Inventory of Climate Smart Agriculture Technologies, Innovations and Management Practices for Green Gram 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

Kenya Climate-Smart Agriculture Project (KCSAP) tasked the Kenya Agricultural and Livestock Research Organization (KALRO) with the implementation of the project's Component 2 on 'Strengthening Climate-Smart Agricultural Research and Seed Systems'. The component activities are geared towards the development, validation, adoption and delivery of context specific climate smart agriculture (CSA) technologies, innovation and management practices (TIMPs). It is also responsible for development of sustainable seed production and distribution systems of priority agricultural value chains to enhance availability and access improved seeds, animal breeds and fingerlings by target beneficiaries. Against this background, KALRO and her National Agricultural Research System (NARS) partners have developed, validated and availed CSA TIMPs for dissemination and adoption. This document provides a detailed inventory of TIMPs that have been developed in Green Gram value chain.

Extensive information from research and background data has been used to develop this TIMPs inventory. 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 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 achievement of the envisaged KCSAP's project 'Triple Wins' of increased productivity, enhanced resilience and reduction of greenhouse gases emissions. Thus, this TIMPs inventory is to be used in conjunction with the respective Green Gram ToT Manual.

Finally, I am greatly indebted to the value chain leaders and all those who participated in the preparation of this inventory of TIMPs. 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 Kenya Climate-Smart Agriculture Project (KCSAP) is a Government of Kenya project with support from both the World Bank and the government. The project runs for five years and implemented in 24 counties, mainly in the arid and semi-arid lands (ASALs), at an approximate cost of KES 25 billion. The project development objective (PDO) is "to increase agricultural productivity and build resilience to climate change risks in the targeted smallholder farming and pastoral communities, and in the event of an Eligible Crisis or Emergency, to provide immediate and effective response." This objective is to be achieved through the implementation of five key components, which are: 1) Upscaling Climate-Smart Agricultural Practices, 2) Strengthening Climate-Smart Agricultural Research and Seed Systems, 3) Supporting Agro-weather, Market, Climate, and Advisory Services, 4) Project Coordination and Management and 5) Contingency Emergency Response.

Component 1 involves facilitating the empowering of farmers and communities to adopt technologies, innovations and management practices (TIMPs) to achieve the Climate Smart Agriculture (CSA) triple-wins of; increased productivity, enhanced resilience (adaptation), and reduced Greenhouse gas (GHG) emissions (mitigation). Component 2 is tasked with the responsibility of providing the TIMPs. Therefore, it supports the development, validation, and adoption of context specific CSA TIMPs to target beneficiaries under Components 1 and 3.

To catalyze uptake of TIMPs, Kenya Agricultural and Livestock Research Organization (KALRO) in conjunction with partners in the National Agricultural Research Systems (NARS) and Consultative Group for International Agricultural Research (CGIAR) compiled inventories of TIMPs for the prioritized value chains. The crop-based value chains are 19 and include roots and tubers (cassava, potato), pulses (dry beans, green gram and pigeon peas), vegetables (tomato, onion, indigenous vegetables, kale and mango), cereals (sorghum, millet, maize, teff) nuts (mango nut), fruits (banana, mango, water melon) and fibre (cotton). Those that are animal production based are five (5) and include apiculture, indigenous chicken (meat and eggs), dairy (cattle and camel), red meat (cattle, sheep and goats) and aquaculture. Also, there are three (3) cross cutting themes on pastures and fodder, natural resource management, and animal health. The TIMPs have been categorized into those ready for upscaling and those requiring validation. Furthermore, gaps that required further research and development of TIMPs have been identified. Training of Trainers' (ToT) manuals focusing on TIMPs that are ready for upscaling for each of the value chains have been subsequently developed to form the basis of training county extension staff, service providers and lead farmers. Those trained are in turn expected to cascade the training to beneficiaries in the targeted smallholder farming, agro-pastoral and pastoral communities in the 24 project counties of Marsabit, Isiolo, Tana River, Garissa, Wajir, Mandera, West Pokot, Baringo, Laikipia, Machakos, Nyeri, Tharaka Nithi, Lamu, Taita Taveta, Kajiado, Busia, Siaya, Nyandarua, Bomet, Kericho, Kakamega, Uasin Gishu, Elgeyo Marakwet and Kisumu.

