the combination of cultural, biological and chemical control options. These are:



	<p>Cultural Control:</p> <ul style="list-style-type: none"> • Use of tolerant varieties such as FHIA 23, FHIA 01 -Gold finger • Use of recommended spacing 3m x 2m for appropriate plant density and good aeration in the orchard • Sterilizing farm tools to prevent spread when pruning • Avoid injuring plants as these serve as pathogen entry points • Destruction of severely infected leaves by cutting and burying them 2feet deep • Enhance plant vigour by proper plant fertilization • Apply 20kg of well decomposed manure per hole at planting and 20 kg yearly thereafter per mat. Supplement with 100g of CAN per mat per year. The disease is more severe where plants do not receive adequate fertilization. • Reduce relative humidity by pruning off old leaves as these enhance disease spread • Avoid overhead irrigation as this promotes spread through splash • Plant a Tithonia boundary around the farm for continuous nitrogen supply • Scout for initial disease symptoms for timely control <p>Chemical control: Spray plants with copper based fungicides and alternate with Ortiva or AzoxyTop 325C according to manufacturers' recommendations</p>
Justification	Incidences of Yellow Sigatoka disease have been reported in all banana growing areas in Kenya. Losses of 40-50% have been attributed to this disease. This is a major banana disease which reduces leaf surface area for photosynthesis hence reducing the plants' capacity to produce higher yields and thus reduces farmer incomes
Region promoted	Some farmers in Kisii, Nyamira, Kiambu, Tharaka Nithi Counties have received information on management of this disease
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, pesticides companies, CGIAR's, Seed producing companies and SMEs, Processors, Agro-input dealers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print

	<ul style="list-style-type: none"> • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Create awareness of the benefits of the IDM package • Willingness of farmers to adopt IDM package • Willingness of stakeholders to participate • Create a platform for interaction of banana value chain stakeholders • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes • Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices • Establishment of FFBS • Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Ministry of Agriculture & Livestock, Development (MoALD) Extension and Capacity Building • International Centre for Insect Physiology and Ecology (ICIPE)– collaborative research on crop protection • Food and Agricultural Organization (FAO)- co-sharing of resources and networking and knowledge management • Common Interest Groups (CIGs)- back stopping the IDM package at grass root level • NGOs (Non-governmental organization), (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Parts of Kisii, Nyamira, Tharaka Nithi, Muranga and Kiambu
Counties where TIMP will be up-scaled	All counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Increased cost of labour for removing affected plant parts and burying in 2 feet deep pits • Some farmers believe in retention of residues in the field as manure
Suggestions for addressing the challenges	Sensitization on the disease and its effect
Lessons learned	Scouting is important for early detection and timely control

Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	5,000-10,000 per acre/ per year (mainly costs for labor for scouting, removing infected leaves and burying, spraying pesticides and field sanitation)
Estimated returns	440 x 30kg per plant = 13,200kg x KES 20 = 264,000 per year Estimated net returns = 264,000 – 10,000= 254,000
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	The disease has been controlled in farms in Tharaka Nithi where farmers pruned off infected leaves timely. The farmers are currently trainers of other farmers besides producing macro propagated bananas
Application guidelines for users	<ul style="list-style-type: none"> • A holistic integrated management approach to control Black Sigatoka disease of banana caused by <i>Mycosphaerella fijiensis</i>. 2012. Luis Pérez-Vicente, FAO 2012. • Integrated Management of banana diseases. (2020). Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. KALRO Fact sheets produced under KCSAP 2020 • Important Banana Diseases. 2017. T.K. Kwambai, L.J. Kwach, H. Okwaro., A.A. Masinde and H.N. Wambani. KALRO Information brochure series No. 2017/092
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling

G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka,
Partner organizations	<ul style="list-style-type: none"> • MoALD • County Governments • Farmer CBO's • Private farm input Stockists /Agro-vets

2.6.10 Integrated management of cigar end rot disease of bananas

2.6.10 TIMP Name	Integrated management of cigar end rot disease of bananas:
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Reduced fruit quality and losses of 30-40% attributed to cigar end rot disease of banana</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p><i>Cigar end rot symptoms on banana fingers</i> <i>Source: Lusike wasilwa KALRO</i></p>
What is it? (TIMP description)	<p>Integrated management of Cigar end rot disease involves the combination of cultural and chemical control options. These are:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Use of tolerant varieties such as Grand Naine • Allow optimal plant density (maximum of 3 suckers at different growth stages) to prevent overcrowding as this leads to high relative humidity which encourages disease development • Scout 2-3 times weekly for early disease detection • Prune off old banana leaves and shade trees to reduce humidity which may create favourable conditions for disease development • Destroy by burning or burying 2 feet deep all severely affected banana fingers/ bunches • Ensure field sanitation by sterilizing farm tools to prevent spread; avoid injuring the fruit

	<ul style="list-style-type: none"> • Remove floral remains on tip of fingers manually 8-11 days after bunch formation • Remove the male bud 15 cm below the last hand (when the fingers have folded in) • Bagging of maturing banana fruits. Use mancozeb based fungicides before fruit emergence • Harvest at maturity to reduce susceptibility to the disease. Scout for the disease for timely control <p>Chemical control:</p> <ul style="list-style-type: none"> • Use azoxystrobin based fungicides e.g Affair Top or Mancozeb based fungicides e.g Dithane M 45 before fruit emergence and harvest at maturity to reduce susceptibility to the disease
Justification	Incidences of cigar end rot disease have been reported in most banana cultivars including Muraru, Valery, Dwarf and Giant Cavendish. Dwarf Cavendish and Gross Michel are most affected, This disease lowers the quality of bananas hence reducing farmers' incomes. Losses of 30-40% have been experienced in susceptible varieties. Use of the IDM package leads to increased productivity, improved food security and hence higher incomes
Region promoted	Some farmers in Kisii, and Nyamira Counties have received training on management of this disease
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, pesticides companies, CGIAR's, Seed producing companies and SMEs, Processors, Agro-input dealers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Create awareness of the benefits of the IDM package • Willingness of farmers to adopt IDM package • Willingness of stakeholders to participate • Create a platform for interaction of banana value chain stakeholders • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes


	<ul style="list-style-type: none"> • Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices • Establishment of FFBS • Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Ministry of Agriculture & Livestock, Development (MoALD) Extension and Capacity Building • International Centre for Insect Physiology and Ecology (ICIPE)– collaborative research on crop protection • Food and Agricultural Organization (FAO)- co-sharing of resources and networking and knowledge management • Common Interest Groups (CIGs)- back stopping the IDM package at grass root level • Non-governmental organization (NGOs) (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Parts of Kisii, Nyamira, Tharaka Nithi, Muranga and Kiambu
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Increased cost of labour for removing affected plant parts and burying in 2 feet deep pits • Some farmers believe in retention of residues in the field as manure
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on the disease and its effect • Farmers could be encouraged to produce well decomposed farm yard manure to reduce incidences
Lessons learned	<ul style="list-style-type: none"> • Scouting is important for early detection and timely control
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	5,000-12,000 per acre/year (mainly costs for labor for scouting for the disease, removing flower buds, bagging of banana bunches and burying infested residues, spraying pesticides and field sanitation)
Estimated returns	<p>440 x 30kg per plant = 13,200kg x KES 20 = 264,000 per acre/per year</p> <p>Estimated net income = 264,000-12,000 = 252,000</p>

Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	The disease has been controlled in farms in Tharaka Nithi where farmers use the IDM package. The farmers are currently trainers of other farmers besides producing macro propagated bananas
Application guidelines for users	<ol style="list-style-type: none"> 1. Integrated Management of banana diseases. (2020). Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. KALRO Fact sheets produced under KCSAP 2020 2. Important Banana Diseases. 2017. T.K. Kwambai, L.J. Kwach, H. Okwaro., A.A. Masinde and H.N. Wambani. KALRO Information brochure series No. 2017/092 3. Cigar End rot of banana. Knowledge Bank. Plantwise
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Nasambu Okoko, Anthony Nyaga, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> • MoALD, County Governments, Farmer CBO's, Private farm input Stockists /Agro-vets

GAPs

1. Assess tolerance of more banana varieties to cigar end rot under high disease pressure
2. Evaluate the use of ITKs in controlling cigar end rot

2.6.11 Integrated management of banana streak disease

2.6.11 TIMP Name	Integrated management of banana streak disease
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Losses of 20-30% attributed to banana streak in Kenya</p>  <p><i>Banana streak disease symptoms on leaf</i> Source: Ruth Amata. KALRO</p>
What is it? (TIMP description)	<p>Banana Streak is a disease caused by a viral pathogen. Integrated management of Banana Streak disease involves the combination of cultural, biological and chemical control options. These are:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Use of virus-free planting material • Regular monitoring banana plantations • Uprooting diseased plants as soon as they are seen and burying them deep or burning them. <p>Indigenous technical knowledge (ITK):</p> <ul style="list-style-type: none"> • Control insect vectors (Mealy bugs). Through use of indigenous technical knowledge; Mix 25ml of surgical spirit with 100 ml of liquid soap/detergent in 20 litres of water and spray. Repeat every 3 days. This is applied during the rainy season or cold areas. For the dry season/warm areas, reduce the surgical spirit to 20 ml and soap to 50ml <p>Chemical control:</p> <ul style="list-style-type: none"> • Use synthetic / chemical pesticides e.g Buprofezin based products e.g Applaud or Spirotetramat based products e.g Movento OD 150 to control the mealy bugs (vector)
Justification	<p>Banana streak disease is a serious viral disease that poses major challenges in banana production in Kenya since it can be transmitted through sharing of planting material by farmers. The disease can also be spread through the insect vector (mealy bugs). The disease causes yield losses of 20-30%. The use of integrated management of banana</p>

	streak disease reduces these losses, increases productivity and farmer incomes and also contributes to food security
Region promoted	It is a fairly new disease in most parts of Kenya. The TIMP is yet to be promoted to most banana growing regions.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, pesticides companies, CGIAR's, Seed producing companies and SMEs, Processors, Agro-input dealers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals <p>Digital Platforms – Website, Dashboards, Apps, social media short message services</p>
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Create awareness of the benefits of the IDM package • Willingness of farmers to adopt IDM package • Willingness of stakeholders to participate • Create a platform for interaction of banana value chain stakeholders • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes • Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices • Establishment of FFBS • Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Ministry of Agriculture & Livestock Development (MoALD)- Extension and Capacity Building • International Centre for Insect Physiology and Ecology (ICIPE)– collaborative research on crop protection • Food and Agricultural Organization (FAO)- co-sharing of resources and networking and knowledge management • Common Interest Groups (CIGs)- back stopping the IDM package at grass root level • Non-governmental organization (NGOs) (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package

	<ul style="list-style-type: none"> • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management <p>Financial institutions to provide credit facilities</p>
C: Current situation and future scaling up	
Counties already promoted	None since this is a relatively new disease in Kenya
Counties where TIMP will be up-scaled	All counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Increased cost of labour for removing affected plant parts and burying in 2 feet deep pits • Some farmers believe in retention of residues in the field as manure and may not be comfortable when asked to uproot and bury them
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on the disease and its effects • Scouting for timely control and minimization of losses
Lessons learned	<ul style="list-style-type: none"> • Scouting is important for early detection and timely control. This would reduce on management costs
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	5,000-10,000 per year (mainly costs for labor for scouting for the disease, removing diseased plants and burying residues 2 feet deep, spraying pesticides and field sanitation)
Estimated returns	$440 \times 30\text{kg per plant} = 13,200\text{kg} \times \text{KES } 20 = 264,000 \text{ per year}$ Estimated net returns = 264,000 – 10,000
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Some of the women are illiterate and they might not understand the protocols written on IDM of banana streak disease • Women have less access to agricultural information, technology and knowledge • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities


	<ul style="list-style-type: none"> There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> Opportunities for youths exists in in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	None
Application guidelines for users	<ol style="list-style-type: none"> Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa Integrated Management of banana diseases. (2020). KALRO Fact sheets produced under KCSAP 2020 Kwambai. T.KKwach. L.J., Okwaro H..., Masinde A.A and. Wambani H.N. Important Banana Diseases. 2017. KALRO Information brochure series No. 2017/092
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Anthony Nyaga, Nasambu Okoko, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> MoALDCounty Governments, Farmer CBO's, Africa Harvest, Private farm input Stockists /Agro-vets

GAPs

1. Assess banana varieties for tolerance to banana streak disease
2. Evaluate biopesticides and ITK's for management of the vector (mealybugs)

2.6.12 Integrated management of anthracnose disease of bananas

2.6.12 TIMP Name	Integrated management of anthracnose disease of bananas:
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Reduced shelf life of bananas attributed to anthracnose disease of banana in Kenya and losses of 20-30% attributed to the disease


	 <p><i>Anthracnose symptoms on banana</i> Source: Margret Muchui, KALRO</p>
What is it? (TIMP description)	<p>Integrated management of Cigar end rot disease involves the combination of cultural and chemical control options. These are:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Allow optimal plant density (maximum of 3 suckers at different growth stages) to enhance aeration and prevent overcrowding as this leads to high relative humidity which encourages disease development • Prune off old banana leaves and shade trees to reduce humidity which may create favourable conditions for disease development • Destroy by burning or burying 2 feet deep all severely affected banana fingers/ bunches • Ensure field sanitation by sterilizing farm tools to prevent spread • Avoid injuring the fruit during harvesting, packaging and storage as such openings serve as avenues for pathogen entry • Bagging of maturing banana fruits reduces disease incidences during storage • Use mancozeb based fungicides before fruit emergence • Harvest at maturity to reduce susceptibility to the disease • Scout for the disease for timely control <p>Indigenous Technical Knowledge</p> <ul style="list-style-type: none"> • Wash the bananas with salty water (25g/5L) to wash off spores before storage • Dip fruits in colourless vinegar (1:4 parts water) for 5 min remove and dry in shaded area before storage • Remove rotting fruits and bury 2 feet deep • Ensure that the storage area is clean
Justification	<p>Anthracnose reduces shelf life and quality of bananas hence leading to increased post harvest losses and reduced incomes to the farmer. Losses of 20-30% have been experienced especially where fruits are stored unhygienically</p>
Region promoted	<p>Kisii, Kiambu, Muranga, and Nyamira Counties have received information on management of this disease</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities,</p>

	pesticides companies, CGIAR's, Seedling producing companies and SMEs, Processors, Agro-input dealers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Create awareness of the benefits of the IDM package • Willingness of farmers to adopt IDM package • Willingness of stakeholders to participate • Create a platform for interaction of banana value chain stakeholders • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes • Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices • Establishment of FFBS • Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Ministry of Agriculture, Livestock Development (MoALD) Extension and Capacity Building • International Centre for Insect Physiology and Ecology (ICIPE) – collaborative research on crop protection • Food and Agricultural Organization (FAO) - co-sharing of resources and networking and knowledge management • Common Interest Groups (CIGs) - back stopping the IDM package at grass root level • (Non-governmental organization (NGOs) (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Kisii, Nyamira, Kiambu, Muranga

Counties where TIMP will be up-scaled	All banana growing counties Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> Increased cost of labour for removing affected plant parts e.g leaves and burying in 2 feet deep pits Some farmers believe in the retention of residues in the field as manure and may not be comfortable when asked to uproot and bury them
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Sensitization of the disease and its effects Scouting for timely control and minimization of losses
Lessons learned	<ul style="list-style-type: none"> Scouting is important for early detection and timely control. This would reduce on management costs
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> The management practices are environmentally safe and can be practiced in any bio-physical environment. Enabling policy frameworks to support the development and adoption of the TIMP is in place Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	3,000-7,000 per acre / per year (mainly costs for labor for scouting for the disease, bagging of banana bunches and burying infested residues, applying ITKs and field sanitation)
Estimated returns	$440 \times 30 \text{ kg per plant} = 13,200 \text{ kg} \times \text{KES } 20 = 264,000 \text{ per acre/year}$ Estimated Net Return = $264,000 - 7000 = 257,000$
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> Some of the women are illiterate and they might not understand the protocols written on IDM of banana anthracnose disease Women have less access to agricultural information, technology and knowledge Women and youths have limited access to credit to buy the required inputs such as chemicals Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> Opportunities for youths exists in uprooting and spraying the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs have limited access to credit to buy the required inputs such as chemicals VMGs have limited access to training and extension services Due to their social status VMGs are often excluded from decision making in development and dissemination activities There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> Opportunities for youths exists in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	None
Application guidelines for users	1. Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. Integrated Management of banana diseases. (2020). KALRO Fact sheets produced under KCSAP 2020

	2. 2017. T.K. Kwambai, L.J. Kwach, H. Okwaro., A.A. Masinde and H.N. Wambani. Important Banana Diseases. KALRO Information brochure series No. 2017/092
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org <u>Tel:</u> +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Anthony Nyaga, Nasambu Okoko, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> MoALD, County Governments, Farmer CBO's, Africa Harvest, Private farm input Stockists /Agro-vets

2.6.13 Integrated management of banana bunchy top disease

2.6.13 TIMP Name	Integrated management of banana bunchy top disease
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Losses of 10-20% attributed to banana bunchy top disease in Kenya</p>  <p><i>Banana bunchy top disease symptoms</i> Source:Infonet Biovision</p>

What is it? (TIMP description)	<p>Banana bunchy top disease is caused by a virus and is vectored by the banana aphid. Integrated management of Banana Bunchy Top disease involves the combination of cultural, biopesticides and chemical control options. These are:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Use of virus-free planting material • Scouting for symptoms 2 - 3 times a week • Uprooting diseased plants as soon as they are seen and burying them deep or burning them <p>Use of biopesticides to control aphids (vector):</p> <ul style="list-style-type: none"> • Use biopesticides e.g Nimbecidine, Achook or Neemraj Super to control banana aphids according to the manufacturers recommendations • Use sticky traps to control aphids <p>Chemical control:</p> <ul style="list-style-type: none"> • Use synthetic / chemical pesticides e.g Alfacyper M EC, Acetak 200 or Battalion 2.5 EC to control the aphids (vector)
Justification	<p>Banana bunchy top disease is a serious viral disease that poses challenges in banana production in Kenya since it can be transmitted through sharing of planting material by farmers. The disease can also be spread through the insect vector (banana aphids). The disease can cause yield losses of 20-30% where infected plant materials are used. The use of integrated management of banana bunchy top disease reduces these losses, increases productivity and farmer incomes and also contributes to food security</p>
Region promoted	<p>It is a fairly new disease in most parts of Kenya. The TIMP is yet to be promoted to most banana growing regions.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<p>Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, pesticides companies, CGIAR's, Seed producing companies and SMEs, Processors, Agro-input dealers, agripreneurs</p>
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Create awareness of the benefits of the IDM package • Willingness of farmers to adopt IDM package • Willingness of stakeholders to participate


	<ul style="list-style-type: none"> • Create a platform for interaction of banana value chain stakeholders • Form well organized farmer groups and networks • Formation of spray service providers (teams) to manage nematodes • Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices • Establishment of FFBS • Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Ministry of Agriculture & Livestock Development (MoALD)- Extension and Capacity Building • International Centre for Insect Physiology and Ecology (ICIPE)– collaborative research on crop protection • Food and Agricultural Organization (FAO)- co-sharing of resources, networking and knowledge management • Common Interest Groups (CIGs)- back stopping the IDM package at grass root level • Non-governmental organization (NGOs) (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	None since this is a relatively new disease in Kenya
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Increased cost of labour for removing affected plant parts and burying in 2 feet deep pits • Some farmers believe in retention of residues in the field as manure and may not be comfortable when asked to uproot and bury them
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on the disease and its effects • Scouting for timely control and minimization of losses
Lessons learned	<ul style="list-style-type: none"> • Scouting is important for early detection and timely control. This would reduce on management costs
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take

D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	3,000-5,000 per year (mainly costs for labor for scouting for the disease, removing diseased plants and burying residues 2 feet deep, spraying pesticides and field sanitation)
Estimated returns	440 x 30 kg per plant = 13,200 kg x KES 20 = 264,000 per year Estimated Net Returns = 264,000 - 5000 = 259,000
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Some of the women are illiterate and they might not understand the protocols written on IDM of banana bunchy top disease • Women have less access to agricultural information, technology and knowledge • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	None
Application guidelines for users	1. Thomas J.E., Iskra-Caruana M.L and Jones D.R.. Banana Bunchy Top Disease. 1994. Disease Fact Sheet No. 4
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Anthony Nyaga, Nasambu Okoko, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> • MoALD • County Governments • Farmer CBO's • Africa Harvest • Private farm input Stockists /Agro-vets

GAPs

1. Assess banana varieties for tolerance to banana bunchy top disease

2.6.14 Integrated management of Crown rot disease of bananas

2..6.14 TIMP Name	Integrated management of Crown rot disease of bananas:
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	<p>Reduced shelf life of bananas attributed to anthracnose disease of banana in Kenya and losses of 10-30% attributed to the disease</p>  <p><i>Crown rot disease of banana</i> Source: Ruth Amata KALRO</p>
What is it? (TIMP description)	<p>Crown rot disease of banana is caused by various fungal pathogens e.g <i>Fusarium</i> spp. Integrated management of crown rot disease of banana involves the combination of cultural, chemical and ITK control options. These are:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Allow optimal plant density (maximum of 3 suckers at different growth stages) to enhance aeration and prevent overcrowding as this leads to high relative humidity which encourages disease development later at storage • Prune off old banana leaves and shade trees to reduce humidity which may create favourable conditions for disease development • Destroy by burning or burying 2 feet deep all severely affected banana fingers/ bunches • Ensure field sanitation by sterilizing farm tools to prevent spread • Avoid injuring the fruit during harvesting, packaging and storage as such openings serve as avenues for pathogen entry • Bagging of maturing banana fruits reduces disease incidences during storage • Harvest at maturity to reduce susceptibility to the disease • Scout for the disease when in storage for timely control <p>Indigenous Technical Knowledge</p> <ul style="list-style-type: none"> • Wash the crown part with salty water (25g/5L), to wash off spores before storage • Dip fruits in colourless vinegar (1:4 parts water) for 5 min remove and dry in shaded area before storage • Remove rotting fruits and bury 2 feet deep • Ensure that the storage area is clean before bringing in fruits


	<p>Chemical control</p> <ul style="list-style-type: none"> In very severe cases, use mancozeb based fungicides before fruit emergence
Justification	Crown rot reduces shelf life and quality of bananas hence leading to increased post harvest losses and reduced incomes to the farmer. Losses of 10-30% have been experienced especially where fruits are stored unhygienically. Use of IDM package reduces the losses, increases yield and incomes through better quality fruits
Region promoted	Kisii, Kiambu, Muranga, and Nyamira Counties have received information on management of this disease
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, KEPHIS, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, pesticides companies, CGIAR's, Seedling producing companies and SMEs, Processors, Agro-input dealers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations - On-farm and on station Agricultural shows/exhibitions/field days Trainings - workshops/Seminars/Meetings Public and private Extension Agents Farmer to farmer extension models Mass media – Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Gross margin analysis Create awareness of the benefits of the IDM package Willingness of farmers to adopt IDM package Willingness of stakeholders to participate Create a platform for interaction of banana value chain stakeholders Form well organized farmer groups and networks Formation of spray service providers (teams) to manage crown rot disease Capacity building of farmers, extension officers and other stakeholders on integrated disease management practices Establishment of FFBS Availability of funds
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> Ministry of Agriculture & Livestock Development (MoALD) Extension and Capacity Building International Centre for Insect Physiology and Ecology (ICIPE)– collaborative research on crop protection Food and Agricultural Organization (FAO)- co-sharing of resources and networking and knowledge management Common Interest Groups (CIGs)- back stopping the IDM package at grass root level

	<ul style="list-style-type: none"> • Non-governmental organization (NGOs) (CARE Kenya): (Farmer Input Promotion) • Farmers/CBO's: participating in trainings and adoption of the IDM package • KALRO and universities to continually undertake research in disease management • PCPB to promote registration of products for disease management • Financial institutions to provide credit facilities
C: Current situation and future scaling up	
Counties already promoted	Kisii, Nyamira, Kiambu, Muranga
Counties where TIMP will be up-scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • Increased cost of labour for burying affected plant parts in 2 feet deep pits • Some farmers believe in retention of residues in the field as manure and may not be comfortable when asked to uproot and bury them
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on the disease and its effects • Encouraging farmers to prepare well decomposed farm yard manure that can be returned on the farm
Lessons learned	Enhancing field and storage hygiene reduces on post harvest losses
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practices are environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	3,000-5,000 per acre/year (mainly costs for labor for scouting for the disease, bagging of banana bunches and burying infested residues, applying ITKs and field sanitation)
Estimated returns	$440 \times 30\text{kg per plant} = 13,200\text{kg} \times \text{KES } 20 = 264,000 \text{ per acre/ year}$ Estimated Net Returns = $264,000 - 5000 = 259,000$
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Some of the women are illiterate and they might not understand the protocols written on IDM of crown rot disease • Women have less access to agricultural information, technology and knowledge • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor intensive
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop

VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	None
Application guidelines for users	<ol style="list-style-type: none"> 1. Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. Integrated Management of banana diseases. (2020). KALRO Fact sheets produced under KCSAP 2020 2. Kwambai T.K., Kwach L.J., Okwaro H., Masinde A.A. and Wambani H.N.. Important Banana Diseases. 2017. KALRO Information brochure series No. 2017/092
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 00800 Nairobi email: cdnarl@kalro.org Tel: +254-711301517
Lead organization and scientists	KALRO: Ruth Amata, Anthony Nyaga, Nasambu Okoko, Mercyline Orayo, Eliud Gatambia, Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> • MoALD , County Governments, Farmer CBO's, Africa Harvest, Private farm input Stockists /Agro-vets

2.6.15 Integrated management of Armillaria in bananas

2.6.15 TIMP Name	Integrated management of Armillaria in bananas
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Yield losses of up to 100% attributed to Armillaria disease affecting banana

	 <p><i>Armillaria</i> disease (Caused by <i>Armillaria</i> spp.) affecting banana Source: Ruth Amata, KALRO</p>
<p>What is it? (TIMP description)</p>	<p>Integrated management of <i>Armillaria</i> in banana involves the use of the combination of cultural methods. These include:</p> <p>Cultural control:</p> <ul style="list-style-type: none"> • Avoid planting banana in fields that had tree crops previously • Plant non host crops in such fields e.g beans, greengrams, sweetpotato, curcubits for 5-7 years and couple this with soil solarization during hot months before bananas can be planted • Consider crop rotation when establishing new orchards • Uproot affected plants and burn • Disinfect farm tools (use 50ml Jik in 1 Litre of water) • Avoid injuring roots as this creates pathogen entry points to eliminate pathogen entry • Control surface run off by digging trenches since water spreads the pathogen <p>Biological control:</p> <ul style="list-style-type: none"> • Drench Trichoderma based biopesticides (Trianum P, Trichotech and Rootgard) in holes at planting, following the 4-7 year rotation and solarisation. Seedlings may be dipped in the Trichoderma before planting. This creates a film of mycelia around roots preventing armillaria from penetrating
<p>Justification</p>	<p>Incidences of <i>Armillaria</i> disease have been reported mainly in banana growing areas in Central Kenya. The disease has been reported in orchards where trees were felled before bananas were planted. This is a very devastating disease which is capable of remaining in the soil for a long time. It causes losses of up to 100%. Where management strategies are not employed the disease is capable of wiping out entire banana orchards since it can be spread through any means that can transfer infected soil (including surface runoff water, farm tools, boots/animal hooves) and tools. There is need to take the necessary preventive measures through integrated disease management practises that ensure that bananas are not planted in fields where trees/shrubs previously grew</p>




Region promoted	Very few farmers in Kiambu and Muranga Counties
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana growers, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, Pesticides companies and CGIAR's, Seedling producers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Training - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer-to-farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Gross margin analysis • Willingness of farmers to adopt • Involvement of community and awareness creation • Continuous surveillance for early detection • Availability of funds to conduct the options
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • KALRO to build capacity of trainers. Public and private (County government extension services, community farmer groups, • County government and private extension service providers will train farmers on the disease and conduct demonstrations either collectively or through farm-to-farm visits. • Researchers to be involved in fine tuning control techniques
C: Current situation and future scaling up	
Counties already promoted	<ul style="list-style-type: none"> • A few regions in Kisii and Nyamira
Counties where TIMP will be up-scaled	<ul style="list-style-type: none"> • All banana-growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> • High cost of labour for removing affected plants • Not all community members will agree to remove affected plants • Movement of affected materials(bananas) from an affected area to clean area thus spreading the disease
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Sensitization on the disease and its effect • Provide subsidy • Limit movement of affected material
Lessons learned	<ul style="list-style-type: none"> • Prevention is the best control measure, excluding the disease from fields where it has not been found. • Involvement of whole community in control is important since the disease can be transmitted through surface runoff from farm to farm. Awareness creation and support from County governments and community would be useful







Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The management practise is environmentally safe and can be practiced in any bio-physical environment. • Enabling policy frameworks to support development and adoption of the TIMP is in place • Awareness of the benefits/advantages/management of the TIMP to enhance acceptability for increased up take
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	5,000-12,000 per acre/year (mainly costs for labor for drenching and spraying biopesticides/pesticides, scouting and field sanitation)
Estimated returns	440 x 30kg per plant = 13,200kg x KES 20 = 264,000 per acre/year Estimated Net Return = 264,000 – 12,000 = 252, 000
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Some of the women are illiterate and they might not understand the protocols written on IDM of Armillaria disease • Women have less access to agricultural information, technology, and knowledge • Women and youths have limited access to credit to buy the required inputs such as chemicals • Some women may not be able to uproot the bananas when infected since it is labor-intensive
Gender-related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to buy the required inputs such as chemicals • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision-making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exists in in uprooting and spraying the crop
E: Case studies/profiles of success stories	
Success stories	The disease has been brought under control in parts of Tharaka Nithi where farmers have embraced IDM of Armillaria
Application guidelines for users	<ol style="list-style-type: none"> 1. Ruth Amata, Nasambu Okoko, Anthony Nyaga, V. Kirigua and Lusike Wasilwa. Integrated Management of banana diseases. (2020). KALRO Fact sheets produced under KCSAP 2020 2. T.K. Kwambai, L.J. Kwach, H. Okwaro., A.A. Masinde and H.N. Wambani Important Banana Diseases. 2017. KALRO Information brochure series No. 2017/092
F: Status of TIMP readiness (1 Ready for up scaling; 2 requires validation; 3 requires further research)	Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO Kabete P.O Box 14733 -00800 email: cdnarl@kalro.org Tel: +254 711301517

Lead organization and scientists	KALRO, Ruth Amata, Nasambu Okoko, Anthony Nyaga, Eliud Gatambia & Josiah Mogaka
Partner organizations	<ul style="list-style-type: none"> MoALD , County Governments, Farmer CBO's, Private farm input Stockists /Agro-vets

Weed Management in Banana

2.6.16 Banana Integrated Weed Management

2.6.16 TIMP Name	Banana Integrated Weed Management	
Crop management practices	Innovation	
A: Description of the technology, innovation or management practice		
Problem addressed	<p>Reduced yield and profitability of banana due to competition from different annual and perennial weed species and poor weed management approaches. Some key weed species include Crab sanguinalis (<i>Digitaria spp.</i>), goose grass (<i>Eleusine indica</i>), Craws feets (<i>Dactyloctenium aegyptium</i>), <i>Sateria spp.</i> Palmer amaranths (<i>Amaranthus palmeri</i>), Red pigweed (<i>A. retroflexus</i>) and Sedges including Yellow nutsedge (<i>Cyperus esculentus</i>), and Purple nutsedge (<i>Cyperus rotundus</i>) are more a challenge in banana cropping systems.</p> <div></div> <p><i>Biodiversity of weed species occurring in a banana field</i> Source: S.Kimani & H. Mwangi</p> <div><div></div><div></div></div>	


	Wondering jew (<i>Commelina benghalensis</i>)	Double thorn (<i>Oxygonum sinuatum</i> and starbur (<i>A. hispidum</i>)
		
	Pigweed (<i>Amaranthus spp.</i>)	Sow thistle(<i>Sonchus oleraceae</i>)
		
	Black jack (<i>Bidens pilosa</i>)	Gallant soldier (<i>Galinsoga parviflora</i>)
		
	(<i>Parthenium hysterophorus</i>):	Goat weed (<i>Ageratum conyzoides</i>)
	Source : Hottensiah Mwangi	
What is it? (TIMP description)	<p>Integrated Weed Management (IWM) is the use of two or more appropriate approaches including preventive, planting in a weed free prepared land, use of mulch (biodegradable or synthetic), cultural, rotation, intercropping and chemical control based on case specific weed condition of the field, resources, accessibility, and type of landscape. Cultural includes transplanting rather than direct planting, proper fertilization, irrigation, use of cover crops and plastic mulch to reduce weed populations. Physical control is the removal of weeds manually or by mechanical means, such as hand weeding or mowing. In manual weeding weeds are removed frequently to ensure area surrounding the banana is weed free as possible. Mow weeds between the rows several times a year to prevent serious competition with young bananas. Chemical control is where appropriate recommended herbicides are applied following the label instructions to control weeds. The weed composition needs to be identified and the data used to implement the</p>	

	best management approach timely. Step one is to monitor fields and maintain records of weeds occurring in each field. Identify species and where they are likely to appear. Proper identification of species will guide on the management approaches to combine. Since one method will be effective only on some species and not others; use two or more approaches as appropriate for a profitable banana crop.
Justification	Bananas are vulnerable to weed invasion especially where growers take weeds for granted. Vine weeds such as cats claw creeper and madeira can quickly spread and smother even kill bananas. Other weeds such as lantana weeds are a challenge. This is due to limited knowledge on weed biology and management strategies which include physical, biocontrol, intercrops, covercrops and herbicide. Whereas manual weeding can be effective for managing some weed species, it is time consuming and labour intensive. However manual weeding can also be ineffective especially because specific types of weeds such as <i>Commelina benghalensis</i> and <i>Portulaca oleraceae</i> get apparently disseminated through cuttings during weeding and is replanted when the activity is done under wet conditions. Hence, regrowth becomes a big problem. Therefore there is need to apply more than one approach to manage the biodiversity of weeds. Judicious use of herbicides integrated with cultural methods gives a promising IWM option for weed control in bananas cropping systems.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension workers, Agrodealers, agri-preneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals Digital Platforms – Website, Dashboards, Apps, social media short message services.
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive research to test, validate and release IWM in bananas. • A platform for interaction of bananas value chain stakeholders • Promote and train on integrated weed management (IWM). • Address environmental and safety concerns related to the use of herbicides. • Accompany the promotion with demos and field days with farmers groups and stakeholders on the effectiveness of the various weed management options using FFBS approach. • Train stakeholders on biology of weeds and weed dynamics in cropping systems.

	<ul style="list-style-type: none"> • Farmers need training on timing with regard to conservation of biodiversity. Preserve pollinators for increased productivity of weed control. • Train users on appropriate use of herbicide and safe use.
Partners/stakeholders for scaling up and their respective roles.	Agrochemical companies, Agrodealers, KALRO, County extension staffs, CBO, & NGOs), agripreneurs.
C: Current situation and future scaling up	
Counties where already promoted if any	
Counties where TIMPs will be up scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in development and dissemination	<p>Lack of bananas innovation platforms to facilitate interaction of farmers with relevant stakeholders, Low use of IWM, labour intensity, High cost of herbicides, Inadequate knowledge and information on types of herbicides to use, how and when to use them and their persistence in the soil.</p> <p><u>Myths on appropriateness of using herbicides</u></p>
Suggestion for addressing the challenges	<ul style="list-style-type: none"> • Establish Banana innovation platforms, Promotion of the technology/ product in the suitable areas conducting demos and field days and involvement of the stakeholder e.g. agro-chemical companies and agro-dealers. • Develop and disseminate information to various stakeholders. • Training on integrated approaches using available methods, including appropriate herbicides for bananas. • Their persistence in different soil environment that can affect follow up intercrop or cover in the first five years of bananas establishment. • Safe use of herbicides.
Lesson learned in up scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • That integrated approaches of weed management are more effective than use of one control method and is environmentally friendly. • Continuous use of herbicide is an environmental, health and social hazard. • Consumers concerns of herbicide residues in the soil and odor absorption by bananas needs attention. • Creation of awareness through demonstrations and farmer field days help in adoption of the technology/ IWM • Availability of market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms.
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Train stakeholders to understand the working of an integrated weed management program. • Address the environmental and social concerns related to use of herbicides.

	<ul style="list-style-type: none"> • A functional agro-dealer network to supply the products when required by the farmers. • Have a safety plan when using herbicides.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES
Estimated returns	KES
Gender issues and concerns in development and dissemination	<ul style="list-style-type: none"> • IWM is labor intensive in terms of handling and application hence may not be adopted by women who are already overburdened. • Women and youth have limited access to land than men. • Women and youth may also have limited access to inputs such as manures and chemicals than men. • Women have less access to agricultural information, technology and knowledge than men.
Gender related opportunities	<ul style="list-style-type: none"> • Opportunity exist for women to access the required credit through the women enterprise funds. • Employment opportunities exist for youths in spraying the weeds
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to land • VMGs may also have limited access to finances to buy the required inputs such as manures and chemicals • VMGs have less access to agricultural information, technology and knowledge
VMG related opportunities	<ul style="list-style-type: none"> • Opportunity exist for youths to access the required credit through the youths' enterprise funds. • Employment opportunities exist for youths in spraying the weeds
E: Case studies/profiles of success stories	
Success stories	Kenya small holder farmers.
Application guidelines for users	.
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	Requires validation.
G: Contacts	
Contacts	Center Director KALRO Kabete, Waiyaki Way, P.O Box 14733-00800, Nairobi
Lead organization and scientists	KALRO , Kabete Dr Hottensiah Mwangi, Dr Momanyi Violet, & Antony Nyaga.
Partner organizations	KALRO- Kabete, KALRO -Thika NGOs, CBOs, County Governments, KEPHIS, MOALD,

2.6.17 Bananas Intercropping System for weed management


2.6.17 TIMP Name	Bananas Intercropping System for weed management
Categories (i.e. technology innovation Or management practice)	Innovation Insert Photo: Banana intercrop
A: Description of the technology, innovation or management practice	
Problem addresses	 <p><i>Occurrence of a wide biodiversity of weeds that compete with bananas cropping system Amaranthas spp, grass weeds</i> Source: Hottensiah Mwangi</p>
What is it? (TIMP description)	<p>Innovative bananas intercropping system is the growing of two or more crops in a banana field at the same time, as a tool to reduce weed space and suppress emerged weeds while to increase productivity & profitability of bananas. It helps achieving efficient land use by reducing weed area. Intercropping systems are defined based on the temporal and spatial arrangements of the crops. Appropriate intercropping systems are strip or row patterns between bananas.</p> <p>Suitable crops should be used for intercrop to provide income in the years you are establishing bananas plantation. Such crops may include planting shallow rooted vegetables (onions, parsley), cereals (maize), legumes (beans) in between rows of bananas. Innovative intercropping systems arrangement reduce weeds. Farmers inter-cropping bananas with other crops reduce weeding and have better returns to their investment in especially in young orchards. This should be done intelligently with specific spacing, the right choice of crops depending on growth habit of the intercrop.</p> <p>Growers require understanding the optimal crop spacing and configuration, selection of crops adapted to bananas intercropping and adopting sequencing approaches that will maximize use of the resources (water, nutrients and light) leading to increased yield and profitability of banana cropping systems..</p>
Justification	<p>Intercrops in middle rows done prudently provide weed control between rows and profit bananas through soil health improvement. Suitable intercrops can provide income during the years before profitability of bananas. Innovative intercropping systems can help farmers achieve the desired productivity and profitability while at the same time diversifying the cropping system and adapting to climate change. Bananas does well when intercropped with</p>



	legumes to mitigate the risk of total crop failure due to drought. Intercropping has important advantages in regard to efficient land use. It can significantly increase total productivity as compared to monocropping thanks to better utilization of water, nutrients and solar energy. Crops in these systems use available resources more efficiently due to different rooting and canopy properties; but they should not shade or disturb root system. Therefore is one of the most dependable ways to sustain bananas production in light of prevailing climate change.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension Staff , agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations - On-farm and on station Agricultural shows/exhibitions/field days Trainings - workshops/Seminars/Meetings Public and private Extension Agents Farmer to farmer extension models Mass media – Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Applied and adaptive research to validate and upscale intercropping system for weed management in banana cropping systems. A platform for interaction of bananas value chain stakeholders Conduct demos and the field days with farmers groups and stakeholders
Partners/stakeholders for scaling up and their respective roles.	County extension staffs, NGOs, Private sectors e.g. seed company and seed dealers, Research organizations (KALRO, Egerton University, UoN), agri-preneurs
C: Current situation and future scaling up	
Counties where already promoted if any	Murang'a
Counties where TIMPs will be up scaled	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in development and dissemination	<ul style="list-style-type: none"> Lack of bananas innovation platforms to facilitate interaction of farmers with relevant stakeholders Limited knowledge on biology of weeds Lack of understanding of innovative intercropping for weed management. Inadequate training and limited extension staff
Suggestion for addressing the challenges	<ul style="list-style-type: none"> Establish banana innovation platforms Facilitation of training of county extension staffs on weeds. Facilitate farmer training on innovative weed management. Conduct demos and field days

Lesson learned in up scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Intercropping systems are knowledge intensive and should not shade, crowd or compete seriously for soil and water. Such a change calls for intensive training and demonstration for farmers to familiarize with the innovation to benefit. • Creation of awareness through demonstrations and farmer field days help in adoption of the innovation bananas intercropping • Availability of market is essential • Partnership is important in innovation dissemination and adoption and this can be facilitated through innovation platforms
Social, environmental, policy and market conditions necessary for development and up-scaling	A farmer learning platform is essential for training on how to deploy the innovative intercropping systems.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	-
Estimated returns	-
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Complexity of the intercropping system may result in increased labour for women who perform most of the crop's activities such as planting and weeding. • Women have less access to information, technology and knowledge. • Women have less access to land and credit that can be used for garden peas farming • Women have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> • Intercropping offers good opportunities women to grow diverse crops for economic gains and at the same time offers enhanced biodiversity benefits. • Affirmative action opportunities such as the women enterprise funds and youth fund exists to access the required credit.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge. • VMGs have limited access to productive resources such as land and credit for garden peas farming. • VMGs have limited access to training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by VMGs due lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Intercropping offers good opportunities to VMGs to grow diverse crops for economic gains and at the same time offers enhanced biodiversity benefits. • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit.

E: Case studies/profiles of success stories	
Success stories	
Application guidelines for users	
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2. Require validation
G: Contacts	
Contacts	Center Director KALRO Kabete, Waiyaki Way, P.O Box 14733-00800, Nairobi
Lead organization and scientists	KALRO Kabete, Dr Hottensiah Mwangi, Dr Violet Momanyi and Antony Nyaga.
Partner organizations	MOALD, County Extension Staff, Farmer Groups and CBOs, NGOs

2.6.18 Cover cropping for weed management in bananas


2.6.18 TIMP Name	Cover cropping for weed management in bananas
Categories (i.e. technology innovation Or management practice)	<p>Technology</p> 
A: Description of the technology, innovation or management practice	
Problem addresses	<p>The wide biodiversity of annual grass weeds and perennial weed species coupled with poor weed management leading to yield losses and lack of profitability in bananas cropping systems especially at young stage. Some key grass weed species including Crab sanguinalis (<i>Digitaria spp.</i>), goose grass (<i>Eleusine indica</i>), Crawsfoot (<i>Dactyloctenium aegyptium</i>), and <i>Sateria spp.</i> Broadleaved weeds include double thorn (<i>Oxygonum sinuatum</i>) Palmer amaranths (<i>Amaranthus palmeri</i>), Red pigweed (<i>A. retroflexus</i>) and Sedges such as Yellow nutsedge (<i>Cyperus esculentus</i>), and Purple nutsedge (<i>Cyperus rotundus</i>) are more of a challenge in bananas growing fields where they have succeeded because of their morphological and phonological characteristics.</p>

	  <p><i>Grass weeds and broad leaved growing in association</i></p>
<p>What is it? (TIMP description)</p>	<p>This is a technology where specific selected crops are grown to produce biomass/canopy to cover soil and suppress weeds. Cover crops in the field may be live cover or dead crop residue. After cover crop has produced biomass, it may later be killed by rolling them down or desiccated with a post emergence herbicide to form a mulch soil cover. This cover acts as a physical barrier cutting off light to stop germinating weed seeds and stop emerging weeds. Large amounts of cover crop biomass suppress weeds in a subsequent season and duration of effective suppression depends on type of cover crop used and amounts of biomass used.</p>
<p>Justification</p>	<p>Cover cropping with appropriate variety of cover crop (technology) works well with bananas in no till system. Cover crop like rye and wheat is planted in fall to develop cover. Large amounts of biomass developed by cover crops suppress weeds in subsequent season. Rolled down cover crop material will reduce weed emergence by forming a physical barrier. Also the cover crop including black oats may produce allelochemicals that inhibit small seeded weeds germination and emergence. Physical chemical suppression may last a month depending on amount of biomass. Cover crops may also be left to conserve moisture and modify soil temperatures where necessary as an added benefit. Different crops could be good cover crops particularly legumes, cereals and increase productivity of bananas.</p>

B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension Staff
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/Seminars/Meetings • Public and private Extension Agents • Farmer to farmer extension models • Mass media – Electronic and print • Publications - posters/brochures/leaflets, manuals <p>Digital Platforms – Website, Dashboards, Apps, social media short message services</p>
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive research to test, validate and release cover cropping in bananas varieties • A platform for interaction of bananas value chain stakeholders • Conduct demos and the field days with farmers groups and stakeholders
Partners/stakeholders for scaling up and their respective roles.	County extension staffs, NGOs, Private sectors e.g. seed company and seed dealers, Research organizations (KALRO, County staff),agripreneurs
C: Current situation and future scaling up	
Counties where already promoted if any	Murang'a
Counties where TIMPs will be upscaled	All banana-growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in development and dissemination	<ul style="list-style-type: none"> • Lack of bananas innovation platforms to facilitate the interaction of farmers with relevant stakeholders • Low use of the cover crop technology • Labour intensity in weeding • Inadequate training and limited extension staff
Suggestion for addressing the challenges	<ul style="list-style-type: none"> • Establish bananas innovation platforms • Information dissemination on the technology • Promotion of the technology in the suitable areas • Facilitation of training of county extension staffs • Contact demos and field days
Lesson learned in up scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Creation of awareness through demonstrations and farmer field days help in adoption of the technology. • Availability of market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms

	<ul style="list-style-type: none"> Cover crop technology is knowledge intensive. Such a change calls for intensive training and demonstration for farmers to familiarize with the technology use to gain its benefits.
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> A farmer learning platform is essential for training on how to deploy the technology.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Depends on crop variety used and method used to manage it.
Estimated returns	-
Gender issues and concerns in development, dissemination, adoption, and scaling up	<ul style="list-style-type: none"> Cover crop reduce labour time and costs. This may reduce the labour burden for the various gender categories especially women who perform most of the weeding activities. Women and youths have limited access to productive resources such as land and the required seeds for the cover crops (BCAs) This time saved can be used to perform other productive activities.
Gender-related opportunities	<ul style="list-style-type: none"> Women can use the cover crops to ensure food and nutritional security in the household. Affirmative action opportunities exist for women and youths to acquire the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> The TIMP will reduce VMG's weeding time that can be used performing other productive activities.
VMG related opportunities	<ul style="list-style-type: none"> Women can use the cover crops to ensure food and nutritional security in the household. Affirmative action opportunities exist for women and youths to acquire the required credit
E: Case studies/profiles of success stories	
Success stories	
Application guidelines for users	1. Mwangi, H.W., Kihurani, A.W., Wesonga, J.M., Ariga, E.S. & Kanampiu, F. (2015a). Factors influencing adoption of cover crops for weed management in Machakos and Makueni counties of Kenya. <i>European Journal of Agronomy</i> 69(2015)1-9. Http://dx.doi.org/10.1016/j.eja.2015.05.001 .
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2. Require validation
G: Contacts	
Contacts	Center Director KALRO Kabete, Waiyaki Way, P.O Box 14733-00800, Nairobi
Lead organization and scientists	KALRO Kabete, Dr Hottensiah Mwangi, Dr Violet Momanyi , Antony Nyaga.
Partner organizations	MOALD, County Extension Staff, Farmer Groups and CBOs, NGOs

2.6.19 Mulching for weed management in banana

2.6.19 TIMP name	Mulching for weed management in banana
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	<p>Weed competition for soil nutrients, moisture, space and unfavorable soil temperatures.</p>  <p><i>Starbur (Acanthospermum hispidum) and Double thorn (Oxygonum sinuatum) and other annual grasses</i></p>
What is it? (TIMP description)	<p>The practice of covering the soil/ground with natural materials or synthetic materials. Mulches control weed seedlings emerging and seeds that germinate near or at the soil surface. There are two types of mulches: biodegradable or natural mulches. Biodegradable include straw, dead leaves and compost to make more favourable conditions for bananas growth, development and efficient production. The mulches should be between 2-4 inches deep to be effective. Non degradable or synthetic mulches can be used.</p> <p>Benefits: Organic mulches suppress weeds; retain moisture in the soil; keep the soil cool; and help improve soil fertility (as the mulches decompose providing calcium, boron, zinc, Nitrogen, Potassium, and trace elements) and improves micro-climate hence increasing biodiversity and productivity of bananas.</p> <p>Synthetic mulches will solarize soils, control weeds and weed seeds, retain soil moisture and controls diseases. Inspect and pull out emerging weeds timely.</p>
Justification	<p>Weeds can easily choke and kill out young seedlings. In Sand box or seed beds use of black polythene prevents light from reaching the small weeds and prevent germination. Organic mulching (straws or dry leaves) on rows have added benefits other than minimizing weeds infestation. It facilitates retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops. It also improves soil structure directly by preventing raindrop impact and indirectly by promoting biological activity. Synthetic mulch are easy to obtain and apply, and are reusable.</p>
B: Assessment of dissemination and scaling up/out approaches	



Users of TIMP	Banana growers, HCD, MOA, KALRO, Extension agents (Public and Private), Research Organizations and Universities, Pesticides companies and CGIAR's, Seedling producers, agripreneurs
Approaches to be used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations - On-farm and on station Agricultural shows/exhibitions/field days Trainings - workshops/Seminars/Meetings Public and private Extension Agents Farmer to farmer extension models Mass media – Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms – Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Applied and adaptive research to test, validate and release mulching technology in bananas A platform for interaction of bananas value chain stakeholders <p>Organic:</p> <ul style="list-style-type: none"> Availability of plant or crop residues for organic mulches. Size of the land. Competing uses of crop residues. Type of the crop residues <p>Synthetic</p> <ul style="list-style-type: none"> Cost of materials Disposal of material after use.
Partners/stakeholders for scaling up and their roles	County government extension services; Provide link with farmers Community farmer groups; play coordination role for ease in problem identification and dissemination
C: Current situation and future scaling up	
Counties where already promoted	Meru
Current extent of reach	Available and practiced in different commodity value chains
Counties where TIMP will be promoted	All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi
Challenges in dissemination	<ul style="list-style-type: none"> Lack of bananas innovation platforms to facilitate interaction of farmers with relevant stakeholders Low use of the agronomic practice Labour intensity and availability of mulching materials Lack of enough plant and crop residues due to competing uses of organic mulches. Possibilities of insect build up categorized as pest or disease vectors or weed seeds in organic mulches. Beware of small tears and rips which will allow weeds emergence through plastic mulches including around the holes . Purple and yellow nutsedge may penetrate mulches as early as six days after transplant in plastic mulches.

Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish bananas innovation platforms • Crop diversification to increase availability of organic mulches. • Establish and follow a good integrated weed management control program for the particular melon varieties. • Monitor for any tears /rips and pull out any weeds without allowing them to take over. • Adapting alternative mulching materials like high absorbance polymers.
Lessons learned	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Creation of awareness through demonstrations and farmer field days help in adoption of the varieties • Creation of awareness through demonstrations and farmer field days help in adoption of the technology/ IWM • Availability of market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • There is need to adapt to alternative mulching technologies in addition to use of organic materials like straws dry leaves, and dry grass.
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Practice is socially acceptable • Environmentally friendly • Increased productivity will provide supply to the markets • Supporting frameworks/policies are available.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Organic mulch is low cost but labour intensive during the initial application.
Estimated returns	Dependent varieties of bananas but generally about 100% of the initial investments assuming other factors are in control.
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Mulching will reduce women's weeding time that can be used in performing other productive activities. • Mulching may be labor intensive for some women who are already overburdened by other domestic activities hence may not to be adopted.
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for the unemployed youths in performing the operation. • Opportunities exist for women to use the readily available on-farm mulch, to enrich their crop for increased productivity.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Mulching will reduce some VMGs weeding time that can be used in performing other productive activities. • Mulching may be labour intensive for some VMGs such as the elderly hence may not to be adopted.
VMG related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for the unemployed youths in performing the operation.

E: Case studies/profiles of success stories	
Success stories	Farmers in different value chains have reported weed suppression, improved soil conditions, reduced runoff and nutrient loss, soil moisture retention in the soil and generally increased crop production following application of mulching technology.
Application guidelines for users	User guidelines are dependent on value chain. Plant clean bananas seeds in clean seed beds Apply mulch between the rows of bananas rows. Mulch management Hand pull weeds that grow out of the mulch.
F: Status of TIMP readiness (1=Ready for upscaling; 2=Requires validation; 3=Requires further research)	Ready to use.
G: Contacts	
Contacts	Centre Director KALRO Kabete, off Waiyaki way, P.O. Box 14733-00800, NAIROBI. <u>Tel:+254-0721822312</u> E-mail: cd.narl@kalro.org
Lead organization and scientists	KALRO, Dr Hottensiah Mwangi, Dr Violet Momanyi. Antony Nyaga.
Partner organizations	MoALD, County governments Public-Private-Partnerships

2.6.20 Solarisation in seedbed for Weed Control

2.6.20 TIMP Name	Solarisation in seedbed for Weed Control
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Competition from biodiversity of weeds in seed beds can slow development of banana seedlings resulting to weak and stunted growth. This depends on weed diversity and density, duration weeds are around to compete for nutrients, moisture and space and the environment. The grass weed problems include crab sanguinalis (<i>Digitaria sanguinalis</i>), Sudan grass (<i>Sorghum halepense</i>) and goose grass (<i>Eleusine indica</i>) and <i>Echinochloa colona</i> . Broadleaved weeds include Palmer amaranths (<i>A. palmeri</i>), Red pigweed (<i>A. retroflexus</i>) and <i>C. arvense</i> L.), (<i>Chenopodium album</i> L.), (<i>Rumex crispus</i> L.) and <i>Portulaca oleraceae</i> . The Purple nutsedge (<i>Cyperus rotundus</i>) and Yellow nutsedge (<i>C. Esculentus</i>) are more challenging.


	  <p><i>Diversity of weed species (grasses, broadleaved, annuals and perennials) that emerge to compete with bananas seedling for available nutrients, moisture and space</i></p>
What is it? (TIMP description)	<p>Solarisation is a method where you use transparent polythene films and increase soil temperatures by 10⁰C or more than atmospheric to kill weed seeds and seedlings. Basic phenomena is building up of lethally high temperatures in top soil where most dormant and viable seeds are present. The Mechanism is mainly breaking dormancy of weed seeds and solar scotching of emerged weed seedlings and direct killing of weed seeds by heat. The mechanism can increase soil temperature by 8-12 °C over non mulched soil. Rhizomes of perennial weeds may be killed if not deeply buried. Effectiveness in control is weed species specific and also depends on length of period of heating.</p>
Justification	<p>Solarization for two consecutive years is successful in controlling perennial weeds such as sedges. Solarization with 0.05 mm T Polythene sheets 40 days is effective in controlling weeds than use of 0.01 mm polythene and takes shorter time duration. This is a good ecological and environmentally friendly method that is sustainable for small scale seedling producers.</p>
Region promoted	Thika-KALRO
Counties where TIMP will be upscaled	<p>All banana growing counties including Meru, Nyeri, Taita Taveta, Kirinyaga, Migori, Kisii, Kiambu, Kericho, Homa Bay, Bungoma, Busia, Nyamira, Vihiga, Tharaka Nithi</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<ul style="list-style-type: none"> Farmers, agriprenuers, extension agencies

Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations - On-farm and on station Agricultural shows/exhibitions/field days Trainings - workshops/Seminars/Meetings Public and private Extension Agents Farmer to farmer extension models Mass media – Electronic and print Publications - posters/brochures/leaflets, manuals <p>Digital Platforms – Website, Dashboards, Apps, social media short message services</p>
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Applied and adaptive research to test, validate and release solarisation bed technology weed control in bananas A platform for interaction of bananas value chain stakeholders Development of mulching for weed management in bananas.
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> Public and private partners –MOALD for extension, Farmer Input Promotion (FIPs) for promotion. Farmer Groups for activity implementation and promotion. Service provider agencies e.g. Micro-finance agencies and banks for credit provision, agro-vets for input supply. Processors and manufacturers to create market for produce, aggregators e.g. Community Action for Rural Development (CARD) for economy of scale sales and marketing and Others e.g. NGOs, CBOs, and FBOs to provide specialist services like community mobilization, nutrition training etc.
C: Current situation and future scaling up	
Current extent of reach	Validation of these solarization needs to be done before recommendations are given to the farmers.
Challenges in dissemination	<ul style="list-style-type: none"> Lack of bananas innovation platforms to facilitate interaction of farmers with relevant stakeholders Low use of the agronomic practice Labour intensity Limited knowledge and information and low literacy levels among the farmers. Capacity building is required to impart knowledge and skills in appropriate use and application of solarization. The farmers need to understand the proper use and application of solarization to avoid buying inappropriate polythene and minimize health, environmental and social hazards.
Recommendations for addressing the challenges	<ul style="list-style-type: none"> Establish bananas innovation platforms There is need to train the agricultural extension county officers as TOTs on appropriate use of solarization. This help in reaching the farmers with the information. Polythene

	disposal should be done carefully to avoid environmental, health and social hazards. Liaise with the agricultural extension and environmental officers on the ground for farmer empowerment and guidance on reuse and polythene disposal.
Lessons learned	<p>Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform.</p> <p>Creation of awareness through demonstrations and farmer field days help in adoption of the technology of Solarisation bed for weed control</p> <p>Availability of market for bananas is essential</p> <p>Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms.</p> <p>Access to and use of information on different methods of weed control will reduce drudgery and cost of weed management. It could give room to increase area under cultivation, productivity and profitability..</p>
Social, environmental, policy and market conditions necessary	Sensitization of communities on alternative methods of weed control and appropriate use of polythene is very necessary.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Solarization to control weeds is cheaper than manual weed control because it requires less labour and achieves timely weed management.
Estimated returns	Not yet estimated
Gender issues and concerns in development, dissemination adoption and scaling up,	<ul style="list-style-type: none"> • Women may have limited access to the required inputs such as the transparent plastic sheets. • Women have limited access to education, training and extension services on the TIMP • Women have less access to agricultural information, technology and knowledge.
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for youths exist in soil solarization through placement of transparent plastic sheets over the production bed.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to education, training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • VMGs have limited access to the required inputs such as the transparent plastic sheets. • There is low adoption by VMGs due lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youths in performing the operation.
E: Case studies/profiles of success stories	
Success stories	.
Application guidelines for users	Scholars space.manoa.hawaii.edu/bitstream/10125/16280/1/8-121pdf

F: Status of TIMP Readiness (1. Ready for up-scaling; 2. Requires validation; 3. Requires Research)	Requires validation and more research
G: Contacts	
Contacts	KALRO,
Lead organization and scientists	KALRO Dr Hottensiah Mwangi, Dr Violet Momanyi, Antony Nyaga.
Partner organizations	MoALD , Counties, Chemical companies.

2.6.21 Stale seedbed for weed control in banana

2.6.21 TIMP Name	Stale seedbed for weed control in banana
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	A rich dormant seed bank of diverse annual and perennial grass and broadleaved weed species in the soil which emerge/germinate and compete with the banana crop for growth resources such as nutrients, water and space leading to yield losses.
What is it? (TIMP description)	<p>Stale seedbed (false) is a weed management technology where weed seeds just below the soil surface are allowed/ stimulated to germinate after rainfall or wetting the soil and then killed (one to two flushes of the weeds) prior to planting the crop while minimizing soil disturbances. Weeds are killed using post-emergent herbicides such as glyphosate at a rate of 100-300ml in 20 litres of water, or the weeds are ploughed into the soil.</p>  <p><i>Flush of young weed seedlings emerged before planting</i> Source: Violet N. Momanyi, KALRO</p> <p>Non-residue paraquat may also be used to destroy dense flush of young weed seedlings. This is followed by sowing the banana. Several passes made in the soil with roto spike tooth hallow is useful to destroy the emerging weeds during preparation of stale beds.</p> <p>Grass weeds include Couch grass (<i>Digitaria abyssinica</i>), and Goose grass (<i>Eleusine indica</i>) while broadleaved include Red</p>




	pigweed (<i>Amaranthus retroflexus</i>), Datura (<i>Datura stramonium</i>) and Purple nutsedge (<i>Cyperus rotundus</i>). The weed problem is aggravated by wrong timing and poor control methods.
Justification	The technology effectively controls broad and narrow leaved weeds that germinate before the crop is planted. Competition from weeds deprive crops of available resources which affects the growth and yield depending on weed density and diversity, stage of weed growth and environment. The technology can effectively control weeds such as couch grass (<i>Digitaria abyssinica</i>), nutsedges e.g. Purple nutsedge (<i>Cyperus rotundus</i>) and Wondering jew (<i>Commelina benghalensis</i>) that are challenging and difficult to control. With sound knowledge of weed phenology and other factors like temperature, irrigation and humidity at the local level it is possible to predict when certain weeds will raise problems in banana seedbed.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<ul style="list-style-type: none"> • Farmers, farmer groups and agriprenuers, extension officers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive research to test, validate and release stale seedbed for weed control in banana varieties • A platform for interaction of banana value chain stakeholders • Capacity building and training on use of polythene and stale bed
Partners/ stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Public and private partners e.g. MoALD for extension • Chemical companies for back stopping • FIPs (Farmer Input Promotion) for promotion • Farmer Groups for activity implementation and promotion • Service provider agencies e.g. Micro-finance agencies and banks for credit provision, agro-vets for input supply • Processors and manufacturers to create market for produce, aggregators e.g. CARD (Community Action for Rural Development) for economy of scale sales and marketing], and Others e.g. NGOs, CBOs, and FBOs to provide specialist services like community mobilization, nutrition training etc
C: Current situation and future scaling up	
Counties where already promoted if any upscaled	None

Counties where TIMP will be upscaled	All the areas where banana is grown
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low use of the technology • Labour intensity and cost of the polythene sheet • Limited knowledge, information and low literacy levels among the farmers • Capacity building is required to impart knowledge and skills in safe use of herbicides and application of stale beds
Recommendations for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • There is need to train the County agricultural extension officers as ToTs on appropriate use of stale beds. This will help in reaching the farmers with the information • Polythene disposal should be done carefully to avoid environmental, health and social hazards • Liaise with the agricultural extension and environmental officers on the ground for farmer empowerment and guidance on use of stale bed
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Creation of awareness through demonstrations and farmer field days will help in adoption of the technology- Stale seedbed • Availability of market is essential • Partnership is important in technology dissemination and adoption which can be facilitated through innovation platforms • Access to and use of information on different methods of weed control will reduce drudgery and cost of weed management. It could give room to increase area under cultivation and increase productivity
Social, environmental, policy and market conditions necessary	Sensitization of communities on alternative methods of weed control and appropriate use of stale beds is very necessary
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Basic costs include ploughing, harrowing, weeding, cost of herbicide which is approximately KES 11,000 per ha.
Estimated returns	Yield is about 440 plants per acre x 30 Kg per bunch @ 20 per Kg = KES 264,000
Gender issues and concerns in adoption and scaling up	<ul style="list-style-type: none"> • Women perform most of the weeding activities therefore the TIMP will reduce their work burden • Women and youth have limited access to resources such as land and chemicals • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge

Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and men in spraying the weeds using glyphosate and other chemicals
VMGs issues and concerns in development and dissemination	<ul style="list-style-type: none"> • VMGs have limited access to productive resources such as land, credit and chemicals • Women and youth have limited access to education, training and extension services than me • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMGs related opportunities	Employment opportunities exist for youth males and men in spraying the weeds using glyphosate and other chemicals
E: Case studies/profiles of success stories	
Success stories	None
Application guidelines for users	<ul style="list-style-type: none"> • Weed control leaflets/ manuals • Information and instructions always displayed on the labels attached to container on how to use
F: Status of TIMP Readiness (1. Ready for up-scaling; 2. Requires validation; 3. Requires Research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO-Kabete P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org
Lead organization and scientists	KALRO: Dr. Hottensiah Mwangi, Dr. Violet Momanyi, Mr. Antony Nyaga
Partner organizations	1) MoALD 2) County governments 3) Chemical companies

2.6.22 Mechanical weed control in banana

2.6.22 TIMP Name	Mechanical weed control in banana
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	High incidence of annual and perennial grass and broadleaved weed species infestation, combined with inappropriate, inefficient and unsustainable control methods used to control leading to low and poor quality yield.
What is it? (TIMP description)	Mechanical/ manual weed control technique manages weed populations through physical removal, injure, kill, or make the growing conditions unfavourable for growth by use of tools such as pangas and jembes. Other methods may alter the growing environment by eliminating light, increasing the temperature of the soil, or depriving the plant of carbon dioxide or oxygen and preparation is done manually using hoes or implements such as

	<p>sub-soilers to kill weeds before planting. Selective mechanical method has little impact on non-target plants whereas a non-selective method affects the entire area being treated. Land is prepared well using hand tools to get a weed free seedbed. Sowing is done in rows to facilitate inter- row weeding. Timely manual weeding is done 2-3 weeks after germination followed by a second at 2 to 3 weeks depending on the rate of re-growth. The intra row weeds can also be removed by hand pulling.</p> <div>  <p><i>Harrowing using a sub-soiler</i></p> </div> <div>  <p><i>Manual seedbed preparations</i></p> </div> <div>  <p><i>Weeding using a "Muro"</i></p> </div> <p>Source: Hottensiah Mwangi, KALRO</p> <p>Delay in weeding should be avoided as it will result into severe competition with the crop. The right tools for weeding are used to avoid shock-stress on the crop due to root damage.</p>
Justification	<p>If not controlled, weeds will take over, win the competition and lower productivity and profitability. Deep tilling disturbs the soil and brings dormant weed seeds to the surface for germination. Some species which are deeply buried can remain dormant in the soil for years before favorable conditions allow germination. The fine soil allows weed seed to grow rapidly by allowing the seed to open and roots to spread easier than compact soils. The emerged weeds can be successfully destroyed by mechanical tillage before planting or weeding after planting to get a clean crop that will give good yields.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<ul style="list-style-type: none"> • Farmers, extension service providers and agriprenuers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/ essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive Research to test, validate and release improved mechanical weeding • A platform for interaction of banana value chain stakeholders • Participatory implementation, stakeholder sensitization

	<ul style="list-style-type: none"> • Suitability of the TIMP to the agro-climatic and socio-economic condition of the farmer e.g. affordability of tools such as a sub-soiler for ploughing and harrowing • Training for users to build capacity on the importance of the technology
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Public and private partners e.g. MoALDC for extension, Jua Kali artisans to make implements such as sub-soilers • Processors and manufacturers to create market for produce, aggregators e.g. CARD (Community Action for Rural Development) for economy of scale sales and marketing, and Others e.g. NGOs, CBOs, and FBOs to provide specialist services like community mobilization, nutrition training etc
C: Current situation and future scaling up	
Counties where already promoted if any	All areas where banana is grown
Counties where TIMP will be up scaled	Meru, Kisii, Western Kenya
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Labour intensity • Appropriate implements are not readily available in the market such as sub-soilers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Work with Jua Kali industries for fabrication of appropriate implements such as sub-soilers
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Awareness creation through demonstrations and farmer field days to promote adoption of technologies • Availability of market is essential • Partnership is important in dissemination and adoption of a technology which can be facilitated through innovation platforms • Access and use of appropriate tools (technology) will provide timely weed control and reduce drudgery thus enhance crop production
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Sensitization of communities on the technology for weed management • Cultivation of banana is socially acceptable • Market availability to absorb the increased production
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Basic costs include ploughing, harrowing, weeding, which is approximately KES 11,000 per ha
Estimated returns	Yield is about 440 plants per acre x 30 Kg per bunch @ 20 per Kg = KES 264,000
Gender issues and concerns in development ,dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women perform most of the crops weeding activities therefore the TIMP will reduce their work burden • Women and youth have limited access to credit to purchase

	<p>the required implement</p> <ul style="list-style-type: none"> • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for women in performing the operation
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implement • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to information on production techniques and low adoption due lack of awareness
VMG related opportunities	Employment opportunities exist for women in performing the operation
E: Case studies/profiles of success stories	
Success stories	Tharaka-Nithi County
Application guidelines for users	Manuals, brochures, fact sheets on integrated weed management developed by KALRO and CABI/ Plantwise. Available at; Training Manuals https://www.kalro.org ; Plantwise Knowledge Bank - CABI.org https://www.cabi.org
F: Status of TIMP Readiness (1. Ready for up-scaling; 2. Validation 3. Requires further research)	1) Ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO-Kabete P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org
Lead organization and scientists	KALRO: Dr. Hottensiah Mwangi, Dr. Violet Momanyi, Mr. Antony Nyaga
Partner organizations	1) MoALD 2) Extension staff in Counties

GAPS

1) Research on gender-sensitive implements such as sub-soilers and weeders that are light and can be used by women and children

2.6.23 Crop rotation for weed control in banana

2.6.23 TIMP Name	
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Diverse weed species and rich weed seed banks in the cropping system that contribute to high crop losses due to competition with the crop for growth resources such as nutrients, space and water.
What is it? (TIMP description)	Crop rotation is the growing of two or more different crops one after the other in the same piece of land to avoid exhausting the soil and to control weeds, pests, and diseases. It is advantageous that the succeeding crop belongs to a family different from that of the previous crop. Bananas may be rotated with pineapples, maize, paddy, sugarcane, pulses, vegetables etc. after a period of 5-8 years depending on the fertility of the soil. Crops such as legumes, maize among others are rotated yearly and are planted in the middle rows of bananas to facilitate weeding hence better control of weeds. Legumes form a good cover on the soil which suppresses weed germination and growth.
Justification	Planting a wide variety of crops with varied characteristics reduces the likelihood that specific weed species will adapt to the system and become problematic. Banana is a heavy feeder and rotation with legumes in middle rows not only gives better control of weeds (this reduces weeding costs) by covering the ground. It also regulates soil temperature, improves soil structure, organic matter content, fertility by fixing nitrogen, adds diversity to the cropping system, increases sustainability of the system and provides the foundation of long term weed management.
Region promoted	All areas where banana are grown
Counties where TIMP will be upscaled	Meru
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, gricultural extension officers, agriprenuers
Approaches to be used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations - On-farm and on station Agricultural shows/exhibitions/field days Trainings - workshops/seminars/meetings Public and private extension agents Farmer - to - farmer extension models Mass media - Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Applied and adaptive research to test, validate and release rotation practice in banana varieties

	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders participatory implementation and stakeholder sensitization
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Public and private partners e.g. MoALD for extension, Jua Kali artisans • Processors and manufacturers to create market for produce, aggregators e.g. CARD (Community Action for Rural Development) for economy of scale sales, and Others e.g. NGOs, CBOs, and FBOs to provide specialist services like community mobilization, nutrition training etc
C: Current situation and future scaling up	
Counties where already promoted if any	All areas where banana is grown
Counties where TIMP will be up-scaled	Meru, Kisii, Western Kenya
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low use of the technology • Small farms due to family sub-divisions • Rotation schedules for banana is not readily available
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Information dissemination on the practices • Promotion of the technology in the suitable areas • Involve farmers in validating known schedules from other research findings or countries in different banana growing regions
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Creation of awareness through demonstrations and farmer field days help in adoption of the varieties • Availability of market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Use of appropriate crop rotation will provide timely weed control which will enhance crop production
Social, environmental, policy and market conditions necessary for development and up-scaling	Sensitization of communities on the crop rotation practices in weed management
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Basic costs include ploughing, harrowing, weeding, which is approximately KES 11,000 per ha
Estimated returns	Yield is about 440 plants per acre x 30 Kg per bunch @ 20 per Kg = KES 264,000
Gender issues and concerns in development and dissemination	<ul style="list-style-type: none"> • Women perform most of the weeding activities therefore the reduced weeds due to crop rotation reduces their work burden • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information,

	technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities for women exist to perform other economic activities due to their reduced workload through weeding
VMG issues and concerns in adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to education, training and extension services • VMGs have less access to credit • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities for VMGs to access credit through affirmative action funds • Increased production will improve food and nutrition security and economic empowerment of VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for users	Production manuals of crop agronomy and weed management TIMPs from KALRO (website: https://www.kalro.org/kcsap/)
F: Status of TIMP Readiness (1. Ready for up-scaling; 2. Validation 3. Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Centre Director, KALRO-Kabete P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org
Lead organization and scientists	KALRO: Dr. Hottensiah Mwangi, Dr. Violet Mumanyi, Mr. Antony Nyaga
Partner organizations	MoALD in Counties

2.6.24 Chemical (herbicide) weed control in banana

2.6.24 TIMP Name	Chemical (herbicide) weed control in banana
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Diversity of annual and perennial grass and broadleaved weed species infestation compete with banana for growth resources and improper weed control measures that lead to low and poor quality yields.
What is it? (TIMP description)	Chemical weed control is a technology used to control the

	<p>germination and growth of the weed species through application of chemicals/ herbicides to weeds or the soil. Herbicide weed control is a technology that requires knowledge on herbicides required for specific crops. Herbicides used to control weeds can be classified as pre- and post- emergent herbicides.</p> <p>Pre-emergent herbicides are applied on to moist soil after field preparation and within 24 hours after planting before both the crop and weed have emerged. An example is Atrazine (150-170 mls in 20 litres water) effectively prevents seed germination of weeds.</p> <p>Post emergent herbicides are applied on the germinated weeds.</p> <p>a) Post-emergent selective herbicides such as 2,4-D (100-150 ml in 20 litres water) sprayed between crop at 2-3 weeks after germination will effectively control broad leaved weeds. Agil 100EC will effectively control grass weeds at a rate of 100-200ml in 20 litres of water.</p> <p>Caution:</p> <p>Fix a hood on the nozzle while spraying a post-emergent herbicide between rows to protect damage to banana since it is also broad leaved. Spraying should only be done after users have been trained and cautioned to the hazards.</p> <p>b) Post-emergent non selective, broad spectrum herbicides such as glyphosate (100-200 ml in 20 litres of water) mostly used in zero and minimum tillage may be applied as directed but guarded with a hood to avoid harming the crop.</p> <p>Appropriate use of herbicides (all applications should be done at the right rate and according to label instructions) reduces drudgery and allows timely weed control. Several selective herbicides are registered for control of annual and perennial weeds in banana. Other post-emergent herbicides are applied in the middle of rows using a hood or a wick where need be to avoid crop injury. Proper calibration of sprayer is critical to maintain correct sprayer pressure, flow rate from each nozzle and tractor speed or walking speed.</p>
Justification	Manual hand weeding is very labour intensive yet labour is scarce and expensive. Use of herbicides can reduce days spent weeding manually from 10-12 days per acre to 0-2 days. There are effective selective and non selective pre and post emergent herbicides registered by PCPB for controlling narrow and broadleaved weeds in various crops such as maize. Examples are mentioned above in the TIMP description.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, researchers, extension service providers, agriprenuers, input providers including agro-dealers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations - On-farm and on station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents

	<ul style="list-style-type: none"> • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive research to test, validate and release herbicide weed control in banana varieties • A platform for interaction of banana value chain stakeholders • Capacity building and training on safe use of herbicide for all users
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Public and private partners such as MoALD for extension • Chemical companies for back stopping • Farmer Input Promotion (FIPs) for promotion • Farmer groups for implementation and promotion • Service provider agencies e.g. Micro-finance agencies and banks for credit provision, agro-vets for input supply • Processors and manufacturers to create market for produce, aggregators e.g. CARD (Community Action for Rural Development) for economy of scale sales and marketing, and others e.g. NGOs, CBOs, and FBOs to provide specialist services like community mobilization, nutrition training etc
C: Current situation and future scaling up	
Counties where already promoted, if any	None
Counties where TIMPs will be up scaled	All regions growing bananas
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low use of agronomic practice • Limited knowledge and information and low literacy levels among the farmers or sprayers to read and interpret label instructions • Capacity building is required to impart knowledge and skills in safe use and application of herbicides • Farmers need to understand proper use and application of herbicides to avoid buying inappropriate herbicides and minimize health, environmental and social hazards
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Strengthen the research-extension-farmer linkage through AIPs • Sensitization campaigns and on-farm demonstrations • Strengthen collaboration among the stakeholders • There is need to train advisory and service providers as ToTs on appropriate use of herbicides. This will lead to information reaching the farmers. Herbicides like all chemicals have to be used with care to avoid environmental, health and social hazards • Liaise with the agricultural extension and environmental officers in the field for farmer empowerment and guidance on safe use of herbicides

Lessons learned in up- scaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Creation of awareness through demonstrations and farmer field days help in adoption of the technology- chemical weed control • Consumers concerns of herbicide residues in the soil and subsequent crops needs attention • Availability of banana market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Access to and use of information on different methods of weed control will reduce drudgery and cost of weed management. It could give room to increase area under cultivation and increase productivity
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Sensitization of communities on alternative methods of weed control and appropriate use of herbicides is vital • Favorable agro-ecological conditions • Favorable institutional policy environment
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Basic costs include ploughing, harrowing, weeding, which is approximately KES 11,000 per ha
Estimated returns	Yield is about 440 plants per acre x 30 Kg per bunch @ 20 per Kg = KES 264,000
Gender issues and concerns in adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to inputs such as herbicides • Technology is not safe for use by expectant women and the physically challenged because of its hazardous/ dangerous nature • Women have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth and men during application of herbicides • Youths can own and operate agrovet shops that stock the right herbicides and offer advisory services to farmers
VMGs issues and concerns in development and dissemination	<ul style="list-style-type: none"> • VMGs have limited access to education, training and extension services • Women have less access to inputs such as herbicides • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness • These are dangerous products that may not be handled by vulnerable groups
VMGs related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and men in spraying • VMGs can own and operate agro vets that stock the right herbicides and offer advisory services to farmers at the agrovet shops

E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers growing banana on large scale farms in Kenya
Application guidelines for users	PCPB website- List of approved herbicides for crops farming. Available at: https://www.pcpb.go.ke/crops/
F: Status of TIMP Readiness (1. Ready for up-scaling; 2. Requires validation; 3. Requires Research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO-Kabete P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org
Lead organization and scientists	KALRO: Dr. Hottensiah Mwangi, Dr. Violet Momanyi, Mr. Antony Nyaga
Partner organizations	1) MoALD in Counties 2) Agro-chemical companies 3) PCPB 4) CropLifeKenya (AAK) 5) National and County Governments

2.6.25 Safe use of herbicides in banana

2.6.25 TIMP Name	Safe use of herbicides in banana
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Excessive herbicide application, spraying without wearing protection, storage in non-designated areas, wrong application techniques and times, use without following guidelines on the labels (rate and Pre-Harvest Interval), wrong disposal of expired herbicides and empty containers, inadequate enforcement of national policies and regulation.
What is it? (TIMP description)	A practice that includes methodologies for safe and appropriate use and handling of herbicides from purchase to disposal of left overs and containers in order to minimize pollution of the environment and contamination of the produce.
Justification	Inappropriate use of herbicides is a common practice in most areas. Incidences of excessive use, improper handling that lead to the spray operators inhaling the chemicals in the process of spraying, use of inappropriate spray equipment that lead to leakages and thereby exposing the operators to health risks as well as contamination of the water bodies have been reported. There is need to correct this through sensitization and capacity building forums for

	end users. Increased chronic diseases in human beings have been reported.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, researchers, extension service providers, input providers including agro-dealers, agriprenuers, spraying teams
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive research to test, validate and employ safe use herbicide application in banana varieties • A platform for interaction of banana value chain stakeholders • Development and availing of the technology • Collaboration between all partners • Willingness of farmers to adhere to adopt the technology • Adequate facilitation: funds, logistics (transport) • Sensitization and accessibility on the technology • Enhanced funding for technology dissemination
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Pests Control Products Board (PCPB) for regulation and approval of herbicides • Farmer Co-operative Societies (FCS) for mobilization and sensitization of farmers, availing products to farmers • Agrochemical manufacturers to avail and distribute products, finance trials • Financial institutions to facilitate acquisition of products by FCS • Research organizations and universities to validate and upscale the TIMP • National and County governments to finance and facilitate extension services to the farmers • Extension service providers for dissemination and sensitization of farmers
C: Current situation and future scaling up	
Counties where already promoted if any	None
Counties where TIMPS will be up- scaled	Meru, Kisii, Western Kenya


Challenges in dissemination	<ul style="list-style-type: none"> • Weak research-extension-farmer linkage in technology delivery • Weak collaboration among the stakeholders • Illiteracy of most farmers • Smuggling of banned herbicides from neighboring countries • Inadequate capacity by farmers and agrochemical companies to dispose expired herbicides and empty/used containers • Lack of innovation platforms to facilitate for interaction of farmers with relevant stakeholders
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Strengthen the research-extension-farmer linkage through AIPs • Sensitization campaigns and on-farm demonstrations • Strengthen collaboration among the stakeholders • Formation of youth spray teams to spray herbicides at a fee • Establishment of training of extension staff and lead farmers as ToTs • Establish banana innovation platforms • Capacity building and sensitization forums for both farmers and agro dealers using participatory approach • Establishment of aggregation centres for the disposal of herbicide containers, left overs and expired products • Increase surveillance along border points to prevent smuggling in of unregistered herbicides
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Upscaling of this technology require youth to apply herbicides and collect empty containers • Successful scaling up is higher when diverse value chain stakeholders collaborate • Availability of registered herbicides is essential • Partnership facilitated through innovation platforms is important in technology dissemination and adoption • The illiteracy levels of farmers may hinder the uptake of the technology
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Organized collective marketing channels • Favorable agro-ecological conditions • Favorable institutional policy environment • Enhancement of policies and laws on pollution from pesticides and other chemicals
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Cost of a complete set of personal protective clothing is approximately KES 5,000
Estimated returns	Not applicable. The TIMP takes care of the herbicide applicator, consumer and environment
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Some women are illiterate therefore they cannot read and interpret amount recommended for use • Women have less access to agricultural information,

	<p>technology and knowledge on the dangers of chemicals especially on storage and disposal</p> <ul style="list-style-type: none"> • Women limited access to education, training and extension services • Women and youth have limited access to finances to buy the recommended herbicides and protective gear
Gender related opportunities	Affirmative action opportunities exist for women and youths to acquire the required credit
VMGs issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Some VMGs are illiterate therefore they cannot read and interpret the amount recommended for use • VMGs have less access to agricultural information, technology and knowledge on the dangers of chemicals especially on storage and disposal • VMGs limited access to education, training and extension services • VMGs may also have limited access to finances to buy the recommended herbicides and protective gear
VMG related opportunities	Affirmative action opportunities exist for women and youths to acquire the required credit
<ul style="list-style-type: none"> • E: Case studies/profiles of success stories 	
Success stories from previous similar projects	<ul style="list-style-type: none"> • The AAK has trained youth spraying teams to assist farmers in a few counties thus reducing cases of people being exposed to herbicides • Some counties who have aggregation centres by AAK for collection of used/ empty herbicides containers which has led to reduction in the farms • Safe use of herbicides campaigns by AAK, PCPB, KALRO and MoALD
Application guidelines for users	<ol style="list-style-type: none"> 1. Momanyi Violet (2017). Guidelines for Safe and Effective Use of Pesticides: Safety Measures for Pesticide Users. A hand book published by Lap Lambert Academic Publishing. Available at: https://www.amazon.com/Guidelines-Safe-Effective-Use-Pesticides/dp/6202006218 2. Manuals, brochures, fact sheets on integrated weed management developed by KALRO and CABI/Plantwise. Available at: Training Manuals https://www.kalro.org Plantwise Knowledge Bank-CABI.org https://www.cabi.org 3. Spray Service Provider Training Manual by Agrochemicals Association of Kenya Available at: https://agrochem.co.ke/wp-content/uploads/2021/05/AAK-SPRAYING-MANUAL

Status of TIMP readiness (1. Ready for upscaling; 2. Requires validation; 3. requires further research)	1) Ready for upscaling
F: Contacts	
Contacts	Centre Director, KALRO-Kabete P.O. Box 14733-00800, Nairobi Email: cd.narl@kalro.org
Lead organization and scientists	KALRO: Dr. Hottensiah Mwangi, Dr. Violet Momanyi, Mr. Antony Nyaga
Partner organizations	1) MoALD 2) CABI 3) PCPB 4) CropLife Kenya (AAK) 5) KEPHIS 6) County Governments 7) Universities

2.7 POSTHARVEST HANDLING

2.7.1 Banana bagging

2.7.1 TIMP Name	Banana bagging
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Poor quality fruit may be as result of damage by insects, wind, leaf and petiole scarring, hail, sunburn, bird feeding leading to poor returns. Banana bagging enhances the quality of banana fruit thus earning higher income than unbagged fruit.
What is it? (TIMP description)	<p>The technology involves placing a translucent polythene bag cover from the base of the bunch and tied at the top. There are two types of banana bagging technology; traditional and early bagging. Early bagging is most recommended and is done before the hands are properly visible and the bracts have fallen.</p> <p>The transparent polyethylene cover recommended is 0.08 mm in thickness, 90 cm in diameter and 155 cm long with perforated holes measuring 12.7mm in diameter.</p> 

	<i>Banana bagging</i> <i>Source: KALRO</i>
Justification	Bunch bagging creates a microclimate that leads to increased finger length and bunch weight due to optimum photosynthesis and improved postharvest quality, including appealing skin colour, reduced sunburn and reduced fruit splitting. Bagging banana protects the fruit from physical damage such as leaf and petiole scarring, hail, sunburn, birds.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, agriculture extension agencies, agriprenuers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Participatory implementation, stakeholder capacity building and networks • Promotions involving Public Private Partnerships (PPP) • Availability of polyethylene bags • Availability of quality standards
Partners/stakeholders for scaling up, their roles and stage of involvement	<ul style="list-style-type: none"> • County government and private extension service providers will train farmers on banana bagging technology. They will also offer advice and collect information on the uptake and practice on the technology • KALRO - To provide technical backstopping on dissemination of banana fruit protection bags • Private sector - To avail the bags to the end users
C: Current situation and future scaling up	
Counties where already promoted, if any	Homa Bay, Nyeri, Meru, Kisii, Nyamira, Tharaka-Nithi, Embu, Kirinyaga
Counties where TIMPs will be upscaled	All the banana growing regions
Challenges in development and dissemination	<ul style="list-style-type: none"> • Banning of polythene products in Kenya • Limited awareness of product by farmers • The use of non-perforated bunch covers in hot, humid climates may damage the bunch physiologically due to overheating, rotting, and premature ripening • Insect pests may proliferate inside non-insecticide treated bunch covers

	<ul style="list-style-type: none"> • Economic loss due to the extra cost of the material and labor needed for application
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to the government agencies, farmers and traders • Capacity building of farmers on how to use the products • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product • Involvement of regulatory agencies and policy makers in up-scaling process, linkage to credit facility providers to promote commercialization, advocacy for its widespread use
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Bunch bagging quickens maturity by two weeks, and improves the fruit quality. In central Kenya, a few farmers are adopting the method by improvisation, using the common polythene shopping bags (yellow) and carefully washed woven fertilizer bags. • The paper can be impregnated with garlic and pepper solution to reduce thrips. • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited Embu, Muranga and Meru from where they increasingly adopted the banana bunch bagging technology
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Favorable environmental conditions • Willingness of producers to use the technology • Regulatory bodies e.g. NEMA to allow use of polythene bags of high density • Market access for high quality banana
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 80
Estimated returns	KES 300-500 per banana bunch
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may also have limited access to finances to buy the required inputs such as the bagging materials • Women have less access to agricultural information, technology and knowledge • Women have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Employment opportunities for youth exist in bagging the bananas
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs may also have limited access to finances to buy the required inputs such as quality planting materials and manure

	<ul style="list-style-type: none"> • VMGs have limited access to education, training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by the VMGs due to lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for VMGs to acquire the required credit • Employment opportunities for youth exist in bagging the bananas
E: Case studies/profiles of success stories	
Success stories	John Rukwaro, Nyeri County, has a five-acre banana farm in Nyeri. Rukwaro practices bagging technology, where he covers the tissue culture banana fruits to protect them from bacterial and fungi infections (Cigar end rot and Panama, a type of Fusarium wilt). His bananas produce bunches weighing up to 80 Kg, thanks to the bagging technology. He sells the bananas in Nyeri and Nairobi towns for KES 300 - 500 depending on the size and weight. In a month, he is able to generate an income of between KES 50,000 - 80,000. Bananas are usually harvested from 12 - 14 months where second harvest is done after every four months until the suckers die. (Source: <i>Seeds of Gold</i> , <i>Daily Nation</i> 10/12/2016).
Application guidelines for users	Banana bagging cover leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Nasambu Okoko, Willis Owino, Charity Gathambiri and Antony Nyaga
Partner organizations	1) JKUAT 2) MoALD (County Governments) 3) Bioversity International 4) Farmer groups, 5) Service provider agencies e.g. financial institutions 6) Traders 7) Processors

GAPS

- 1) Validation of the best polythene to use (i.e. colour and perforations) for bagging to give optimal results under different AEZs


2.7.2 Determination of Banana Maturity Indices

2.7.2 TIMP name	Determination of banana maturity indices
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem addressed	Immature harvesting and over mature fruits that contribute to poor quality fruits and postharvest loss
What is it? (TIMP description)	The practice involves determination of maturity indices of banana fruit. This include use of physical (color, shape and size), physiological (ethylene evolution and respiration rate), biochemical (total soluble solids, titratable acidity).
Justification	Banana fruits harvested at the right maturity stage for the target market and use. Inappropriate harvesting stage (over mature or immature) results in high postharvest losses since the fruits cannot be used for the interested purpose or fail to meet the quality standards for the target market and hence rejected. This leads to low returns from banana sale.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers
Approaches to be used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations on-farm and on-station Agricultural shows/exhibitions/field days Trainings - workshops/seminars/meetings Public and private extension agents Farmer - to - farmer extension models Mass media - Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Create awareness of the benefits of harvesting of banana at the right maturity stage Willingness of producers and traders to adopt the practice Create a platform for interaction of banana value chain stakeholders
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> KALRO officers - To provide appropriate parameters to determine maturity indices Extension officers – To be involved in training of beneficiaries Marketers - avail of good market for quality fruits
C: Current situation and future scaling up	
Counties where already promoted, if any	Kiambu, Murang'a, Embu
Counties where TIMP will be upscaled	All counties that produce banana

Challenges in dissemination	Local market has not fully embraced quality as a parameter for value determination
Suggestions for addressing the challenges	Create consumer awareness to appreciate quality banana
Lessons learned in upscaling, if any	Farmers have indigenous knowledge on determination of harvesting stage which must be taken into consideration during training
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • Favorable environmental conditions • Willingness of producers to use the technology • Market access for high quality banana • Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	None
Estimated returns	Not done – need to establish the benefit observing harvest maturity
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to information, technology and knowledge • Women and youth have limited access to education, training and extension services • Women and youths have less access to credit to purchase the required inputs
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited access to productive resources such as land, credit, and quality seed. • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit
E: Case studies/profiles of success stories	
Success stories from previous projects	The practice has been adopted in Murang'a and Kiambu Counties, where farmers have sold high volumes
Application guidelines for users	Banana manual, KALRO banana App
F: Status of TIMP readiness (1. Ready for upsaling; 2. Requires validation; 3. Requires further research)	1) Ready for up scaling
F: Contacts	
Contacts	Institute Director, KALRO – HRI P.O. Box 220 – 01000 Thika Email: kalro.kandara@kalro.org

Lead organization and scientists	KALRO-HRI: Charity Gathambiri, Wayua Francis, Nasambu Okoko and Antony Nyaga
Partner organizations	1) JKUAT 2) UoN

2.7.3 Appropriate banana harvesting technique

2.7.3 TIMP Name	Appropriate banana harvesting technique
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	High postharvest losses due to inappropriate harvesting methods.
What is it? (TIMP description)	<p>This is a management practice involving careful handling of banana during and after harvesting. There are two commonly used methods for harvesting banana i.e. it involves one person (Figure A) or two persons (Figure B). After harvesting the bunch, the pseudo-stem is cut off with a clean implement at ground level. The cut is covered with soil to avoid easy entry by the banana weevil.</p>  <p><i>Fig. A. Banana harvesting Fig. B. Banana harvesting</i> Source: KALRO</p>
Justification	Inappropriate harvesting time and harvesting practices leads to rotting and postharvest losses of bananas
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, agriprenuers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services


Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Participatory implementation • Stakeholder capacity building and networks • Promotions involving Public Private Partnerships (PPP) • Increased production of high-quality bananas • Availability of quality standards
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Farmers and farmer groups – Provide land for demonstration plots; labour; manage trials; keep records to be used in M&E • County government and private extension service providers will train farmers on appropriate harvesting procedures. They will also offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of appropriate harvesting procedure
C: Current situation and future scaling up	
Counties where already promoted, if any	Kisii, Homa Bay, Migori, Muranga and Embu
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Lack of knowledge and appropriate harvesting technology • Negative attitude by farmers towards adoption of new agricultural TIMPs
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the technology to farmers and traders • Capacity building of farmers on appropriate harvesting technology • Availing data on economics and the gains to be made through adoption of the TIMP
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Proper harvesting procedure reduce loss by up to 25% • Involvement of stakeholders such as CBOs and NGOs enhances adoption • Consistent trainings, demonstrations and sensitisations would motivate farmers to adopt the technology
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Favorable environmental conditions • Willingness of producers to use the technology • Market access for high quality banana • Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet estimated
Estimated returns	Not yet estimated
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to information, technology and knowledge • Women and youth have limited access to education, training and extension services

	<ul style="list-style-type: none"> • Women and youths have less access to credit to purchase the required inputs
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited access to productive resources such as land, credit, and quality seed • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Affirmative action opportunities exist for women and youths to acquire the required credit
E: Case studies/profiles of success stories	
Success stories	Karurumo Smallholder Horticulture Aggregation and Processing Centre, in Embu County. Use of the technology has enabled the farmers to sell their banana fruits to different buyers for between KES 6-10 a piece, up from the KES 3- 5 offered by most buyers during the peak season.
Application guidelines for users	Banana harvesting leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO – HRI P.O. Box 220 – 01000 Thika Email: kalro.kandara@kalro.org
Lead organization and scientists	KALRO-HRI: Charity Gathambiri, Francis Wayua, Nasambu Okoko, Willis Owino
Partner organizations	1) JKUAT 2) MoA (County Governments) 3) Farmer groups 4) Service provider agencies e.g. financial institutions 5) Traders 6) Private sector processors

GAP

1) Establishing maturity indices for the specific varieties in different agroecological zone


2.7.4 Banana de-handing tool

2.7.4 TIMP name	Banana de-handing tool
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	High postharvest losses in banana due to inappropriate banana de-handing practice
What is it? (TIMP description)	<p>This is a tool that is used in banana de-handing, it is easy to handle and sharp</p>  <p><i>De-handing of banana using the tool</i> <i>Source: Charity Gathambiri, 2022</i></p>
Justification	High Post-harvest losses due mechanical injuries on banana fruits during de-handing
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana producers and agriprenuers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Participatory approach, formation of innovation platforms, On-farm demonstration
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Agricultural Extension officers - To participate during training of stakeholders, NGOs - Participate in dissemination of technology

	<ul style="list-style-type: none"> • Research institutions - To provide information on the technology • Local artisans - To fabricate the equipment
C: Current situation and future scaling up	
Counties where already promoted, if any	Kiambu and Murang'a
Counties where TIMP will be upscaled	Bomet, Kericho, Tharaka-Nithi and Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Adoption of the technology by farmers • Availability of the tool to farmers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Continuous training of farmers and calculate the benefits of using the tool • Build capacity for local production of the tool in Jua Kali sector
Lessons learned in upscaling, if any	The de-handing tool to be fabricated with local artisan
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> • The extra cost of production must be matched with better returns – better prices for the banana fruits • Favorable environmental conditions • Willingness of producers to use the technology • Market access for high quality banana • Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 2000 per tool
Estimated returns	KES 400-500 per bunch
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to information, technology and knowledge. • Women and youth have limited access to education, training and extension services • Women and youths have less access to credit to purchase the required inputs
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Employment opportunities exist for women in de-handing
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited access to productive resources such as land, credit, and quality seed • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities exist for women and youths to acquire the required credit • Employment opportunities exist for women in de-handing
E: Case studies/profiles of success stories	

Success stories from similar previous projects	Reduced mechanical injuries in harvested fruits – reduced postharvest losses
Application guidelines for users	<ul style="list-style-type: none"> Banana Production manual Banana harvesting and handling leaflets
F: Status of TIMP readiness (1. Ready for upsaling; 2. Requires validation; 3. Requires further research)	1) Ready for upsaling
G: Contacts	
Contacts	Institute Director, KALRO – HRI P.O. Box 220 – 01000 Thika Email: kalro.kandara@kalro.org
Lead organization and scientists	KALRO-HRI: Charity Gathambiri, Francis Wayua, Nasambu Okoko and Antony Nyaga
Partner organizations	1) KALRO 2) Traders 3) Local artisans 4) HCD

2.7.5 Use of stackable crates during packaging, transportation and marketing of banana


2.7.5 TIMP name	Use of stackable crates during packaging, transportation and marketing of banana
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	High postharvest losses in banana is contributed by inappropriate packaging which lead to mechanical injuries
What is it? (TIMP description)	 <p>Stackable crates Source: Charity Gathambiri, 2022</p> <p>Stackable crates are easy to handle and especially when they are empty. When the crates are filled with banana the crates are easily stackable and leaving a safe space where the produce is not compressed.</p>
Justification	Most traders/transporters do not package banana appropriately. They wrap them in banana leaves or load them into open trucks without any packaging. This leads

	to excessive mechanical injuries and ultimately high post-harvest losses. This can be minimized by proper packaging during transportation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana producers, agriprenuers
Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations on-farm and on-station Agricultural shows/exhibitions/field days Trainings - workshops/seminars/meetings Public and private extension agents Farmer - to - farmer extension models Mass media - Electronic and print Publications - posters/brochures/leaflets, manuals Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Participatory approach, cost/benefit analysis, policy directive that prohibits poor packaging and promotes the use of crates
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> Extension officers- carry out demonstrations to producers and traders NGOs- Dissemination of the technology, KALRO- Provide technical information on stackable crates Private Sector- Availability of stackable crates
C: Current situation and future scaling up	
Counties where already promoted, if any	Murang'a and Kiambu
Counties where TIMP will be upscaled	All Counties where banana are grown
Challenges in dissemination	<ul style="list-style-type: none"> Availability stackable plastic crates Attitudes on packaging of tomato especially with transporters
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Build capacity for traders on effect of using crates in reducing losses Policy directive that prohibits the use of sacks or open lorries to transport perishable produce Partner with private sector on manufacturing of the crates
Lessons learned in upscaling, if any	<ul style="list-style-type: none"> Negative attitude from traders Need for space saving stackable crates to reduce the cost transporting empty crates after delivering produce to the market
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> The extra cost of production must be matched with better returns – better prices for the banana fruits Favorable environmental conditions Willingness of producers to use the technology Market access for high quality banana Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	<ul style="list-style-type: none"> Ordinary bread crate (KES 500 – 700)