KALRO, having the responsibility of implementing the activities under Component 2, has been instrumental in using its information resources and those of partners and collaborators to come up with the inventories of TIMPs and corresponding ToT manuals. Use of these information resources coupled with the accompanying training and contribution of the other project components will go a long way in enabling KCSAP to meet its development objectives.

The National Project Coordination Unit is grateful to all who participated in the development and production of this TIMPs inventory for Green Gram 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.

Francis Muthami
National Project Coordinator
Kenya Climate-Smart Agriculture Project

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Abbreviations and Acronyms

AAK	Agrochemical Association of Kenya
AEZ	Agroechological Zone
AFA	Agricultural and Food Authority
AIP	Agricultural Innovation Platform
AMRI	Agricultural Mechanization Research Institute
ASK	Agricultural Society of Kenya
ASALs	Arid and Semi-Arid Lands
ATRC	Agricultural Technology Development Centre
CA	Conservation Agriculture
CABI	Centre for Agriculture and Bioscience International
CAN	Calcium Ammonium Nitrate
CARD	Community Action for Rural Development
CBO	Community Based Organization
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
CSA	Climate Smart Agriculture
DAP	Di-ammonium Phosphate
DL	Desert Locusts
DLLO-EA	Desert Locust Control Organization of Eastern and Central Africa
EPZ	Export Processing Zone
FBO	Farmer Based Organization
FFBS	Farmer Field and Business School
FFS	Farmer Field School
FIP	Farmer Input Promotion
FPEAK	Fresh Produce Exporters Association of Kenya
FAO	Food and Agriculture Organization
FCRI	Food Crop Research Institute
FSMS	Food Safety Management System
GAP	Good Agricultural Practice

GHG	Greenhouse Gas
GPS	Global Positioning System
HACCP	Hazard Analysis Critical Control Points
HCD	Horticultural Crops Directorate
ICIPE	International Centre of Insect Physiology and Ecology
ICM	Integrated Crop Management
ICRAF	International Centre for Research in Agroforestry (World Agroforestry Centre)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDM	Integrated Disease management
ILRI	International Livestock Research Institute
IMM	Integrated Manure Management
IPM	Integrated Pest Management
IPR	Intellectual Property Rights
ITK	Indigenous Technical Knowledge
iSDA	Innovative Solution for Decision Agriculture
ISFM	Integrated Soil Fertility Management
IWM	Integrated Weed Management
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KALRO	Kenya Agricultural and Livestock Research Organization
KCSAP	Kenya Climate-Smart Agriculture Project
KCEP	Kenya Cereal Enhanced Programme
KCEP_CRAL	Kenya Cereal Enhanced Programme –Climate Resilient Agricultural Livelihoods
KEBS	Kenya Bureau of Standards
KEFRI	Kenya Forestry Research Institute
KEPHIS	Kenya Pant Heath Inspectorate Service
KESREF	Kenya Sugar Research Foundation
KES	Kenyan Shilling
KIRDI	Kenya Industrial Research and Development Institute
KRC	Kenya Red Cross
KSU	KALRO Seed Unit

MoALFI	Ministry of Agriculture, Livestock, Fisheries and Irrigation
NARI	National Agricultural Research Institute
NARS	National Agricultural Research Systems
NGO	Non-Governmental Organization
NIB	National Irrigation Board
PTC	Practical Training Center
PCPB	Pest Control Products Board
PLWD	People Living With Disabilities
PPE	Personal Protective Equipment
PPP	Public Private Partnership
RELMA	Regional Land Management Unit
SACDEP	Sustainable Agriculture Community Development Programm
SIDA	Swedish International Development Agency
SME	Small and Medium Enterprises
TIMPs	Technologies, Innovation and Management Practices
ToT	Training of Trainer
TSBF	Tropical Soil Biology and Fertility
UoN	University of Nairobi
VC	Value Chain
VMG	Vulnerable and Marginalized Group

INTRODUCTION

Greengram is an important pulse crop commonly grown and consumed by rural and urban communities in Kenya and contributes about KES 32 billion to the Kenyan economy. It is used in several food products, both as a whole grain and in processed form. It also an excellent source of high quality protein with high digestibility. Greengram is considered to be the most hardy of all the pulse crops and is suitable for drought prone areas where many other crops cannot grow. It is mainly grown for sale in local and export markets and also for food and is increasingly becoming recognized as an excellent part of a healthy diet throughout Kenya. Green gram is a nutritious source of food with 24% protein content and is a comparatively low-cost source of protein. It has high levels of iron (6 mg/100 g dry seeds), which is deficient in most Kenyan diets. It is also high in fibre, various vitamins and amino acids. With more than 302,000 ha under green gram, the country produces 149,000 tons annually, which is far below the domestic demand. Over the last five years, the country has registered a 61% increase in green gram acreage from 188,000 ha in 2012 to over 302, 000 ha in 2017. This is attributed to expansion of green gram to non-traditional growing areas due to climate change. Despite its importance in drought prone environments and high demand, its yields have remained low. Moreover, green gram lessens 'hidden hunger and is a principal part of global human diet. Its starch is easier to digest than that from other legumes, has less flatulence thus it is well tolerated bychildren. . Greengram also contributes significantly to improve soil quality by fixing nitrogen in the soil. It can add up to about 30-40 kg N/ha after the harvest of the crop. Thus, after harvesting, when the greengram residues are left on the surface, the succeeding crop (normally a cereal) requires about 25% less nitrogen application. Crop residues of greengram can be used as fodder and mulch. Besides other uses, greengram can be specifically grown for hay, green manure or as a cover crop. Despite its superior nutritive value its utilization at the household level is limited due to lack of knowledge on green gram diversified products as well as limited application of improved green gram technologies innovations and management practices.

1.0 Definition of terms and summary tables of Green Grams Technologies, Innovations and Management Practices (TIMPS)

1.1 Definition of terms

Technology: This is defined as an output of a research process which is beneficial to the target clientele and (mainly farmers, pastoralists, agro-pastoralists and fisher folk for KCSAP's 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 and 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 Green Grams Value Chain

The inventory process resulted in a total of 94 TIMPs including 38 technologies, 7 innovations and 49 management practices, distributed among the 5 sub-themes, as indicated below:

Table 1. Number of Technologies Innovations and Management Practices

Commodity/VC	**Sub-Theme**	**Technologies**	**Innovations**	**Management Practices**
Green grams	*Improved Varieties*	*6*	*0*	*0*
Green grams	*Green gram Seed system*	*0*	*0*	*3*
Green grams	*GAP and Food Safety*	*0*	*0*	*2*
Green grams	*Agronomy*	*2*	*0*	*4*
Green grams	*Integrated Soil and Water Management*	*9*	*1*	*1*
Green grams	*Integrated Disease Management*	*0*	*0*	*9*
Green grams	*Integrated Pest Management*	*0*	*0*	*12*
Green gram	*Weeds*	*5*	*1*	*2*
Green grams	*Post-harvest*	*4*	*0*	*4*
Green grams	*Processing and Value addition*	*0*	*4*	*0*
Green grams	*Mechanization*	*11*	*1*	*0*
Green grams	*Farming Business and Marketing*	*0*	*0*	*8*
Green grams	*Policy*	*0*	*0*	*4*
Overall Total		**38**	**7**	**49**

1.3 Summary of Status of TIMPs in Green Gram Value Chain

The inventory process resulted in a total of 69 TIMPs that are ready for upscaling, 38 TIMPs that require validation and 14 TIMPs that require further research 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
Green grams	*Improved Varieties*	*6*	*6*	*2*
Green gram	*Seed System*	*3*	*2*	*0*
Green gram	*GAP and Food Safety*	*2*	*0*	*0*
Green gram	*Agronomy*	*6*	*6*	*6*
Green grams	*Integrated Soil Fertility and Water Management*	*6*	*5*	*1*
Green grams	*Integrated Disease Management*	*9*	*0*	*0*
Green grams	*Integrated Pest Management*	*12*	*0*	*0*
Green grams	*Weeds*	*5*	*4*	*3*
Green grams	*Post-harvest*	*7*	*1*	*1*
Green grams	*Processing and value addition*	*0*	*4*	*0*
Green grams	*Mechanization*	*9*	*2*	*1*
Green gram	*Farming business and marketing*	*1*	*7*	*0*
Green gram	*Policy*	*3*	*1*	*0*
Overall Total		**69**	**38**	**14**