	<ul style="list-style-type: none"> Stackable crate (KES 750)
Estimated returns	Not done – need for cost benefit analysis study
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Women have less access to information, technology and knowledge Women have limited access to education, training and extension services
Gender related opportunities	Opportunity exist for women packaging while the youths males can package them in crates
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs have less access to agricultural information, technology and knowledge VMGs have limited access to training and extension services Due to their social status VMGs are often excluded from decision making in development and dissemination activities There is low adoption by VMGs due lack of awareness.
VMG related opportunities	Opportunity exist for women packaging while the youths' males can package them in crates
E: Case studies/profiles of success stories	
Success stories from similar previous projects	The practice will be validated
Application guidelines for users	<ul style="list-style-type: none"> Flyer or poster showing how bananas are packaged in the crates Photo evidence of reduced injuries on harvested fruits
F: Status of TIMP readiness (1. Ready for upsaling; 2. Requires validation; 3. Requires further research)	2) Requires Validation
G: Contacts	
Contacts	Institute Director, KALRO – HRI P.O. Box 220 – 01000 Thika Email: kalro.kandara@kalro.org
Lead organization and scientists	KALRO: Charity Gathambiri, Francis Wayua, Antony Nyaga and Nasambu Okoko
Partner organizations	1) KALRO 2) TECHNOSERVE 3) HCD 4) FPEAK


2.7.6 Charcoal cooler for banana storage

2.7.6 TIMP name	Charcoal cooler for banana storage
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Lack of affordable and appropriate cooling technology for producers in rural areas

What is it? (TIMP description)	<p>Charcoal cooler is a cooling technology which operates on the principle of evaporative cooling. Under hot and dry conditions typical of dry seasons and ASALS, the charcoal cooler can achieve a temperature difference of 10 – 15°C compared to ambient room conditions.</p>  <p>Charcoal cooler Source: KALRO</p>
Justification	<p>Cold storage is important to preserve postharvest quality of banana fruits. However conventional cold rooms are expensive and require electricity. A charcoal cooler is relatively cheaper and can be applied in rural areas which don't have electricity. The charcoal cooler can be used for pre-cooling prior to long-term cold storage. They can also be used for temporary storage of banana fruits when waiting for buyers or processing.</p>
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agripreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good collaboration between all partners • Adequate facilitation: Funds, logistics (Transport)
Partners/stakeholders for scaling up and their roles	MoALD, individual farmers, farmer groups/CBOs, youth groups
C: Current situation and future scaling up	
Counties where already promoted if any	Kirinyaga, Tharaka-Nithi, Meru, Embu, Kiambu, Vihiga, Machakos on other horticultural produce
Counties where TIMP will be upscaled	Bomet, Kericho, Tharaka-Nithi and Nyeri
Challenges in dissemination	Limited materials to construct the charcoal cooler, ban of charcoal burning/selling
Suggestions for addressing the challenges	Research in alternative inert material that can be used instead of charcoal
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Farmer participatory approach works

	<ul style="list-style-type: none"> • Application/adoption of complementary cold chain practices is key to realize the benefits
Social, environmental, policy and market conditions necessary for upscaling	<ul style="list-style-type: none"> • The extra cost of production must be matched with better returns – better prices for the banana fruits • Favorable environmental conditions • Willingness of producers to use the technology • Market access for high quality banana • Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Varies from KES 300,000 to 600,000 depending on various factors where a 4 x 4 M modular cost KES 600,000
Estimated returns	Not done – under study by University of Nairobi
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to information, technology and knowledge • Women and youth have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> • Opportunity exist for youth males in constructing the cooling unit using the readily available materials
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited access to productive resources such as land and credit • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Opportunity exist for youth males in constructing the cooling unit using the readily available materials
E: Case studies/profile of Success stories	
Success stories from previous similar projects	Youth groups in Kiambu, farmers in peri-urban Nairobi County
Application guidelines for users	Proper training on construction guidelines is very essential
F: Status of TIMP readiness 1) Ready for upscaling 2) Requires validation 3. Requires further research	1) Ready for upscaling
F: Contacts	
Contacts	Institute Director, KALRO – HRI P.O. Box 220 – 01000 Thika Email: kalro.kandara@kalro.org
Lead organization and scientists	KALRO-HRI: Charity Gathambiri, Francis Wayua, Antony Nyaga and Nasambu Okoko
Partner organizations	1) University of Nairobi 2) JKUAT 3) MOA 4) Traders 5) Processors


2.7.7 Zero energy brick cooler

2.7.7 TIMP Name	Zero energy brick cooler
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	High postharvest losses (50%) caused by lack/limited cooling technologies for banana
What is it? (TIMP description)	<p>The Zero energy brick cooler consist of a double brick wall filled with sand in between, and a storage chamber. The sand is kept moist with water. The inside chamber is cooled through evaporation of the water in the sand.</p>  <p><i>Zero energy brick cooler</i> <i>Source: KALRO</i></p>
Justification	Appropriate cooling reduces postharvest losses, reduces nutrient losses and extends shelf-life
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, green grocers, processors, agriprenuers, household consumers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Use of locally available materials to construct the chamber • Formation of marketing groups that would construct the chamber communally
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers groups to be trained in postharvest handling of the mangoes • Research scientists and agricultural extension workers to provide farmers with knowledge on ZECC
C: Current situation and future scaling up	

Counties where already promoted if any	Murang'a and Kiambu
Counties where TIMP will be up scaled	All Counties where banana is grown
Challenges in dissemination	Lack of starter capital to construct the cooler
Suggestions for addressing the challenges	Avail appropriate financing
Lessons learned in up scaling if any	Need to continue capacity building of the farmers and users on repair and maintenance of the technology
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • The extra cost of production must be matched with better returns – better prices for the banana fruits • Favorable environmental conditions • Willingness of producers to use the technology • Market access for high quality banana • Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Low cost about KES 80,000
Estimated returns	Reduced postharvest losses, increased income, nutrition
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to information, technology and knowledge • Women and youths have limited access to education, training and extension services
Gender related opportunities	<ul style="list-style-type: none"> • Opportunity exist for youths during construction of the zero energy bricks cooler using the readily available materials
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited access to productive resources such as land and credit • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Opportunity exist for youth during construction of the zero energy bricks cooler using the readily available materials
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Fruit and vegetable farmers in Embu, Kirinyaga, etc. have used the technology to reduce losses and extend shelf-life for banana, other fruits and vegetables, hence the marketing time for the products.
Application guidelines for users	Factsheets, brochures and manuals on postharvest handling of banana from KALRO
F: Status of TIMP readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Institute Director, KALRO-Mtwapa P.O. Box 16-80109 Email: Kalro.Mtwapa@kalro.org Phone: 0202024751

Lead organization and scientists	KALRO: Charity Gathambiri, James Ndambuki, Francis Wayua, Finyange Pole, Violet Kirigua and Lusike Wasilwa
Partner organizations	1) Agricultural University and Colleges, 2) MoALD 3) NGOs 4) CBOs

2.7.8 Coolbot™

2.7.8 TIMP Name	Coolbot™
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	High postharvest losses due to lack of cooling facilities (postharvest cold chain)
What is it? (TIMP description)	<p>It is a low cost postharvest temperature management that improved the shelf life of banana using less power. The Coolbot™ is a small electrical device that uses an off-the-shelf air conditioner to produce cold air, converting a well-insulated room into a cold room at much lesser cost than that needed to buy a refrigeration unit. It keeps a well-insulated room as cold as 4°C, consistently, while at the same time using about half the electricity of a comparably sized standard compressor.</p>  <p><i>Coolbot™ device that uses an off-the-shelf air conditioner to produce cold air</i> <i>Source: KALRO</i></p>
Justification	Poor temperature management is one of the environmental factors that contribute to high postharvest losses in perishable commodities. This leads to spoilage, loss of income, and significant amounts of time spent traveling to sell and purchase fresh produce particularly in rural communities. The high cost of conventional cold rooms required for cold storage makes them inaccessible for majority of smallholder farmers in developing countries hence the need for cheaper alternatives. One such alternative is the Coolbot™ technology which has been tested and adopted in several countries.
B: Assessment of dissemination and scaling up/out approaches	


Users of TIMP	Farmers, extension agencies, aggregators, agriprenuers, traders
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality bananas, availability of quality standards
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Farmers and farmer groups – Provide land for demonstration plots; labour; manage trials; keep records to be used in M&E • County government and private extension service providers will train farmers on Coolbot™. They will also offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of Coolbot™ cooler
C: Current situation and future scaling up	
Counties where already promoted, if any	Homa Bay, Migori, Makueni, Machakos
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of the technology by farmers • Inadequate funds to install the Coolbot™
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the technology to farmers and traders • Capacity building of farmers on how to use the technology • Linkage to credit facility providers to promote commercialization, advocacy for its widespread use
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Linking entrepreneurs to credit and market enhances adoption of Coolbot™ technology • Farmers have often been encouraged to form groups as a strategy to enhance their bargaining power Groups have also exploited group advantage to get training/extension services and buy agro-inputs more cheaply
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • The extra cost of production must be matched with better returns – better prices for the banana fruits • Favorable environmental conditions

	<ul style="list-style-type: none"> • Willingness of producers to use the technology • Market access for high quality banana • Organize farmers into groups
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 40,000
Estimated returns	Not yet estimated
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women have less access to information, technology and knowledge • Women and youth have limited access to education, training and extension services • Women and youths may have limited access to credit to purchase the the Coolbot™
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youths in fabricating the Coolbot™
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Employment opportunities exist for youths in fabricating the Coolbot™
E: Case studies/profiles of success stories	
Success stories	Karurumo Smallholder Horticulture Aggregation and Processing Centre, in Embu County. Use of the technology has enabled the Centre to sell their banana fruits to different buyers for between KES 6-10 a piece, up from the KES 3- 5 offered by most buyers during the peak season.
Application guidelines for users	Coolbot™ leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Charity Gathambiri, Antony Nyaga, Nasambu Okoko, Willis Owino
Partner organizations	1) JKUAT 2) MoALD (County Governments) 3) Farmer groups 4) Service provider agencies e.g. financial institutions

	5) Traders 6) Private sector processors
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2.8 VALUE ADDITION


2.8.1 Banana ripening chamber

2.8.1 TIMP name	Banana ripening chamber
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Postharvest loss and low quality fruits occur in banana value chain due poor ripening practice
What is it? (TIMP description)	<p>The ripening chamber is made of plywood and lined with polythene inside. It has a lower section where organic source of ethylene (purple passion fruits, avocado etc.) is placed.</p>  <p><i>Banana ripening chamber</i> <i>Source: KALRO</i></p>
Justification	Low quality fruits and post-harvest losses occur during ripening. Ripening chamber shorten the period of ripening to three days, uniform ripening is achieved and the quality of the fruit is maintained.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana producers, agriprenuers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services

Critical/essential factors for successful promotion	Participatory approach, cost/benefit analysis
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> Extension staff - mobilize farmers during training and participate in training NGOs - Upscale the technology to the beneficiaries Research institutions - Provide technical backstopping
C: Current situation and future scaling up	
Counties where already promoted, if any	Kiambu, Murang'a and Meru
Counties where TIMP will be up-scaled	All counties where banana is produced
Challenges in dissemination	<ul style="list-style-type: none"> Availability of ripening chamber if demand is created
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Build capacity of local carpenters to construct the chamber
Lessons learned in upscaling, if any	It is important to train local artisans on how to fabricate banana ripening chamber
Social, environmental, policy and market conditions necessary	<ul style="list-style-type: none"> The beneficiaries will adopt the technology Available markets that offer better prices for quality banana Favourable weather condition to have enough volume for the market Regulation are put in place to offer quality banana in the market to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	A ripening chamber which holds 105-120 Kg (3 bunches) costs about KES 14,000
Estimated returns	Ripe fruit cost KES 10 x 3 x 100 = KES 3,000 after 3 days
Gender issues and concerns in development and dissemination adoption and scaling up	<ul style="list-style-type: none"> Women may have less access to information, technology and knowledge on the technology Women may have limited access to education, training and extension services on the technology
Gender related opportunities	<ul style="list-style-type: none"> Create employment for women and youth
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs may have less access to agricultural information, technology and knowledge on the technology VMGs have limited access to training and extension services on the technology Due to their social status VMGs are often excluded from decision making in development and dissemination activities There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> Create employment for VMG Use of banana ripening chamber lead to access of new markets
E: Case studies/profiles of success stories	

Success stories from similar previous projects	<ul style="list-style-type: none"> The ripening chamber has been promoted by youth groups in Muranga and Kiambu Counties who supply banana to schools
Application guidelines for users	<ul style="list-style-type: none"> Flyer or poster with information on ripening chamber and its operations Banana Production manual, KALRO
F: Status of TIMP readiness (1. Ready for upsaling; 2. Requires validation; 3. Requires further research)	1) Ready for up-scaling
G: Contacts	
Contacts	Institute Director, KALRO – HRI P.O. Box 220 Thika 01000 Email: kalro.kandara@kalro.org
Lead organization and scientists	KALRO-HRI: Charity Gathambiri, Francis Wayua, James Ndambuki, Antony Nyaga
Partner organizations	1) KALRO 2) Producers 3) Traders 4) Local Artisans

2.8.2 Banana flour

2.8.2 TIMP Name	Banana flour
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem to be addressed	Limited utilization of cooked banana which has more nutrients than maize flour
What is it? (TIMP description)	Flour prepared from dried banana (cooking varieties)  <i>Flour prepared from dried banana</i> <i>Source: KALRO</i>
Justification	Use of banana flour will reduce over-reliance on maize flour as main source of starch contributing to food and nutritional security. Diversification of banana food products will enhance consumption of banana and demand thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, processors, extension agencies, agripreneurs, traders

Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality bananas, availability of quality standards
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • Farmer groups – provide land for establishment of small-scale banana flour processing facility • County government and private extension service providers will train farmers on banana flour production technology They will also offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of banana flour production technology • KEBS – Standards formulation for banana flour; certification of private banana flour processors • Private sector processors (e.g. Nyangorora banana processors, KEBUK banana processors) – will be used as ToTs to train farmers on banana flour production; they will also act as market for the banana flour from farmers • Supermarkets and institutions (e.g. schools and hospitals) will provide ready markets for banana flour
C: Current situation and future scaling up	
Counties where already promoted, if any	Homa Bay, Migori, Makueni, Machakos Meru, Kisii, Nyamira, Tharaka-Nithi, Kakamega, Murang'a, Nyeri, Embu, Kirinyaga, Bungoma
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of the technology by farmers • Majority of Kenyan population only recognize maize flour as staple food • Difficulty in acquiring certification from regulatory authorities • Lack of universally acceptable standards for the product • Limited credit facilities available

Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to the government agencies, farmers, and traders • Capacity building of farmers on how to use the products • Involvement of regulatory agencies and policy makers in up-scaling process, linkage to credit facility providers to promote commercialization, advocacy for its widespread use • Nutrition education to Kenyan consumers on the need to diversify their food base and include other crops like bananas • Working with KEBS to develop standards for banana flour • Linking farmers to credit facility providers to get capital to engage in banana flour production agribusiness
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited KIRDI and learned on the banana flour production technology • Adequate capacity building is essential for technology adoption
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Beneficiaries will adopt the technology • Consumers will appreciate consumption of banana flour • Weather will be favourable to produce enough banana for processing • The processors will observe hygiene to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 160 per Kg of banana flour (8 Kg bananas make 1Kg flour)
Estimated returns	KES 250 per Kg of banana flour
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women and youth agro-processors/ entrepreneurs; start by targeting informal roadside sellers of <i>mandazi</i> and <i>chapatti</i> in the study areas, who may find it easy to incorporate banana flour into their product portfolios • Women do not have easy access to credit facilities, training and education
Gender related opportunities	<ul style="list-style-type: none"> • Women and youth stand to benefit in production, use and sale of banana flour. Start by targeting informal roadside sellers of <i>mandazi</i> and <i>chapatti</i> in the study areas, who may find it easy to incorporate banana flour into their product portfolios
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Banana flour can be used to make cheap nutritious food products, which will lead to enhanced production and consumption by VMGs hence bettering their health and incomes


	<ul style="list-style-type: none"> • The micro-nutrients in banana flour are particularly healthy for persons with chronic diseases
VMG related opportunities	<ul style="list-style-type: none"> • Opportunity to produce, trade in and consume locally produced banana flour based products • Nutritious products can be made from banana flour contributing to the nutrition of VMGs • Women can diversify family diet and generate income at village level by making the products for sale
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • The Kisii banana processing factory • The case of Nyangorora banana processors in Kisii County • Afmago Self-help group in Kisii • Khwisero Emuhaya, Butere and Kakamega (KEBUK) banana mini-processing factory in Khwisero • These groups process banana flour and sell to the community; they also use the flour to make baked products (bread, mandazi, cakes and buns) • The case of G-Star youth group in Nyeri. The group buys bananas from the local community which they dry using solar driers, mill and then pack the flour. They mill banana porridge flour fortified with maize and sorghum, which they sell locally • The case of Monica Kithinji, a 73-year old banana farmer from Nkubu, Meru County, who makes KES 400,000 profit monthly from selling the nutrient-rich flour. She owns Wedo Foods, a banana flour processing company. She supplies banana flour to Kirinyaga Millers and Stawi Foods and Fruits Ltd
Application guidelines for users	Banana flour production leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	<p>Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039</p>
Lead organization and scientists	KALRO; Charity Gathambiri, James Ndambuki, Francis Wayua, Antony Nyaga, Nasambu Okoko, Willis Owino
Partner organizations	<ol style="list-style-type: none"> 1) JKUAT 2) MoALD (County Governments) 3) KEBS 4) Farmer groups 5) Service providers e.g. financial institutions

	6) Traders 7) Processors
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GAPS

- 1) Optimizing blending *ratio* and processing *procedures* for banana flour
- 2) Characterizing the various banana varieties for their banana flour yield production potential
- 3) Providing data on gross margins for banana flour production

2.8.3 Fried banana chips

2.8.3 TIMP Name	Fried banana chips
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Limited utilization of cooking banana and products made from banana are more nutritious than those made from Irish potato
What is it? (TIMP description)	<p>Cooking banana product prepared by slicing into long slices and deep frying</p>  <p><i>Banana crisps</i> <i>Source: KALRO</i></p>
Justification	Banana crisps will reduce over-reliance on other food crops known to be used in making chips. Banana is nutritious and contributes to food and nutritional security. Diversification of banana food products will enhance consumption of banana and demand thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, small-scale processors, entrepreneurs, agriprenuers, traders, restaurants, schools and training institutions, consumers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models

	<ul style="list-style-type: none"> • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); availability of high quality bananas, availability of quality standards
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • County government and private extension service providers will train farmers on banana flour production technology, offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of banana chips production technology • KEBS – Standards formulation for banana chips; certification of private banana chips processors • Private sector processors (e.g. Nyangorora banana processors, KEBUK banana processors) – will be used as ToTs to train farmers on banana chips production; they will also act as market for the banana chips from farmers • Supermarkets and institutions (e.g. schools and hospitals) will provide ready market for banana chips
C: Current situation and future scaling up	
Counties where already promoted, if any	Meru, Kirinyaga, Embu, Taita Taveta, Muranga, Kisii, Tharaka-Nithi, Bungoma, Nyamira, Kakamega and Homa Bay
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of product by farmers and consumers • Limited processing technology at the household level (bananas are mainly boiled) • Difficulty in acquiring certification from regulatory authorities • Lack of product standards from certifying authorities • Limited credit facilities • Limited consumer awareness of value added banana products
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to farmers, consumers and other value chain actors • Capacity building of farmers on how to prepare the product • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product

	<ul style="list-style-type: none"> • Involvement of regulatory agencies and policy makers in up-scaling process, linkage to credit facility providers to promote commercialization, advocacy for standards development for value added banana products; nutrition education to consumers
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited KIRDI and learned on the banana chips production technology • Adequate capacity building is essential for technology adoption
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Beneficiaries will adopt the technology • Consumers will appreciate consumption of banana chips • Weather will be favourable to produce enough banana for processing • The processors will observe hygiene to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	10 fingers of banana costs KES 200 and produces 10 sachets of crisps
Estimated returns	A 50g sachet of banana crisps costs KES 50 Returns =KES 300
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women may have less access to information, technology and knowledge on the technology • Women may have limited access to education, training and extension services on the technology
Gender related opportunities	Employment opportunities exist for women in making banana chips for both home consumption for sale
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have less access to agricultural information, technology and knowledge on the technology • VMGs have limited access to training and extension services on the technology • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Employment opportunities exist for VMGs such as women and youth in banana chips making for consumption and sale
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • The case of Nyangorora banana processors in Kisii County • Khwisero Emuhaya, Butere and Kakamega (KEBUK) banana mini-processing factory in Khwisero


	<ul style="list-style-type: none"> These two groups process and sell product to the community, shops and supermarkets
Application guidelines for users	Banana chips production leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Nasambu Okoko, James Ndambuki, Charity Gathambiri and Antony Nyaga
Partner organizations	1) MoALD (County Governments) 2) KEBS 3) KIRDI 4) Farmer groups 5) Service provider agencies e.g. financial institutions 6) Processors and manufacturers 7) Private sector processors e.g. Nyangorora banana processors in Kisii and KEBUK factory in Kakamega County 8) Supermarkets 9) Institutions (schools, hospitals)

GAPS

- 1) Characterising the various banana varieties for their banana chips production potential (i.e. which variety produces the best quality chips)
- 2) Optimising the chips production procedures
- 3) Providing data on gross margins for fried banana chips production

2.8.4 Fried banana crisps

2.8.4 TIMP Name	Fried banana crisps
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Cooking banana has limited products and underutilization lead to postharvest loss
What is it? (TIMP description)	Fried banana crisps are made from cooking banana sliced and deep fried

	 <p><i>Fried banana crisps</i> Source: KALRO</p>
Justification	Banana crisps will reduce over-reliance on other food crops known to be used in making crisps for snacks. Banana is nutritious and contributes to food and nutritional security. Diversification of banana food products will enhance consumption of banana, and demand thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, small-scale processors, agripreneurs, traders, restaurants, consumers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); availability of high quality bananas, availability of quality standards
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • County government and private extension service providers will train farmers on banana crisps production technology, offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of banana crisps production technology • KEBS – Standards formulation for banana crisps; certification of private banana crisps processors • Private sector processors (e.g. Nyangorora banana processors, KEBUK banana processors) – will be used as ToTs to train farmers on banana crisps

	<p>production; they will also act as market for the banana crisps from farmers</p> <ul style="list-style-type: none"> • Supermarkets and institutions (e.g. schools and hospitals) will provide ready market for banana crisps
C: Current situation and future scaling up	
Counties where already promoted, if any	Kisii
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of product by farmers and consumers • Limited processing technology at the household level • Difficulty in acquiring certificates from regulatory authorities Lack of standards for the product • Lack of credit facilities • Limited consumer awareness of value added banana product Limited appropriate packaging materials
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to farmers, consumers and other value chain actors • Capacity building of farmers on how to prepare the product • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product • Involvement of regulatory agencies and policy makers in up-scaling process • Linkage to credit facility providers to promote commercialization • Advocacy for standards development for value added banana products • Sensitize consumers on nutritional value of bananan flour • Development of environmentally friendly packaging materials
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited KIRDI and learned on the banana crisps production technology. • Adequate capacity building is essential for technology adoption.
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Beneficiaries will adopt the technology • Consumers will appreciate consumption of banana crisps • Weather will be favourable to produce enough banana for processing • The processors will observe hygiene to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	

Basic costs	10 fingers banana costs KES 200/-, add cooking oil, and packaging costs This produces 10 sachets of crisps
Estimated returns	A 50g sachet of banana crisps costs KES 50/- Returns=KES 300
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women may have less access to information, technology and knowledge on the technology • Women may have limited access to education, training and extension services on the technology
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for women in banana crisps making for both consumption and sale
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have less access to agricultural information, technology and knowledge on the technology • VMGs have limited access to training and extension services on the technology • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Employment opportunities exist for some VMGs such as women in banana crisps making for both consumption and sale
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • The case of Nyangorora banana processors in Kisii County • Khwisero Emuhaya, Butere and Kakamega (KEBUK) banana mini-processing factory in Khwisero • These two groups process and sell product to the community, shops and supermarkets
Application guidelines for users	Banana crisps production leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Nasambu Okoko, Willis Owino, Charity Gathambiri, Antony Nyaga
Partner organizations	1) JKUAT 2) MoALD (County Governments) 3) KEBS 4) KIRDI 5) Farmer groups

	6) Service provider agencies e.g. financial institutions 7) Processors and manufacturers 8) Private sector processors e.g. Nyangorora banana processors in Kisii and KEBUK factory in Kakamega County 9) Supermarkets 10) Institutions (schools, hospitals)
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GAPS

- 1) Characterising the various banana varieties for their banana crisps production potential (for example, which variety produces the best quality crisps?)
- 2) Optimising the crisps production procedures
- 3) Providing data on gross margins for fried banana crisps production

2.8.5 Banana juice

2.8.5 TIMP Name	Banana juice
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Postharvest losses occur in dessert banana and limited banana utilization
What is it? (TIMP description)	Juice prepared from ripe bananas. The process include; <ul style="list-style-type: none"> • Peel well ripe banana • Put in a blender and add orange/lemon juice and water • Blend until smooth and serve
Justification	Processing ripe banana into juice diversifies the range of products from banana. Ripe banana is nutritious and this will contribute to food and nutritional security. Broadening of banana food products will enhance consumption of banana and demand thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, small-scale processors, agripreneurs, traders, restaurants, consumers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services

Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); availability of high quality bananas, availability of quality standards • Farmers should organise themselves into growers' associations which facilitate setting up of factories to process bananas into various products • The government should facilitate affordable credit to empower farmers take up banana agribusiness
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • County government and private extension service providers will train farmers on banana juice production. They will also offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of banana juice production • KEBS – Standards formulation for banana juice; certification of private banana juice processors • Private sector processors (e.g. Nyangorora banana processors, KEBUK banana processors) – will be used as ToTs to train farmers on banana juice production; they will also act as market for the banana juice from farmers • Supermarkets and institutions (e.g. schools and hospitals) will provide ready market for the banana juice
C: Current situation and future scaling up	
Counties where already promoted, if any	Kisii, Meru
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of product by farmers and consumers • Limited processing technology at the household level (ripe bananas are mainly used as dessert) • Difficulty in acquiring certificates from regulatory authorities • Lack of standards for the product • Lack or limited credit facilities • Limited consumer awareness of value-added banana products
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to farmers, consumers and other value chain actors • Capacity building of farmers on how to prepare the product • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product

	<ul style="list-style-type: none"> • Involvement of regulatory agencies and policy makers in up-scaling process, linkage to credit facility providers to promote commercialisation, advocacy for standards development for value added banana products; nutrition education to consumers
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited KIRDI and learned on the banana juice production technology • Adequate capacity building is essential for technology adoption
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Beneficiaries will adopt the technology • Consumers will appreciate consumption of banana juice • Weather will be favourable to produce enough banana for processing • The processors will observe hygiene to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet estimated
Estimated returns	Not yet estimated
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women may have less access to information, technology and knowledge on the technology • Women may have limited access to education, training and extension services on the technology
Gender related opportunities	Employment opportunities exist for women in banana juice making for both consumption and sale
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have less access to agricultural information, technology and knowledge on the technology • VMGs have limited access to training and extension services on the technology • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Employment opportunities exist for some VMGs such as women in making banana juice for consumption and sale
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • The case of Nyangorora banana processors in Kisii County • The group process banana juice and sell to the community
Application guidelines for users	Banana juice production leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation

G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Nasambu Okoko, James Ndambuki, Charity Gathambiri, Antony Nyaga
Partner organizations	1) JKUAT 2) MoALD (County Governments) 3) KEBS 4) KIRDI 5) Farmer groups 6) Service provider agencies e.g. financial institutions 7) Processors and manufacturers 8) Private sector processors e.g. Nyangorora banana processors in Kisii and KEBUK factory in Kakamega County 9) Supermarkets 10) Institutions (schools, hospitals)

GAPS

1. Fine-tuning the production protocol and packaging
2. Determining market demand and gross margins
3. Characterize different banana varieties for their nutritional composition and suitability in processing various value-added products (flour, juice, jam, wine)

2.8.6 Banana jam

2.8.6 TIMP Name	Banana jam
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Ripe bananas are highly perishable and lead to postharvest losses and has limited banana value added products.
What is it? (TIMP description)	Jam prepared from ripe bananas
Justification	Value addition of ripe banana in jam will reduce postharvest losses. Broadening of ripe banana products will increase consumption of thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, small-scale processors, agripreneurs, traders, restaurants, consumers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings

	<ul style="list-style-type: none"> • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP) • Availability of high quality bananas, availability of quality standards • Farmers should organize themselves into growers' associations which facilitate setting up of factories to process bananas into various products • The government should facilitate affordable credit to empower farmers take up banana agribusiness
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • County government and private extension service providers will train farmers on banana wine production technology, offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of banana jam production technology • KEBS – Standards formulation for banana jam; certification of private banana jam processors • Private sector processors (e.g. Nyangorora banana processors, KEBUK banana processors) – will be used as ToTs to train farmers on banana jam production; they will also provide market for bananas from farmers • Supermarkets and institutions (e.g. schools and hospitals) will provide marketss for the banana jam
C: Current situation and future scaling up	
Counties where already promoted, if any	Kisii, Meru
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of product by farmers and consumers • Limited processing technology at the household level • Difficulty in acquiring certification from regulatory authorities • Lack of standards for the product • Lack of credit facilities • Limited consumer awareness of value added banana products

Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to farmers, consumers and other value chain actors • Capacity building of farmers on how to prepare the product • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product • Involvement of regulatory agencies and policy makers in up-scaling process, linkage to credit facility providers to promote commercialization, advocacy for standards development for value added banana products; nutrition education to consumers
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited KIRDI and learned on the banana juice production technology • Adequate capacity building is essential for technology adoption
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Beneficiaries will adopt the technology • Consumers will appreciate consumption of banana jam • Weather will be favourable to produce enough banana for processing • The processors will observe hygiene to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet estimated
Estimated returns	Not yet estimated
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women may have less access to information, technology and knowledge on the technology • Women may have limited access to education, training and extension services on the technology
Gender related opportunities	Employment opportunities exist for women in making banana jam for both home consumption and sale
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have less access to agricultural information, technology and knowledge on the technology • VMGs have limited access to training and extension services on the technology • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness •
VMG related opportunities	Employment opportunities exist for some VMGs such as women in banana jam making for both consumption and sale

E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> The case of Nyangorora banana processors in Kisii County, and Khwisero Emuhaya, Butere and Kakamega (KEBUK) banana mini-processing factory in Khwisero These groups processes banana jam and sell to the community
Application guidelines for users	Banana jam production leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Nasambu Okoko, Willis Owino, Charity Gathambiri, Antony Nyaga
Partner organizations	1) JKUAT 2) MoALD (County Governments) 3) KEBS 4) KIRDI 5) Farmer groups 6) Service provider agencies e.g. financial institutions 7) Processors and manufacturers 8) Private sector processors e.g. Nyangorora banana processors in Kisii and KEBUK factory in Kakamega County 9) Supermarkets 10) Institutions (schools, hospitals)

GAPS

- 1) Characterizing the various banana varieties for their banana jam production potential (i.e. which variety produces the best jam)
- 2) Optimizing the jam production procedures
- 3) Providing data on gross margins and market demand for banana jam production

2.8.7 Banana wine

2.8.7 TIMP Name	Banana wine
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Ripe banana have a short life that contribute to postharvest losses and there limited banana value added products.

What is it? (TIMP description)	Wine prepared from ripe bananas. It is made by fermenting banana juice by adding wine yeast and sugar.
Justification	Limited ripe banana products and its perishability lead to postharvest losses. Processing banana wine will reduce postharvest losses and also increase products prepared from ripe banana.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, small-scale processors, agripreneurs, traders, restaurants, consumers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); availability of high quality bananas, availability of quality standards • Farmers should organise themselves into growers' associations which facilitate setting up of factories to process bananas into various products • The government should facilitate affordable credit to empower farmers take up banana agribusiness
Partners/stakeholders for scaling up and their respective roles	<ul style="list-style-type: none"> • County government and private extension service providers will train farmers on banana wine production technology. They will also offer advice and collect information on the uptake and practice on the technology • KALRO and JKUAT – will train trainers and provide technical backstopping on dissemination of banana wine production technology. • KEBS – Standards formulation for banana wine; licensing and certification of private banana wine processors • Private sector processors (e.g. Nyangorora banana processors, KEBUK banana processors) – will be used as ToTs to train farmers on banana wine production • Supermarkets and institutions will provide markets for the banana chips
C: Current situation and future scaling up	
Counties where already promoted, if any	Kisii

Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Limited awareness of product by farmers and consumers • limited processing technology at the household level (bananas mainly eaten ripe as dessert) • Difficulty in acquiring certificates from regulatory authorities • Lack of standards for the product • Lack of credit facilities • Limited consumer awareness of value added banana products
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Awareness creation about the product to farmers, consumers and other value chain actors • Capacity building of farmers on how to prepare the product • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product • Involvement of regulatory agencies and policy makers in up-scaling process, linkage to credit facility providers to promote commercialisation, advocacy for standards development for value added banana products; nutrition education to consumers
Lessons learned in up scaling, if any	<ul style="list-style-type: none"> • Participation in farmer tours exposes farmers to new technologies and ideas. For example, the groups in Kisii visited KIRDI and learned on the banana juice production technology • Adequate capacity building is essential for technology adoption
Social, environmental, policy and market conditions necessary for development and up-scaling	<ul style="list-style-type: none"> • Beneficiaries will adopt the technology • Consumers will appreciate consumption of banana wine • Weather will be favourable to produce enough banana for processing • The processors will observe hygiene to ensure food safety issues are considered
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet estimated
Estimated returns	Not yet estimated
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Women may have less access to information, technology and knowledge on the technology • Women may have limited access to education, training and extension services on the technology
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for women in making banana wine for both home consumption and sale


VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs may have less access to agricultural information, technology and knowledge on the technology. • VMGs have limited access to training and extension services on the technology. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities. • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Employment opportunities exist for some VMGs such as banana wine making for both consumption and sale
E: Case studies/profiles of success stories	
Success stories	<ul style="list-style-type: none"> • The case of Nyangorora banana processors in Kisii County • This group processes banana juice and sell to the community
Application guidelines for users	Banana crisps production leaflets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	2) Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100 Kakamega Email: kalro.kakamega@kalro.org or director.nrri@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua, Nasambu Okoko, Willis Owino, Charity Gathambiri, Antony Nyaga
Partner organizations	1) JKUAT 2) MoALD (County Governments) 3) KEBS 4) KIRDI 5) Farmer groups 6) Service provider agencies e.g. financial institutions 7) Processors and manufacturers 8) Private sector processors e.g. Nyangorora banana processors in Kisii and KEBUK factory in Kakamega County 9) Supermarkets 10) Institutions (schools, hospitals)

GAPS

1. Characterising the various banana varieties for their banana wine production potential (i.e. which variety produces the best wine)
2. Optimising the wine production procedures
3. Providing data on gross margins and market demand for banana wine production

2.9 MECHANIZATION OF BANANA PRODUCTION ACTIVITIES

2.9.1 Bulldozer


2.9.1 TIMP Name	Bulldozer
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Slow and tedious processes of bush clearing, in a commercialized banana commodity • Manual bush clearing delays job finishing leading to late planting • High cost of manual labour • High drudgery level
What is it? (TIMP description)	<p>Crawler bulldozer (crawler dozer) or bulldozer, is a tracked earthmoving machine with a front-mounted blade. It's widely used in civil engineering, mining, and construction. A bulldozer is an earthmoving machine designed to push large quantities of rubble, soil, sand and other loose materials. They are used by farmers as tractors to plough and clear land. Over time, dozers have evolved to accommodate a variety of environments and applications with high levels of efficiency.</p>  <p><i>Crawler tractor bulldozer in agricultural bush clearing operation under supervision</i> <i>Source: Adama, 2013</i></p>
Justification	This heavyweight is great for moving heavy materials from one area to another. This bulldozer is ideal for traversing dense and irregular terrain since the tracks give it great traction. They also have rippers that assist with crushing and clearing dense terrain.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, agriprenuers, researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals

	<ul style="list-style-type: none"> Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Grading: Also called land leveling, grading creates a level base Finish grading: Dozers are also fit for finish grading, which involves leveling off an inch or two of an already-graded surface Removing materials and obstructions: Clean a job site with a dozer to remove extra earth, dirt, rocks, sand or rubble Spreading materials: For landscaping or grading, dozers are useful for spreading soil, sand and other materials dumped from heavy machinery
Partners/stakeholders for scaling up and their roles	<ol style="list-style-type: none"> 1) KALRO 2) ATDC 3) AMS 4) Universities 5) Contractors 6) Bulldozer dealers 7) NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> Lack of the machines Small size of land to be established High initial cost for small-scale farmers to own or hire crawler bulldozers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Centralized hire serve providers Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> Hastens the speed of bush clearing Increases land for Banana cultivation Leaves land less vulnerable to soil erosion
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> Creation of awareness on mechanization importance in the community. Include all gender groups in research, and validation. Favourable Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs Shantui D6	KES 18,000,000
Estimated returns	KES 7,000/ hour after paying round trip of KES 1,000/ Km
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Men perform most of the land clearing and ploughing activities therefore the implement will reduce their work burden Women and youth have limited access credit to purchase the Crawler bulldozer Women and youth have limited access to education, training and extension services Women have less access to agricultural information, technology and knowledge

Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI –Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators


2.9.2 Ranging rod

2.9.2 TIMP Name	Ranging rod
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • It's difficult to set out straight lines on the field • It's difficult to see a point on the ground from a distance
What is it? (TIMP description)	A ranging rod is a surveying instrument used for marking the position of stations, and for sightings of those stations, as well as for ranging straight lines.

	 <p>Ranging line Source: KALRO-Katumani</p>
Justification	When a survey is supposed to be conducted on any site, its length is greater than the chain. It becomes essential that the measurements are aligned with the chain. This method of marking intermediate points on the survey line is defined as ranging and can only be attained by a ranging rod.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Surveyors, engineers, contractors
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, low cost, portable
Partners/stakeholders for scaling up and their roles	KALRO, universities, survey equipment dealers, construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out straight lines on the field • Ease of seeing a point on the ground from a distance

Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community • Involvement of all gender groups in research, and validation • Formulate favourable policy on cost of agricultural equipment
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 2,200
Estimated returns	KES 1200 /day gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasirembe W.W.
Partner organizations	Local fabricators

2.9.3 Levelling stuff

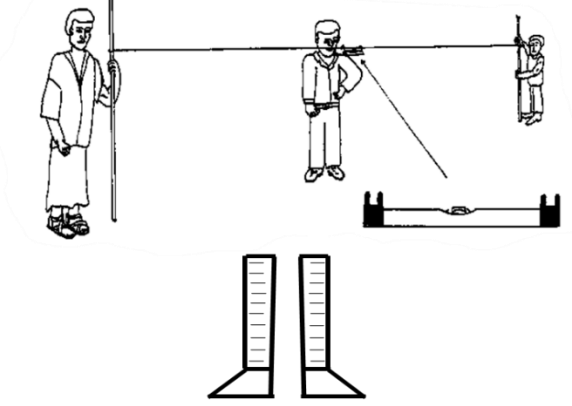
2.9.3 TIMP Name	Levelling stuff
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • It's difficult to set out straight lines on the field • It's difficult to see a point on the ground from a distance
What is it? (TIMP description)	<p>A level stuff, also called levelling rod, is a graduated wooden or aluminium rod, used with a levelling instrument to determine the difference in height between points or heights of points above a vertical datum. It is a straight rod with graduation marks with zero from the bottom. It helps in determining how much above or below the station from the line of sight.</p>  <p><i>Levelling stuff</i> <i>Source: KALRO-Katumani</i></p>
Justification	Levelling is a process of determining the height of one level relative to another. It is used in surveying to establish the elevation of a point relative to a datum, or to establish a point at a given elevation relative to a datum.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Surveyors, engineers, contractors, agriprenuers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings

	<ul style="list-style-type: none"> • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, low cost, portable
Partners/stakeholders for scaling up and their roles	KALRO, universities, survey equipment dealers, construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out straight lines on the field • Ease of seeing a point on the ground from a distance
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community • Involvement of all gender groups in research and validation • Formulate favourable policy on cost of agricultural equipment
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 5,500
Estimated returns	KES 32/ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit • Employment opportunity exist for youths to perform the task
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit • Employment opportunity exist for youths to perform the task

E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1 – Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators


2.9.4 Line level

2.9.4 TIMP Name	Line level
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • It's difficult to set out straight lines on the field. • It's difficult to see a point on the ground from a distance
What is it? (TIMP description)	A line level consists of two poles, between which a length of string is suspended. A spirit level is hung on the string. The level is the type used by builders, but has small hooks at either end. The poles should be of even height (about 1.5 m) and the string (about 2 mm in diameter) and precisely 10 metres in length. A notch is made in each pole at exactly the same height (about 1.4 m above ground level) and the ends of the string tied around these notches. The centre of the string (5 m from each end) is marked and the level itself is suspended there.

	 <p><i>A line level consisting of a string suspended in two poles</i> <i>source: KALRO-Katumani</i></p>
Justification	The line level is a simple surveying instrument which can be used to lay out contours and gradients, and also to measure the slope of land. It is simple to operate and is easier to transport than other similar surveying tools such as the A-frame. It is especially quick and very accurate when used properly. However, a line level does require three people to operate it.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, extension staff, surveyors, engineers, contractors
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, low cost, portable
Partners/stakeholders for scaling up and their roles	KALRO, universities, survey equipment dealers, construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out straight lines on the field • Ease of seeing a point on the ground from a distance

Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community • Involvement of all gender groups in research, and validation • Formulate favourable policy on cost of agricultural equipment
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 2,500
Estimated returns	KES 500/ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement. • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit. • Employment opportunity exist for youths to perform the task
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit • Employment opportunity exist for youths to perform the task
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Soil and water conservation has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI -Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators


2.9.5 Total Station Theodolite

2.9.5 TIMP Name	Total Station Theodolite
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Measuring long distances where a measuring tape is not appropriate • Measuring angles of object points far apart • Documenting field details on paper
What is it? (TIMP description)	<p>A total station (ST) or total station theodolite (TST) is an electronic/optical instrument used for land surveying. It is an electronic transit theodolite integrated with electronic distance measurement (EDM). It is used to measure both vertical and horizontal angles and the slope distance from the instrument to a particular point. The instrument has an on-board computer to collect data and perform triangulation calculations.</p>  <p><i>Source: Egerton University</i></p>
Justification	Total stations are the primary survey instrument used in agricultural land surveying. The electronic theodolite part of total station is used for measuring vertical and horizontal angle. For measurement of horizontal angles any convenient direction may be taken as reference direction. For vertical angle measurement vertical upward (zenith) direction is taken as reference direction suited to measuring contour points.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Surveyors, engineers, contractors
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, ability to store information, portable

Partners/stakeholders for scaling up and their roles	1) KALRO 2) Universities 3) Survey equipment dealers 4) Construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out horizontal and vertical measurements on the field • Ease of measuring ground angles from a distance
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community • Involvement of all gender groups in research, and validation • Formulate favourable policy on cost of agricultural
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 105,000
Estimated returns	KES 615/ha of protected land gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness	1) Ready for upscaling

(1-ready for upscaling; 2-requires validation; 3-requires further research)	
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators


2.9.6 Tripod stand

2.9.6 TIMP Name	Tripod stand
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • A total station needs to be raised off the ground • Different users require varying heights of operation • The total station theodolite need to be firmed to a specific point • The total station theodolite need to swing around a specific point
What is it? (TIMP description)	<p>A tripod consists of three legs and a head where the level instrument is mounted. The tripod could be of aluminum or wood material. When leveling the level instrument, the tripod head must be set approximately level beforehand by adjusting the tripod legs.</p>  <p><i>A tripod stand for mounting total station theodolite</i> Source: Egerton University</p>
Justification	A tripod will reduce total station theodolite movements and improves picture quality, hence perfect sunrise or sunset.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Surveyors, engineers, contractors
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS)

	<ul style="list-style-type: none"> • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, ability to store information, portable
Partners/stakeholders for scaling up and their roles	KALRO, universities, survey equipment dealers, construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out horizontal and vertical measurements on the field • Ease of measuring ground angles from a distance
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community • Involvement of all gender groups in research, and validation • Formulate favourable policy on cost of agricultural
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 12,000
Estimated returns	70/ ha of protected land gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness

VMG related opportunities	Can create employment for VMG at local level
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI -Katumani P.O. Box 340 Machakos Email: cd.katumani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University Nasirembe W.W.
Partner organizations	Local fabricators


2.9.7 Plumb bob

2.9.7 TIMP Name	Plumb bob
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Alignment of the centre of the total station theodolite to the point on the ground • Develop verticality of the total station theodolite
What is it? (TIMP description)	<p>A plumb bob is used to check if objects are vertical. A plumb bob consists of a piece of metal (called a bob) pointing downwards, which is attached to a cord. When the plumb bob is hanging freely and not moving, the cord is vertical.</p>  <p><i>A plumb bob</i> <i>Source: KALRO</i></p>
Justification	A level and plumb bob are each helpful when trying to align components of a survey project. Levels are used to draw lines and

	check horizontal, vertical and even angled surfaces, while plumb bobs are handy for transferring marks and aligning elements over long vertical distances.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Surveyors, engineers, contractors
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, ability to level, portable
Partners/stakeholders for scaling up and their roles	KALRO, universities, survey equipment dealers, construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out horizontal and vertical measurements on the field. • Ease of measuring ground angles from a distance
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community. • Involvement of all gender groups in research, and validation • Formulate favourable Policy on cost of agricultural
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 300
Estimated returns	KES 2/ ha of protected land gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge

Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI –Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasirembe W.W.
Partner organizations	Local fabricators

2.9.8 Measuring tape


2.9.8 TIMP Name	Measuring tape
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Measurement of short distances • A ruler is much shorter and not flexible
What is it? (TIMP description)	<p>Tapes are used in surveying to take linear measurements. They are available in different lengths (e.g. 10, 30, 50, 100 m) and made of different materials.</p> 

	<i>A measuring tape</i> <i>Source: KALRO</i>
Justification	A measuring tape is a flexible tool used for measuring length. It is made up of materials like fiberglass, cloth, plastic, metal ribbon or strip. So, it is a kind of flexible ruler also known as a tape measure. It is marked in centimetres and inches.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Surveyors, engineers, contractors
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Efficiency, ability to level, portable
Partners/stakeholders for scaling up and their roles	KALRO, universities, survey equipment dealers, construction contractors
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Murang'a, Nyeri
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of survey equipment • Lack of technical ability to use the equipment
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Train stakeholders on how to use survey equipment • Avail equipment to the stakeholders
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Ease of setting out horizontal and vertical measurements on the field • Ease of measuring ground angles from a distance
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on ranging rod importance to the community • Involvement of all gender groups in research, and validation • Formulate favourable Policy on cost of agricultural
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 1,500
Estimated returns	KES 5/ ha of protected land gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the surveying activities therefore the implement will ease their work • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services

	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI -Katumani P.O. Box 340 Machakos Email: cd.katumani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasirembe W.W.
Partner organizations	Local fabricators

2.9.9 Wheeled excavator


2.9.9 TIMP Name	Wheeled excavator
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Slow and tedious processes of cut-off excavation, in a commercialized banana commodity • Manual bush clearing cut-off excavation delays job finishing leading to late planting • High cost of manual labour • High drudgery level
What is it? (TIMP description)	An excavator is heavy construction equipment consisting of a boom, dipper, bucket and cab on a rotating platform known as the "house". The house sits atop an undercarriage with tracks or wheels. They are a natural progression from the steam shovels and often mistakenly called power shovels. All movement and

	<p>functions of a hydraulic excavator are accomplished through the use of hydraulic fluid, with hydraulic cylinders and hydraulic motors. Due to the linear actuation of hydraulic cylinders, their mode of operation is fundamentally different from cable-operated excavators which use winches and steel ropes to accomplish the movements.</p>  <p><i>Wheeled excavator with a boom, dipper, bucket and cab</i> <i>Source: Nasirembe W; KALRO-Katumani</i></p>
Justification	This heavyweight is great for moving heavy materials from one area to another. This excavator is ideal for traversing dense and irregular terrain since the tracks give it great traction. They also have rippers that assist with crushing and excavating dense terrain.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Excavators are typically used for digging excavations and for trenching purposes. • Their versatility and effectiveness make them vital at agricultural sites
Partners/stakeholders for scaling up and their roles	KALRO, ATDC, AMS, universities, contractors, bulldozer dealers, NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of the machines • Small size of land to be established

	<ul style="list-style-type: none"> • High initial cost for small-scale farmers to own or hire crawler bulldozers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Centralized hire serve providers • Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Hastens the speed of bush clearing • Increases land for Banana cultivation • Leaves land less vulnerable to soil erosion
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on mechanization importance in the community. • Include all gender groups in research, and validation • Favourable Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs (Volvo excavator wheeled 20 ton)	KES 8,000,000
Estimated returns	KES 10,000/ hr after paying round trip of KES 1,000/ Km
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the land clearing and cultivation activities therefore the implement will reduce their work burden • Women and youth have limited access credit to purchase the wheeled excavator. • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements. • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	

Contacts	Institute Director, KALRO AMRI -Katumani P.O. Box 340 Machakos Email: cd.katumani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators

2.9.10 Wheeled tractor


2.9.10 TIMP Name	Wheeled tractor
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Slow and tedious processes of seedbed preparation, in the commercialized banana commodity • Drudgery and fatigue • Low output • Inefficiency and inconsistency of work • Untimeliness • High cost of manual labour
What is it? (TIMP description)	<p>A tractor is an engineering vehicle specifically designed to deliver a high tractive effort (or torque) at slow speeds, for the purposes of hauling a trailer or machinery such as that used in agriculture. Most commonly, the term is used to describe a farm vehicle that provides the power and traction to mechanize agricultural tasks, especially (and originally) tillage, trailer towing, planting, weeding, ridging, planting, spraying, harvesting, ground grading and much more agricultural functions. Agricultural implements may be towed behind, mounted behind or in front of the tractor and the tractor may also provide a source of power if the implement is mechanized. It is therefore fitted with various equipment at alternate times for easing farm operations</p>  <p><i>Wheeled tractor fitted with a ploughing implement</i> Source: Nasiremba W.; KALRO-Katumani</p>
Justification	A tractors is an essential necessity of farming as it provides machine power for performing farm applications. In addition to routine farm activities, it is efficient, timely, consistent, releases

	labour and reduces cost as compared to manual labour.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Tractors are typically used for land preparation. • Their versatility and effectiveness make them vital at agricultural sites
Partners/stakeholders for scaling up and their roles	KALRO, ATDC, AMS, universities, contractors, bulldozer dealers NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of the machines • Small size of land to be established • High initial cost for small-scale farmers to own or hire crawler bulldozers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Centralized hire serve providers • Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Hastens the speed of land preparation • Increases land for Banana cultivation • Leaves land less vulnerable to soil erosion when ploughed along the contour
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on mechanization importance in the community • Include all gender groups in research, and validation • Favourable policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs (Volvo excavator wheeled 20 ton)	KES 6,000,000
Estimated returns	KES 7,000/ ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the land ploughing activities therefore the implement will reduce their drudgery of work • Women and youth have limited access credit to purchase the wheeled tractor • Women and youth have limited access to education, training and extension services

	<ul style="list-style-type: none"> • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators

2.9.11 Mould board plough


2.9.11 TIMP Name	Mould board plough
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	<ul style="list-style-type: none"> • Unbroken heavy clods in the soil and gives it an uneven structure • Uneven plough depth • Requirement of added weight for ballasting
What is it? (TIMP description)	Mouldboard plough is an agricultural implement and is generally considered to be an important tillage implement for power tiller and tractor operation. A mouldboard plough does four jobs namely

	<p>a) cutting the furrow slice, b) lifting the furrow slice, c) inverting the furrow slice and d) pulverizing the furrow slice. Ploughing accounts for more traction energy than any other field operation. The plough conserves moisture and biomass while pulverizing the soil hence climate smart.</p>  <p>Mouldboard plough Source: B.S. Tractors Pvt Ltd</p>
Justification	Has high efficiency, versatile and atomically seeks the desired depth when well-adjusted. The various models have different features that enable high efficiency in preparation of the land, improved soil health, weed and pest control.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Mould boards are typically used for land preparation • Their versatility and effectiveness make them vital at agricultural sites
Partners/stakeholders for scaling up and their roles	KALRO, ATDC, AMS, universities, contractors, bulldozer dealers, NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of the mould board ploughs • Small size of land to be established • High initial cost for small-scale farmers to own or hire mould board ploughs hitched tractors
Suggestions for addressing	<ul style="list-style-type: none"> • Centralized hire serve providers

the challenges	<ul style="list-style-type: none"> • Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Hastens the speed of land preparation • Increases land for Banana cultivation • Leaves land less vulnerable to soil erosion when ploughed along the contour • Conserves moisture in the soil
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on mechanization importance in the community • Include all gender groups in research, and validation • Favourable Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 450,000
Estimated returns	KES 50/ ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the crops land preparation activities therefore the implement will reduce their work burden. • Women and youth have limited access credit to purchase the mouldboard plough • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI -Katumani P.O. Box 340

	Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasirembe W.W.
Partner organizations	Local fabricators

2.9.12 Disc harrow


2.9.12 TIMP name	Disc harrow
Category (i.e. Technology, Innovation or Management Practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	<ul style="list-style-type: none"> • Slow and tedious processes of seedbed preparation, in a commercialized banana commodity • Difficult to break clods manually • Delayed operation lead to late planting • Low acreage because of lack of manual labour • High cost of manual labour
What is it? (TIMP description)	<p>A harrow, farm implement used to pulverize soil, break up crop residues, uproot weeds and cover seed. It is a farm implement used for surface tillage. It is used after ploughing for breaking up and smoothing out the surface of the soil. The purpose of harrowing is to break up clods and to provide a smooth soil structure, called tilth, that is suitable for planting. Coarser harrowing may also be used to remove weeds and to cover seed after sowing.</p>  <p><i>Disc harrow</i> Source: https://fonts.gstatic.com/s/i/productlogos/lens_camera/v1/192px.sv</p>
Justification	Has high efficiency, versatile and atomically seeks the desired depth when well-adjusted. The various models have different features that enable high efficiency in preparation of the land, improved soil health, weed and pest control.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, extension staff, researchers, universities
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings

	<ul style="list-style-type: none"> • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Good collaboration between all partners • Adequate facilitation: Funds, Logistics (Transport) • Timeliness, efficiency, cheap cost, multiple usage
Partners/stakeholders for scaling up and their roles	Ministry of Agriculture extension service for technology dissemination, individual farmers, farmer groups/CBOs
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> • High initial cost for small-scale farmers • Lack of the mould board ploughs • Fear of machines
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Produce profitably to generate money for buying the harrow • Acquaintance with machines through training • Encourage group investment
Lessons learned in up-scaling if any	<ul style="list-style-type: none"> • Low level of extension • Increase farmer machine interaction • Conduct demonstrations
Social, environmental, policy and market conditions necessary for upscaling	<ul style="list-style-type: none"> • Organized producer groups to ensure consistence availability of raw materials • Organized marketing channels
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 350,000
Estimated returns	KES 800/ ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform the harrowing activities therefore the implement will reduce their work burden • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement. • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements. • VMGs have limited access to training and extension services

	<ul style="list-style-type: none"> • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness.
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profile of success stories	
Success stories from previous similar projects	This has been done in Kiambu at household level but needs to be up scaled contractual level
Application guidelines for users	Brochures and factsheets with detailed guidelines on banana value addition documented
F: Status of TIMP readiness 1) Ready for upscaling 2) Requires validation 3. Requires further research	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katumani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasirembe W.W., Sam Nyakach
Partner organizations	1) JKUAT 2) MoALD 3) Tractor hire service contractors

2.9.13 Hand-held hole drill


2.9.13 TIMP Name	Hand-held hole drill
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Due to increased cost of manual labour, digging of planting holes is expensive, slow and tedious process. It is also difficult to prepare uniformly spaced contour holes leading to late planting.
What is it? (TIMP description)	Hole digger is an engine driven machine that augers holes in rows at equal distances as desired mechanically and economically. It used for hole making during tree planting, electric poles and farm hedges. It can auger down to about 90 cm deep with a consistent diameter in just 30 seconds. The hole diameter is determined by the auger size.

	 <p><i>Hand-held hole drill</i> Source: https://earthaugerkenya.com/images/specc.png</p>
Justification	Has high efficiency, versatile and atomically seeks the desired depth when well-adjusted. The various models have different features that enable high efficiency during hole making.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Hole diggers are typically used for boring Banana seedling holes • Their versatility and effectiveness make them vital at agricultural sites
Partners/stakeholders for scaling up and their roles	KALRO, ATDC, AMS, universities, contractors, bulldozer dealers NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of the power hole drills • Small size of land to be established • High initial cost for small-scale farmers to own or hire power hole drills hitched tractors

Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Centralized hire serve providers • Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Hastens the speed of hole drilling • Increases land for Banana cultivation • Conserves moisture in the soil
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on mechanization importance in the community • Include all gender groups in research, and validation • Favourable Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 98,000
Estimated returns	KES 150/ hole
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform the banana hole planting digging activities therefore the implement will reduce their work burden • Women and youth have limited access credit to purchase the implement • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements • VMGs have limited access to training and extension services. • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2- Requires validation; 3-Requires further research)	1) Requires validation
G: Contacts	
Contacts	The Institute Director, KALRO AMRI-Katumani P.O. Box 340. Machakos Email: cd.katamani@kalro.org Phone: 0711369535

Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators

















2.9.14 Tractor hole drill

2.9.14 TIMP Name	Tractor hole drill
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Due to increased cost of manual labour, digging of planting holes is expensive, slow and tedious process. It is also difficult to prepare uniformly spaced contour holes leading to late planting.
What is it? (TIMP description)	<p>Hole digger is a power take off (PTO) driven machine that augers holes in rows at equal distances as desired mechanically and economically. It used for hole making during tree planting, electric poles and farm hedges. It can auger down to about 90 cm deep and have a consistent diameter in just 30 seconds.</p>  <p><i>Tractor hole drill</i> <i>Source: B.S. Tractors Pvt Ltd</i></p>
Justification	The auger makes a definite and uniform hole diameters and depths as desired, selected from the auger specifications. Users spend 50 times shorter a time and as little as 90ml of fuel to auger a hole. It augers as it removes detached soil forming a much neater hole, with a well-defined circumference. It is easy to use since holes can be made at pre-defined point by driving the compact tractor.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, contractors and researchers
Approaches used in dissemination	<ul style="list-style-type: none"> Farmer Field and Business School (FFBS) Agricultural innovation platforms (AIP) Demonstrations on-farm and on-station Agricultural shows/exhibitions/field days Trainings - workshops/seminars/meetings Public and private extension agents Farmer - to - farmer extension models Mass media - Electronic and print Publications - posters/brochures/leaflets, manuals

	<ul style="list-style-type: none"> Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> Hole drills are typically used for land preparation Their versatility and effectiveness make them vital at agricultural sites
Partners/stakeholders for scaling up and their roles	KALRO, ATDC, AMS, universities, contractors, bulldozer dealers NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> Lack of the mould hole drills Small size of land to be established High initial cost for small-scale farmers to own or hire mould board ploughs hitched tractors
Suggestions for addressing the challenges	<ul style="list-style-type: none"> Centralized hire serve providers Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> Hastens the speed of hole drilling Makes identical holes
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> Creation of awareness on mechanization importance in the community Include all gender groups in research, and validation Favourable Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 450,000
Estimated returns	KES 50/ ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> Men perform most of the banana planting holes digging activities therefore the implement will reduce their work burden. Women and youth have limited access credit to purchase the implement. Women and youth have limited access to education, training and extension services Women have less access to agricultural information, technology and knowledge.
Gender related opportunities	<ul style="list-style-type: none"> Employment opportunities exist for youth males and males in operating the implement. Affirmative action opportunities such as the women and youth enterprise fund exists for them to access the required credit.
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs have limited access to credit to purchase the farm implements VMGs have limited access to training and extension services Due to their social status VMGs are often excluded from decision making in development and dissemination activities There is low adoption by VMGs due lack of awareness

VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasiremba W.W.
Partner organizations	Local fabricators

2.9.15 Motorised sprayer

2.9.15 TIMP Name	Motorised sprayer																																																																								
Category (i.e. technology, innovation or management practice)	Technology																																																																								
A: Description of the technology, innovation or management practice																																																																									
Problem to be addressed	Manual spraying of banana is a slow and tedious process since it requires a long projectile spray which cannot be attained by a manual knapsack sprayer. Banana has a high number of pests that invade leaf, flowers and fruit.																																																																								
What is it? (TIMP description)	<div><div></div><div><table><caption>Nozzle Guide for Band and Directed Spraying</caption><thead><tr><th></th><th> Even Flat Fan</th><th> Non Even Flat Fan</th><th> Hollow Cone</th><th> Full Cone</th><th> Disc and Core Cone</th></tr></thead><tbody><tr><td>Herbicides</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Pre-emergence</td><td>Very Good</td><td>Good</td><td>Very Good</td><td>Good</td><td></td></tr><tr><td>Post-emergence Contact</td><td>Good</td><td>Very Good</td><td>Good</td><td></td><td></td></tr><tr><td>Post-emergence Systemic</td><td>Very Good</td><td>Good</td><td></td><td></td><td></td></tr><tr><td>Fungicides</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Contact</td><td>Good</td><td></td><td>Good</td><td></td><td>Very Good</td></tr><tr><td>Systemic</td><td>Very Good</td><td></td><td></td><td></td><td>Good</td></tr><tr><td>Insecticides</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Contact</td><td>Very Good</td><td>Very Good</td><td>Very Good</td><td></td><td>Very Good</td></tr><tr><td>Systemic</td><td></td><td></td><td></td><td></td><td>Good</td></tr><tr><td>Growth Regulators</td><td>Good</td><td></td><td></td><td>Very Good</td><td></td></tr></tbody></table></div></div> <div><p><i>A motorized knapsack sprayer</i></p><p><i>Source: Nasiremba W.W.; KALRO Katumani</i></p></div>		 Even Flat Fan	 Non Even Flat Fan	 Hollow Cone	 Full Cone	 Disc and Core Cone	Herbicides						Pre-emergence	Very Good	Good	Very Good	Good		Post-emergence Contact	Good	Very Good	Good			Post-emergence Systemic	Very Good	Good				Fungicides						Contact	Good		Good		Very Good	Systemic	Very Good				Good	Insecticides						Contact	Very Good	Very Good	Very Good		Very Good	Systemic					Good	Growth Regulators	Good			Very Good	
	 Even Flat Fan	 Non Even Flat Fan	 Hollow Cone	 Full Cone	 Disc and Core Cone																																																																				
Herbicides																																																																									
Pre-emergence	Very Good	Good	Very Good	Good																																																																					
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Post-emergence Systemic	Very Good	Good																																																																							
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Systemic	Very Good				Good																																																																				
Insecticides																																																																									
Contact	Very Good	Very Good	Very Good		Very Good																																																																				
Systemic					Good																																																																				
Growth Regulators	Good			Very Good																																																																					
Justification	Pests are a major menace in agricultural production know to reduce crop yield of up to 98% and. Also, broad leafed weeds																																																																								

	compete with banana seedling for nutrients and light greatly reducing their yield. However, manual sprayers are labour intensive and expensive. It has lower pressure reducing its efficiency hence a motorized knapsack comes in handy.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Banana farmers, researchers and agribusiness entrepreneurs
Approaches used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Applied and adaptive research to test, validate and release improved cabbage varieties • A platform for interaction of Banana value chain stakeholders • Use by Farmers
Partners/stakeholders for scaling up and their roles	KALRO, ATDC, AMS, universities, contractors, small agricultural implement dealers, NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Kiambu
Counties where TIMP will be up scaled	Nyeri, Meru, Murang'a
Challenges in dissemination	<ul style="list-style-type: none"> • Lack of motorized sprayers • Small size of land to be established • High initial cost for small-scale farmers to own or hire sprayers
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Centralized hire serve providers • Form farmer cooperatives for collective ownership
Lessons learned in up scaling if any	<ul style="list-style-type: none"> • Hastens the speed of spraying
Social, environmental, policy and market conditions necessary for development and up scaling	<ul style="list-style-type: none"> • Creation of awareness on mechanization importance in the community. • Include all gender groups in research, and validation. • Favourable Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 55,000
Estimated returns	KES 600/ ha
Gender issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Men perform most of the spraying activities therefore the implement will reduce their drudgery of work. • Women and youth have limited access credit to purchase the motorized sprayer

	<ul style="list-style-type: none"> • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge
Gender related opportunities	<ul style="list-style-type: none"> • Employment opportunities exist for youth males and males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
VMG issues and concerns in development, dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have limited access to credit to purchase the farm implements • VMGs have limited access to training and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • There is low adoption by VMGs due lack of awareness
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for unemployed youth males in operating the implement • Affirmative action opportunities such as the women and youth enterprise fund exists for VMGs to access the required credit
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as wheat and rice
Application guidelines for users	<ul style="list-style-type: none"> • Demonstrations and training • User manuals
F: Status of TIMP readiness (1-Ready for upscaling; 2-Requires validation; 3-Requires further research)	1) Ready for upscaling
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization and scientists	KALRO, Egerton University, Nasirembe W.W.
Partner organizations	Local fabricators

2.10 BANANA FARMING BUSINESS AND MARKETING

2.10.1 Transformative graduation model of production of banana

2.10.1 TIMP Name	Transformative graduation model of production of banana
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to farmers' limited transformation from subsistence-oriented production to commercial-oriented production. Farmers remain at low productivity if there is lack of efforts to shift to the commercial level.
What is it? (TIMP description)	The transformative model builds resiliency of farmers of banana to focus on market orientation. The transformation model aims at a shift from subsistence to semi-commercial to fully commercial. At the subsistence level, farmers use traditional inputs and the outputs consumed at home. At the semi-commercial level, farmers use both traditional and improved inputs while the output is consumed at home and some get into the markets. At fully commercial, inputs are accessed from the markets and outputs solely for the markets.
Justification	Transformative model ensures increase in productivity due to the surplus demand. Without transformation of banana production, the crop will remain subsistence and commercialization will not be attainable, leading to the decline in production and income.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, traders, processing industries, extension, NGOs, research institutions
Approaches to be used in Dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders, • Produce acceptance of improved technologies • Acceptance of smallholder farmers to produce banana • Availability of banana enterprise investors, buyers, prices of banana
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – investments in banana production, • County extension staff - Organization of farmers and technical service delivery,

	<ul style="list-style-type: none"> • NGOs – Organization of farmers and service delivery, private sector (local traders and exporters) – Support in input services and providing markets for the banana production, • Research institutions – Availing improved seeds, backstopping, producer and marketing organizations – Includes lobby groups
C: Current situation and future scaling up	
Counties where already promoted if any	The transformation has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya.
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders, • Disorganization and scattered farmers • Lack of cohesiveness • Small-scale farming • Lack of training in group dynamics • Limited investment by buyers • Fluctuating prices of banana • Level of policy support
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Disorganization and scattered farmers – Formation of marketing groups • Small-scale farming – Aggregation of production, group dynamics – Capacity building • Limited investment by buyers – County and national government support • Fluctuating prices of banana– Setting minimum price and mobbing up glut from the market • Policy support – price policy, subsidies, inputs support
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Production should be linked with banana buyers • Market surveys • Individual marketing instead of collective marketing • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – acceptability by the farmers, group dynamics • Cultures, environmental conditions – Enhancing natural resource management • Policy conditions – Policy support in extension, inputs, prices, production organizations (cooperatives), infrastructure, investment environment
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre

Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Women are widely discriminated in rural producer organizations that are linked to markets • Women have limited access to markets
Gender related opportunities	<ul style="list-style-type: none"> • Men and youth stand to benefit with higher profit margins through collective bargaining during marketing
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs are widely discriminated in rural producer organizations that are linked to markets
VMG related opportunities	<ul style="list-style-type: none"> • VMGs stand to benefit with higher profit margins through collective bargaining and marketing • Opportunities exist for unemployed youth in production and marketing through ICT
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	Training factsheets, manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	2 – Requires validation
G: Contacts	
Contacts	Institute Director, KALRO AMRI-Katumani P.O. Box 340 Machakos Email: cd.katamani@kalro.org Phone: 0711369535
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Efficiency evaluation of the farmer-market linking models
- 2) Equity distribution among the producers
- 3) Productivity levels among the smallholder farmers due to farmer-market linking models
- 4) Farmer accessibility to production inputs

2.10.2 Building a business plan for banana production

2.10.2 TIMP Name	Building a business plan for banana production
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to unplanned and traditional production, leading to lack of production targets, losses and market failure.
What is it? (TIMP)	A banana business plan serves as an internal management and

description)	organizing tool, used to communicate outside the business, or both. The document contains the elements of marketing strategy, marketing costs, income streams and financial requirements.
Justification	With a business plan in hand, banana farmers and rural entrepreneurs will be able to take that first step toward the creation of a successful and sustainable business. The plan enables farmers to control costs, develop marketing strategies and build plans for the production to meet market demand.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, traders, processors
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Education levels of the farmers and investors in banana production • Availability of information on banana production and marketing • Seed availability and accessibility • Efficient seed system to ensure quality • Diversification of banana food products through value addition • Well organized farmer groups and networks • Established marketing models and path ways • County and central government support • Funding to research • New banana varieties
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Users of business plans, county extension staff - capacity building • NGOs – Capacity building, private sector (local traders, exporters) • Buyers of banana • Research institutions – Capacity building, financial Institutions • Financial support
C: Current situation and future scaling up	
Counties where already promoted if any	The practice has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya.
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders

	<ul style="list-style-type: none"> • Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on banana production and marketing • Levels of policy support • Levels of education • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Disorganization and scattered farmers – Formation of production clusters • Small-scale farming – aggregation of production to assume large scale-farming • Inadequate information to stakeholders on the banana production – Developing information hub • Level of policy support – support in extension services • Levels of education – Capacity building • Establish innovation platforms
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Low adoption of business planning • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – Acceptable in Counties growing banana • Environmental conditions – Availability of water resources • Policy conditions – Policy support in opportunities selected
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	High illiteracy levels of women leading to lack of record keeping and poor records
Gender related opportunities	Being a high value crop, opportunities exist for youth since they are highly literate and can be able to come up with good business plan
VMG issues and concerns in development and dissemination, adoption and scaling up	Some of the VMGs are illiterate hence cannot keep good records
VMG related opportunities	Being a high value crop, opportunities exist for youth since they are highly literate and can be able to come up with good business plan
E: Case studies/profiles of success stories	

Success stories from previous similar projects	None
Application guidelines for Users	<ul style="list-style-type: none"> • Training factsheets • Manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
2) Requires validation	
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Impact of business plan on banana production
- 2) Adoption of business plan

2.10.3 Collective marketing

2.10.3 TIMP Name	Collective marketing
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity leading to low production due to small-scale production and marketing of banana products. Also market inaccessibility due to individual farmer marketing, leading to low market power.
What is it? (TIMP description)	Collective marketing is marketing as a group where farmers establish an entity to create market links. It involves formation of a group of farmers with an objective of reducing market inaccessibility. Collective marketing is carried through Producer Organizations' (POs) is an institutional vehicle for promoting agricultural production by helping farmers solve common problems in relation to production inputs, credit, technical knowledge and marketing of the produce.
Justification	Due to small-scale farming of banana, marketing as a group would enable farmers to gain from economies of scale. The advantages of collective marketing are bigger volumes, uniform quality, reliable sellers, reliable buyers, continuous supply, higher price and organization. The smallholder farmers of banana do marketing individually. Due to that, there is lack of economic scale and the prices offered are low. The formation of producer organizations assists small-scale farmers in aggregating the banana produce to form a large scale and gain bargaining power for higher prices.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, traders, policy makers, researchers

Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Production programme outlined • Sell their produce before the collective sale • The farmer is not able to deliver the agreed amount to the group • Side-selling • Bad weather • Variable quality
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Defining production programme • County extension staff - capacity building • NGOs – Capacity building
C: Current situation and future scaling up	
Counties where already promoted if any	The practice has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya.
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on banana production and marketing • Defining production programmes of banana • Levels of policy support
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Disorganization and scattered farmers – Formation of production clusters • Small-scale farming – aggregation of production to assume large scale-farming • Inadequate information to stakeholders on banana production – Developing information hub • Defining production programmes of banana – SWOT analysis • Level of policy support – support in extension services
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Volume target: low volume due to side-sales • Partnership is important in technology dissemination and adoption and this can be enhanced through innovation platforms

Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – lack of trust among members • Environmental conditions – favourable condition for banana production • Policy conditions – Infrastructural support
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Women are widely discriminated in rural producer organizations • Women also have limited participation and influence in rural producer organizations • Limited access to assets, resources and services, required to join producer groups • Strict rules of entry and requirements of producers' organizations may limit women participation
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities exist for the various gender categories to benefit from higher profit margins through collective bargaining during marketing. • Opportunities exist for unemployed youth in collective marketing through ICT
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs are widely discriminated in rural producer organizations • VMGs also have limited participation and influence in rural producer organizations • Limited access to assets, resources and services, required to join producer groups
VMG related opportunities	<ul style="list-style-type: none"> • VMGs stand to benefit with higher profit margins through collective bargaining and marketing • Opportunities exist for unemployed youth in collective marketing through ICT
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	<ul style="list-style-type: none"> • Training factsheets • Manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
G: Contacts	
Contacts	Institute Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Profitable opportunities
- 2) Performance of marketing as a group

2.19.4 Profitability analysis

2.10.4 TIMP Name	Profitability analysis
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity is due to low farmers' income. The problem of failure of profitability analysis is common among the smallholder farmers. Lack of profitability analysis by farmers in banana production, leads to lack of comparison of costs and returns and therefore poor performance of the agro-enterprise.
What is it? (TIMP description)	Profitability analysis involves recording of costs and returns and therefore determination of profit which indicates the performance of the banana agro-enterprise.
Justification	Profitability analysis reviews the management success and sustainability of the banana business. It indicates areas of adjustment.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, extension, NGOs, researchers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Record keeping of costs and returns • Ability of farmers to keep records
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – record keeping, county extension staff – Facilitators • NGOs – Facilitators • Private sector (local traders and exporters) – Buyers • Research institutions – Facilitators
C: Current situation and future scaling up	
Counties where already promoted if any	None
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders

	<ul style="list-style-type: none"> • Inability of farmers to keep records • Use of non-costed family labour in banana production
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Inability of farmers to keep records – capacity building • Use of non-costed family labour in banana production – capacity building on how to cost family labour
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Availability of market • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – Awareness on record keeping • Environmental conditions – suitable for the increased production of banana, policy conditions – Policy support in costs of inputs and prices of outputs, market conditions – Higher prices than costs
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	High illiteracy levels of women leading to lack of record keeping and poor record keeping
Gender related opportunities	Opportunities exist for youths to venture in this management practice since majority are literate and can be able to keep good farm record
VMG issues and concerns in development and dissemination, adoption and scaling up	Some of the VMGs are illiterate hence cannot keep good records
VMG related opportunities	Opportunities exist for youths to venture in this management practice since majority are literate and can be able to keep good farm record
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	Training factsheets, manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Investigation on strategies to reduce costs of production of banana
- 2) Investigation on price increasing strategies