Table 3: Inventory of Green Gram TIMPs by Category and Status

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
2.1 Improved varieties	*2.1.1 Green Gram variety KAT N26*	*Technology*	*Ready for upscaling Requires validation Requires further research*
	2.1.2 Green Gram variety Biashara	*Technology*	*Ready for upscaling Requires validation*
	2.1.3 Green Gram variety Ndengu Tosha	*Technology*	*Ready for upscaling Requires validation*
	2.1.4 Green Gram variety Karembo	*Technology*	*Ready for upscaling Requires validation*
	2.1.5 Variety KS 20	*Technology*	*Ready for upscaling Requires validation*
	2.1.6 Variety KAT N22	*Technology*	*Ready for upscaling Requires validation Requires further research*
2.2 Green gram System	*2.1.1 Own seed production*	*Management practice*	*Ready for outscaling*
	2.1.2 Informal seed production	*Management practice*	*Ready for outscaling Requires validation*
	2.1.3. Formal Seed production	*Management practice*	*Ready for outscaling*

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
			Requires validation
2.3 Good Agricultural Practices and Food Safety	*2.3.1 Good Agricultural Practices (GAP)*	***Management Practice Innovation***	***Ready for upscaling***
	2.3.1 Food Safety and Food Safety	***Management Practice***	***Ready for upscaling***
2.4. Agronomy	*2.4.1 Plant spacing*	*Management practice*	*Ready for upscaling Requires validation Requires further research*
	2.4.2. Zero tillage	*Management practice*	*Ready for upscaling Requires validation Requires further research*
	2.4.3 Conventional tillage	*Management practice*	*Ready for upscaling Requires validation Requires further research*
	2.4.4 Intercropping	*Management practice*	*Ready for upscaling Requires validation Requires further research*
	2.4.5 Sole cropping	*Management practice*	*Ready for upscaling Requires validation Requires further research*
	2.4.6 Mulching	*Management practice*	*Ready for upscaling*

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
			Requires validation Requires further research
2.5. Natural Resource Management	*2.5.1 Manure management*	*Technology*	*Requires validation*
	2.5.2 Soil Testing Technology	*Innovation*	*Requires validation*
	2.5.3 Integrated soil fertility management	*Technology*	*Requires validation*
	2.5.4 Rapid soil testing services	*Innovation*	*Requires validation*
	2.5.5 Contour bunds	*Technology*	*Ready for upscaling*
	2.5.6 Zai pits	*Technology*	*Ready for upscaling*
	2..5.7 Bench terraces	*Technology*	*Ready for upscaling*
	2.5.8 Fanya juu	*Technology*	*Ready for upscaling*
	2.5.9 Tied ridges	*Technology*	*Ready for upscaling*
	2.5.10 Conservation agriculture	*Management practices*	*Ready for upscaling*
	2.5.11 Multiple cropping	*Technology*	*Requires validation Requires further research*
2.6. Intergated Disease Management	2.6.1 Integrated management of rust disease	Management practice	Ready for upscaling
	2.6.2. Integrated management of Anthracnose disease	Management practice	Ready for upscaling
	2.6 .3. Integrated management of Powdery Mildew disease	Management practice	Ready for upscaling
	2.6..4 Integrated management of Cercospora disease	Management practice	Ready for upscaling
	2.6.5. Integrated management of Yellow Mosaic Disease	Management practice	Ready for upscaling