2.10.5 Market research for market information

2.10.5 TIMP Name	Market research for market information
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity is due to lack of market information. Failure of the smallholder farmers in gathering information on markets, leads to knowledge asymmetries among the smallholder farmers. Also this leads to poor connectivity of smallholders to distance markets.
What is it? (TIMP description)	Market research gathers information on the product buyers, demand, type required, minimum volume purchased, collective marketing volume, quality, packaging requirements, frequency of delivery, purchase price, means of payment and willing to buy from local farmers.
Justification	Without market research, the smallholder farmers will continue being market disintegrated and lack of information, leading to low market participation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, traders, processors
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Improve technology • More land and more members • Farmers work with other groups • Farmers form new groups
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Members of producer organization • County extension staff - Capacity building • NGOs – Capacity building • Private sector (local traders and exporters) – Targeted markets • Research institutions – Capacity building

C: Current situation and future scaling up	
Counties where already promoted if any	None
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Issues related to increasing production from existing group • Issues related to increasing production from increasing size of existing groups
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Issues related to increasing production from existing group – farmers reach their new production target from the group members and farmers investing in new technology to achieve new targets • Issues related to increasing production from increasing size of existing groups – the first group help new farmers to develop an enterprise plan and the new farmers to join the existing groups or form an associated group
Lessons learned in upscaling if any	None
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – are there other farmers who want to join the group • Environmental conditions – would the increase in production come from improved technology • More land, or new members in the group • Policy conditions – Policies supporting formation and functioning of producer organizations • Market conditions – new markets
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Inadequate representation of women and youth in market research • Women have less access to market information
Gender related opportunities	Employment opportunity exist for educated youths in market research
VMG issues and concerns in development and dissemination, adoption and scaling up	<p>VMGs also have limited participation in market research</p> <p>VMGs have less access to market information</p>
VMG related opportunities	Employment opportunity exist for educated youths in market research
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	<ul style="list-style-type: none"> • Training factsheets • Manuals • Power point slides are available

F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)		2) Requires validation
G: Contacts		
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294	
Lead organization/scientists	KALRO: Wambua, J.M.	
Partner organizations	1) MoALD 2) Farmers	

GAPS

- 1) Processes in scaling up agro-enterprise development approach and production
- 2) Effects of scaling up plan

2.10.6 Contracted banana production system

2.10.6 TIMP Name	Contracted banana production system
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity due to market failure in banana production, leading to low income and poor quality
What is it? (TIMP description)	Contract farming involves investment by the private companies, extending lines of credit to producers in the form of farming inputs and technical assistance. Under contract farming terms, contractors commit themselves to buy the entire product at an agreed price. On the other hand, producers avail desired produce for sale.
Justification	Without contract farming smallholder farmers realize low prices for their produce. Contract farming is a contractual arrangement between producers and buyers of a farm product. The contract can either be oral or written, and will specify one or more conditions of production and marketing of an agricultural product. In essence, contract farming commits the farmer to produce a certain commodity at a certain time for an agreed price and, in return, the contractor undertakes to buy the commodity, and may provide agricultural extension and other services to producers in order to satisfy production requirements in terms of quality and quantity. The benefits of contract farming to farmers are market access, increased incomes, reduction in the risk of price fluctuations, credit and financial intermediation, timely provision of inputs, monitoring and labour incentives, reduction of production risk, introduction of higher-value crops, improved collective bargaining, household spill-over benefits and improved access to extension. A written contract farming is recommended.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, traders, extension, research institutions, farmer cooperative societies

Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Willing farmers • Availability of traders • Competitiveness of banana • Production volume • Enforcement • Bidding contract farming
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Contract party and beneficiaries • County extension staff – Capacity building, signing contract • NGOs – Capacity building • Private sector (local traders and exporters) – Contract party and beneficiaries • Research institutions – Capacity building
C: Current situation and future scaling up	
Counties where already promoted if any	None
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Disorganization and scattered farmers • Small-scale farming • Lack of information by part of the producers • Level of policy support
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Formation of production clusters • Small-scale farming – Increase volume through increase in productivity • Capacity building • County policy formulation and enforcement for contract farming
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Availability of market • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms

	<ul style="list-style-type: none"> Increased benefits
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> Social conditions – Conflicts with traditional farming Environmental conditions – reduced environmental pollution through safe use of agrochemicals Input support in the contract improves natural resource management Policy conditions – Policy in formulation and enforcement Market conditions – volume, place, price, promotion, traders
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> Women have less access to knowledge and information on contract farming Women have less access to land for farming
Gender related opportunities	Opportunities exist for youth to enter into contract farming through renting of land for farming for increased profit margins
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> VMGs have less access to knowledge and information on contract farming VMGs have less access to land for farming
VMG related opportunities	Opportunities exist for youth to enter into contract farming through renting of land for farming for increased profit margins
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	Training factsheets, manuals and power point slides
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

1. Performance of contracted farming in terms of productivity, sales and profit
2. Equity distribution
3. Improvement in skill and information delivery

2.10.7 Marketing innovation model

2.10.7 TIMP Name		Marketing innovation model
Category (i.e. technology, innovation or management practice)		Management practice
A: Description of the technology, innovation or management practice		
Problem addressed		Low banana productivity due to the farmers' failure to apply entrepreneurship in the production and marketing of banana which also lead to low prices.
What is it? (TIMP description)		Marketing innovation encompasses entrepreneurship where farmers undertake technology modification, finance and business acumen in an effort to transform innovations into economic goods and ultimately profit.
Justification		Marketing innovation involves product diversification. Diversification develops various marketing channels. Failure to apply innovation in marketing of banana, the market outlook will be narrow.
B: Assessment of dissemination and scaling up/out approaches		
Users of TIMP		Farmers, agriprenuers, extension, NGOs, researchers
Approaches to be used in dissemination		<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion		<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Organization of farmers • Availability of innovations • Achievement of profit • Access to finance • Availability of facilitators • Availability of many traders • Production volume and quality
Partners/stakeholders for scaling up and their roles		<ul style="list-style-type: none"> • Farmers – Acceptability of innovations, county extension staff – Facilitators • NGOs – Facilitators, private sector (local traders and exporters) – Buyers • Research institutions – Facilitators
VMG related opportunities		Increased production and sales of banana by VMGs leading to improved livelihood
C: Current situation and future scaling up		
Counties where already promoted if any		None

Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Small-scale farming • Lack of market information • Low profitability in banana farming • Lack of policy support
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Small-scale farming – capacity building to farmers • Availability of information on innovations • Profitable innovations • Strengthening county policy support
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Availability of market • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Reduced cost of production increases profits
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – Conflicts with traditional methods • Environmental conditions – Use of pesticides and disposal • Market conditions – Contract farming • Access to inputs such as fertilizer
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Women lack entrepreneurial skills and capacity to engage in entrepreneurship • Women lack basic reading and numeracy skills so they can run their businesses • Women do not know how to save their money that can be used in entrepreneurship • Women do not usually apply for loans that can be used to manage their businesses and increase their profits due to lack of collateral
Gender related opportunities	<ul style="list-style-type: none"> • Opportunities exist for women to venture in entrepreneurship through the women enterprise fund
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs lack basic reading and numeracy skills so they can run their businesses • VMGs lack the business acumen • VMGs lack the starting capital
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Increased income and diversification in investments
Application guidelines for Users	Training factsheets, manuals and power point slides are available

F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)		2) Requires validation
G: Contacts		
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294	
Lead organization/scientists	KALRO: Wambua, J.M.	
Partner organizations	1) MoALD 2) Farmers	

GAPS

1. Sustainability based on market prices
2. Innovations for the increased productivity

2.10.8 Digital marketing

2.10.8. TIMP Name	Digital marketing
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to the market inaccessibility among the smallholder farmers. The smallholder farmers have limited use of technologies which are necessary for linking to markets leading to poor market access and constraints in marketing channels, skills and market information.
What is it? (TIMP description)	Internet/mobile marketing refers to the online marketplace that provides buyers and sellers with an avenue to meet and exchange goods and services. These can include a variety of online platforms, tools, and content delivery systems.
Justification	Internet/mobile marketing is increasingly becoming mandatory for businesses of all types. This high adaptability of internet marketing is an important benefit that businesses can take advantage to provide their consumers with the best shopping experience. Consumers use a variety of online methods for finding, researching, and eventually making purchasing decisions. Internet marketing reduces costs.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<ul style="list-style-type: none"> • Farmers, agriprenuers, traders, processors
Approaches to be used in Dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print

	<ul style="list-style-type: none"> • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • A platform for interaction of banana value chain stakeholders • Education levels of the farmers and investors in banana production and profitability analysis • Levels of experiences in banana production • Availability of information on banana production and marketing
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Sellers of banana production • County extension staff - Capacity building • NGOs – Capacity building • private sector (local traders and exporters) – Buyers of banana • Research institutions – Capacity building
C: Current situation and future scaling up	
Counties where already promoted if any	None
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Lack of banana innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low digital skills of farmers • Unconsolidated produce for the market • Small-scale farming, inadequate information to stakeholders on the banana production and marketing and profitability • Limited internet connectivity • Levels of policy support on internet infrastructure
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Establish banana innovation platforms • Capacity building • Delivery of produce to the designated centres • Sensitization to appreciate need for consolidation of produce • Developing of information hubs • Upgrade internet connectivity and information hub • Policy support in internet infrastructure and utilization
Lessons learned in upscaling if any	<ul style="list-style-type: none"> • Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption and this can be facilitated through • Innovation platforms requires stakeholders involvement • Remains the best cost effective option for marketing in terms of searching for the market information
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – low levels of adoption of information technology, environmental conditions – improved internet connectivity • Policy conditions – policy supporting information hubs • Market conditions – high costs of information technologies
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre

Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Women have less access to the required tools such as phones and computer • Women are more illiterate and therefore cannot use the ICTs
Gender related opportunities	Opportunities exist for youth to use the ICT tools since most of them are highly literate and have phones or the computers
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • VMGs have less access to the required tools such as phones and computer • VMGs are more illiterate and therefore cannot use the ICTs
VMG related opportunities	Opportunities exist for youth to use the ICT tools since most of them are highly literate and have access to phones or computers
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	Training factsheets, manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
G: Contacts	
Contacts	Institute Director, KALRO-Katamani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Levels of digital skills by farmers
- 2) Performance of the internet marketing in terms of productivity, sales and profitability

2.11 AGRICULTURAL POLICY OPTIONS

2.11.1 Framing banana production in the national agricultural policy

2.11.1 TIMP Name	Framing banana production in the national agricultural policy
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to limited policy support in inputs and outputs markets. The smallholder farmers are inaccessible to inputs and outputs markets. The instruments and the rules to achieve the policy productivity objectives are inappropriate for the smallholder farmers of banana production but instead favour the large scale farmers in Kenya. Moreover, the smallholder banana farmers are not

	aware of the instruments and rules for achieving productivity objectives.
What is it? (TIMP description)	The national agricultural policy strategy framework provides instruments and rules for the smallholder farmers to increase banana productivity in the Counties.
Justification	Agricultural policy making in Kenya overlook diverse agricultural transformation pathways that are sustainable in local social/material conditions and based on smallholder farmers' knowledge leading to the unmet stated objectives of policy. The policy is meant to reduce poverty by building smallholder livelihoods and increasing agricultural productivity, however these policies are not met. We consider the pathways through which smallholder farmers' perspectives and knowledge can be included in policy going forward.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, policy makers, traders, agriprenuers, processing industries, extension, NGOs, research institutions, extension services
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Availability of stakeholders, availability of specific banana-based policies
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Demanding banana policies to support production and marketing • County extension staff - Sensitization of farmers • NGOs – Sensitization of farmers • Private sector (local traders and exporters) – Demanding banana policies to support production and marketing • Research institutions – Sensitization of stakeholders • Policy makers – Assist in policy making
C: Current situation and future scaling up	
Counties where already promoted if any	The practice has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Value Chain: Banana yields remain low and total domestic production is unable to satisfy demand by manufacturers leading to growing imports of raw materials.

	<ul style="list-style-type: none"> • Standards: Existing standards at the production level are poorly defined and implemented, and largely do not include environmental or CSA criteria. Voluntary certifications are piecemeal and not widely adopted. • Aggregation: Aggregation models including cooperatives—suffered after the downturn in banana production, wherein many farmers abandoned banana production. The organizations provide few services to farmers while providing limited bargaining power. • Financial Incentives: The government provides only limited support to banana producers through subsidized seed, irrigation infrastructure, and research. Meanwhile the bulk of financial incentives, including tax breaks, exemption from import duties, and subsidized electricity, target apparel manufacturers downstream in the value chain, primarily those in Export Processing Zones (EPZs). Some private companies are investing backward in their supply chains to increase farmer production by entering purchase contracts and financing access to inputs. However, none of these efforts are explicitly tied to environmental or CSA standards.
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Value Chain: Enhance productivity and total production through better seeds, irrigation, and CSA management practices. Develop targeted incentives to encourage stronger engagement of producers by downstream actors. • Standards: Existing banana standards and classifications should be redesigned to align with Kenya's climate-smart agriculture strategy, in coordination with relevant institutions across the sector. Farmer cooperatives should receive public support to promote and enable higher quality production through input access and CSA extension training. • Aggregation: Partnerships between farmer cooperatives and banana producers can strengthen market linkages, set guaranteed prices for farmers, and enable access to resilient, high-yielding seeds and other climate-smart inputs. • Financial Incentives: Financial incentives can be designed to incentivize private sector, downstream value chain actors to provide services to producers, for example through conditional subsidies. The government may opt to continue its efforts to implement quality-based banana payments, including CSA-criteria, while offering comprehensive service provision for producers through public-private partnerships. Building public-private partnerships is key to filling service gaps for smallholders to improve productivity and disseminate CSA practices.
Lessons learned in upscaling if any	None

Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – Traditional farming of banana where there is no value chain • Environmental conditions – Use of pesticides • Policy conditions – Lacking specific banana policy, market conditions - Poor market infrastructure
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Inadequate representation of youth and women in policy development forums at all levels • Inadequate representation of youth and women in the policy of validation process
Gender related opportunities	Opportunities exist for adequate youth representation in the policy formulation and validation process if they focus and strategize well
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Inadequate representation of VMGs in policy development forums at all levels • Inadequate representation of VMGs in the policy of validation process
VMG related opportunities	Opportunities exist for VMGs participation in all levels of policy formulation since there are policy frameworks to support their participation
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for Users	Training factsheets, manuals and power point slides
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
1) Ready for upscaling	
G: Contacts	
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Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- Adoption of policies
- Equity distribution among the stakeholders
- Productivity levels among the smallholder farmers of banana
- Farmer accessibility to production inputs
- Impact on banana prices

2.11.2 Participation in County Integrated Development Planning

2.11.2 TIMP Name	
Category (i.e. technology, innovation or management practice)	Participation in County Integrated Development Planning
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to limited participation of the smallholder during County development planning. Based on that, there is lack of County integration of banana production and marketing during planning.
What is it? (TIMP description)	The County Integrated Development Planning builds a plan for each county in Kenya to be implemented in five years. The planning process is participatory, involving the development stakeholders in the County. It is during this planning period where the issues in banana production, marketing and processing are considered.
Justification	In the Counties where the banana value chain creates wealth among the smallholder farmers, centralization of the farmers agency and voices during the County Integrated Developing Planning is needed. Failure to plan for the banana production would to less optimization of opportunities.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agripreneuers, traders, processing industries, extension NGOs, research institutions, policy makers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	<ul style="list-style-type: none"> • Availability of stakeholders • Availability of agricultural policies and specific banana-based policies • Issues in banana business • Specific policy objective statement
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – Demanding banana policies to support production and marketing • County extension staff - Sensitization of farmers • NGOs – Sensitization of farmers • Private sector (local traders and exporters) – Demanding banana policies to support production and marketing • Research institutions – Sensitization of stakeholders

C: Current situation and future scaling up	
Counties where already promoted if any	The practice has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on the agricultural policies whether National or County • Poorly established banana value chain • Banana production are specific to agro-ecological zones and not all the Counties in Kenya grow banana
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Disorganization and scattered farmers – Formation of producer organizations as an institution • Small-scale farming – Policies for increasing productivity • Inadequate information to stakeholders on the agricultural policies whether National or County – Sensitization of stakeholders • Poorly established banana value chain – strengthening banana value chain • Banana production are specific to agroecological zones and not all the Counties in Kenya grow banana – Diversification of banana
Lessons learned in upscaling if any	None
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – Acceptability of the policies • Environmental conditions – Lack of a comprehensive land use policy • Policy conditions – Lacking specific banana policy, market conditions - Poor market infrastructure
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Inadequate representation of youth and women in the development process of the county integrated plans • Inadequate representation of youth and women in the policy of validation process.
Gender related opportunities	Opportunities exist for women and youths to participate in the policy cycle since the constitution supports their participation
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Inadequate representation of VMGs in the development process of the county integrated plans • Inadequate representation of VMGs in the policy of validation process
VMG related opportunities	Opportunities exist for VMGs to participate in the process of developing the county integrated development plans

E: Case studies/profiles of success stories		
Success stories from previous similar projects	None	
Application guidelines for Users	Training factsheets, manuals and power point slides are available	
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)		1) Ready for upscaling
G: Contacts		
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katamani@kalro.org Phone: 0736333294	
Lead organization/scientists	KALRO: Wambua, J.M.	
Partner organizations	1) MoALD 2) Farmers	

GAPS

- 1) Adoption of policy options
- 2) Equity distribution among the stakeholders
- 3) Productivity levels among the smallholder farmers
- 4) Farmer accessibility to production inputs

2.11.3 Policy instruments related to banana

2.11.3 TIMP Name	Policy instruments related to banana
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to the existing policy instruments which fail to support the smallholder farmers' issues in banana production and marketing. Therefore, weak policy instruments have led to the market failure for both inputs and outputs.
What is it? (TIMP description)	The policy instruments are the means to achieve policy objectives. For the banana production, some of the policy instruments include subsidy in the inputs and also minimum price for the banana outputs.
Justification	Without policy instruments the banana productivity will remain low. It is very likely that a particular policy instrument, although designed to have primarily an efficiency, distributive, or stability effect, will also have some impact on the other objectives related to banana production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, agriprenuers, traders, processing industries, extension, NGOs, research institutions, policy makers
Approaches to be used in dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days

	<ul style="list-style-type: none"> • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Availability of policy objectives, availability of policy instruments
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – beneficiaries of policy instruments • County extension staff - Sensitization of farmers • NGOs – Sensitization of farmers • Private sector (local traders and exporters) – beneficiaries • Research institutions – Sensitization of stakeholders
C: Current situation and future scaling up	
Counties where already promoted if any	The practice has been adopted by farmers in banana growing areas in Kisii, Nyamira, Migori, Busia, Embu, and Siaya
Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri
Challenges in development and dissemination -	<ul style="list-style-type: none"> • Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on the agricultural policies whether National or County • Poorly established banana value chain • Banana production are specific to agro-ecological zones and not all the Counties in Kenya grow banana
Suggestions for addressing the challenges	<ul style="list-style-type: none"> • Disorganization and scattered farmers – Formation of producer organizations as an institution • Small-scale farming – Policies for increasing productivity • Inadequate information to stakeholders on the agricultural policies whether National or County – Sensitization of stakeholders • Poorly established banana value chain – Strengthening banana value chain • Banana production are specific to agro-ecological zones and not all the Counties in Kenya grow banana – Diversification of banana
Lessons learned in upscaling if any	None
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none"> • Social conditions – Low understanding of policy instruments • Environmental conditions – lack of a comprehensive land use policy • Policy conditions – Lacking specific banana policy • Market conditions – Poor market infrastructure
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre
Estimated returns	Returns per year KES 1,200,000 per acre

Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Inadequate representation of youth and women in policy development forums at all levels. • Inadequate representation of youth and women in the policy of validation process.
Gender related opportunities	Opportunities exist for adequate youth representation in the policy formulation and validation process if they focus and strategize well
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none"> • Inadequate representation of VMGs in policy development forums at all levels • Inadequate representation of VMGs in the policy of validation process
VMG related opportunities	<ul style="list-style-type: none"> • Opportunities exist for VMGs participation in all levels of policy formulation since there are policy frameworks to support their participation
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none"> • Inadequate representation of youth and women in policy development forums at all levels • Inadequate representation of youth and women in the policy of validation process
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for users	Training factsheets, manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)	
	1) Ready for upscaling
G: Contacts	
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Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Validation of policy instruments
- 2) Equity distribution among the stakeholders
- 3) Farmer accessibility to production inputs markets
- 4) Farmers accessibility to output markets

2.11.4 Policy cycle

2.11.4 TIMP Name	Policy cycle
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low banana productivity due to the development of agricultural

	policies not relevant to the problem emergency in banana and also without staged follow-up.
What is it? (TIMP description)	The policy process is normally conceptualized as sequential parts or stages. These are; (1) problem emergence, (2) agenda setting, (3) consideration of policy options, (4) decision-making, (5) implementation and (6) evaluation. Policy cycle is a valuable device for new policy development. It is a tool which divides complex procedures into convenient and manageable steps. These individual steps provide a frame work and antedates any forthcoming issues related to policy development. The policy cycle is usually divided into five stages: agenda setting, formulation, implementation, and evaluation
Justification	Why is a policy cycle an appropriate tool for making policies related to banana? The policy cycle creates the need for a policy based on the agricultural problem emergence/issues. The policy cycle is an idealized process that explains how policy should be drafted, implemented and assessed. It serves more as an instructive guide for those new to policy than as a practical strictly-defined process, but many organizations aim to complete policies using the policy cycle as an optimal model. Policy cycle is a valuable device for new policy development. It is a tool which divides complex procedures into convenient and manageable steps. These steps are flexible enough to incorporate any changes at the time of new policy development and as a part of continuous change once it is implemented.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	<ul style="list-style-type: none"> • Farmers, agriprenuers, traders, processing industries, extension, NGOs, research institutions
Approaches to be used in Dissemination	<ul style="list-style-type: none"> • Farmer Field and Business School (FFBS) • Agricultural innovation platforms (AIP) • Demonstrations on-farm and on-station • Agricultural shows/exhibitions/field days • Trainings - workshops/seminars/meetings • Public and private extension agents • Farmer - to - farmer extension models • Mass media - Electronic and print • Publications - posters/brochures/leaflets, manuals • Digital Platforms - Website, Dashboards, Apps, social media short message services
Critical/essential factors for successful promotion	Availability of stakeholders, the stages of problem emergence, formulation, implementation and evaluation
Partners/stakeholders for scaling up and their roles	<ul style="list-style-type: none"> • Farmers – generate issues, county extension staff - capacity building • NGOs – capacity building, private sector (local traders and exporters) – generate issues • Research institutions – capacity building, policy makers
C: Current situation and future scaling up	
Counties where already promoted if any	None

Counties where TIMPs will be upscaled	Baringo, Bomet, Kericho, Tharaka-Nithi, West Pokot and Nyeri	
Challenges in development and dissemination -	<ul style="list-style-type: none">• Disorganization and scattered farmers• Small-scale farming, inadequate information to stakeholders on issues• Poorly established banana value chain	
Suggestions for addressing the challenges	<ul style="list-style-type: none">• Disorganization and scattered farmers – issues on formation of producer organizations as an institution• Small-scale farming – issues on aggregation• Inadequate information to stakeholders – Sensitization on the roles of each policy cycle stages• Poorly established banana value chain – strengthening banana value chain	
Lessons learned in upscaling if any	None	
Social, environmental, policy and market conditions necessary for development and upscaling	<ul style="list-style-type: none">• Social conditions – Different issues among the banana producers• Environmental conditions – environmental issues• Policy conditions – Lacking specific banana policy• Market conditions – Market issues	
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations		
Basic costs	Total costs, including manure, fertiliser and labour, would average KES 360,000 a year per acre	
Estimated returns	Returns per year KES 1,200,000 per acre	
Gender issues and concerns in development and dissemination, adoption and scaling	<ul style="list-style-type: none">• Inadequate representation of youth and women in policy development forums at all levels.• Inadequate representation of youth and women in the policy of validation process	
Gender related opportunities	Opportunities exist for adequate youth representation in the policy formulation and validation process if they focus and strategize well	
VMG issues and concerns in development and dissemination, adoption and scaling up	<ul style="list-style-type: none">• Inadequate representation of VMGs in policy development forums at all levels.• Inadequate representation of VMGs in the policy of validation process.	
VMG related opportunities	Opportunities exist for VMGs participation in all levels of policy formulation since there are policy frameworks to support their participation	
E: Case studies/profiles of success stories		
Success stories from previous similar projects	None	
Application guidelines for Users	Training factsheets, manuals and power point slides are available	
F: Status of TIMP Readiness (1. Ready for upscaling, 2. Requires validation, 3. Requires further research)		2) Requires validation
G: Contacts		
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	Phone: 0736333294
Lead organization/scientists	KALRO: Wambua, J.M.
Partner organizations	1) MoALD 2) Farmers

GAPS

- 1) Analysis of policy model
- 2) Impact on the new policy on banana production and marketing



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