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
	2.6..6 Integrated management of Halo blight disease	Management practice	Ready for upscaling
	2.6.7 Integrated management of bacterial leaf blight disease	Management Practice	Ready for upscaling
	2.6..8 Integrated management of Root rot disease	Management Practice	Ready for upscaling
	2.6..9 Integrated management of Scab disease	Management Practice	Ready for upscaling
2.7. Integrated Pest Management	2.7.1 .Integrated Management of Root Knot Nematodes	Management Practice	Ready for upscaling
	2.7.2. Integrated Management of white flies	Management Practice	Ready for upscaling
	2.7.3. Integrated Management of Flea beetles	Management Practice	Ready for upscaling
	2.7.4. Integrated Management of Aphids	Management Practice	Ready for upscaling
	2.7.5. Integrated Management of blister beetles	Management Practice	Ready for upscaling
	2.7.6 Integrated Management of Locusts	Management Practice	Ready for upscaling
	2.7.7. Integrated Management of bruchids	Management Practice	Ready for upscaling
	2.7.8. Integrated Management of Cut worms	Management Practice	Ready for upscaling
	2.7.9. Integrated Management of flower thrips	Management Practice	Ready for upscaling
	2.7.10. Integrated Management of Pod sacking bugs	Management Practice	Ready for upscaling
	2.7.11. Integrated Management of Bean flea	Management Practice	Ready for upscaling
	2.7.12 Integrated Management of Red spider mite	Management Practice	Ready for upscaling
2.8. Weed Management	*2.8.1 Integrated Weed Management in Green gram*	*Management Practice*	*Ready for upscaling*
	2.8.2 Mulching for weed management in green gram production	*Technology*	*Ready for upscaling Requires validation*

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
	2.8.3 Solarization Bed for Weed Control in green gram	*Technology*	*Requires validation Requires further research*
	2.8.4 Stale seed bed for Weed Control in green gram	*Technology*	*Requires validation Requires further research*
	2.8.5 Mechanical weed control in green gram production	*Technology*	*Ready for upscaling*
	2.8.6 Chemical weed control in green gram production	*Technology*	*Requires validation Requires further research*
	2.8.7 Safe Use of herbicides in green gram production	*Innovation*	*Ready for upscaling*
2.9. Post-Harvest	*2.9.1 Harvesting*	*Management practice*	*Requires validation*
	2.9.2 Drying	*Management practice*	*Ready for upscaling*
	2.9.3 legume thresher	*Technology*	*Ready for upscaling*
	2.9.4 Winnowing	*Management Practice*	*Ready for upscaling*
	2.9.5 Mechanized Solar drier	*Technology*	*Ready for upscaling*
	2.9.6 Portable electronic moisture metre	*Technology*	*Ready for upscaling*
	2.9.7 Destoning machine	*Technology*	*Ready for upscaling*
	2.9.8 Grain stores/hermetic bags	*Management practice*	*Ready for upscaling*
	2.9.9 Hemetic bags	*Technology*	*Ready for upscaling*
	2.9.10 Green gram stores	*Management practice*	*Ready for upscaling*
2.10. Processing and Value Addition	2.10.1. Green gram flour	Innovation	Requires validation

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
	2.10.2 Green gram balls	Innovation	Requires validation
	2.10.3 Green gram crackies	Innovation	Requires validation
	2.10.4Green gram cakes	Innovation	Requires validation
2.11. Mechanization	*11.2.1 Mould board plough*	*Technology*	*Ready for upscaling*
	11.2.2 Tine harrow	*Technology*	*Ready for upscaling*
	11.2.3 Seed drill	*Technology*	*Requires validation*
	11.2.4 Combine harvester	*Technology*	*Requires validation*
	11.2.5 Thresher	*Innovation*	*Requires validation*
	11.2.6 Knapsack Motorized mist blower	*Innovation*	*Requires validation*
	11.2.7 Power tiller	*Technology*	*Requires validation*
	11.2.8 Shallow scraper	*Technology*	*Requires validation*
2.12. Business and Marketing			
	2.12.1 Transformative Model of production of green grams	Management practices	Requires validation
	2.12.2. Building a business plan	Management practices	Requires validation
	2.12.3 Collective marketing	Management practices	Requires validation
	2.12.4 Profitability analysis	Management practices	Ready for upscaling
	2.12.5 Market research	Management practices	Requires validation
	2.12.6 Contracted production model	Management practices	Requires validation
	2.12.7 Marketing innovation model	Management practices	Requires validation
	2.12.8 Internet/mobile marketing	Management practices	Requires validation

TIMPs Sub-Theme	TIMPs Title	TIMPs Category	Status
2.13. Policy Options	2.13.1. Integrating National Agricultural Policy Strategy Framework	Management practices	Ready for upscaling
	2.13.2 County Integrated Development planning	Management practices	Ready for upscaling
	2.13.3. Policy Instruments	Management practices	Ready for upscaling
	2.13.4 Policy cycle	Management practices	Requires validation

2.1. Improved Varieties

2.1.1 TIMP name	Green Gram variety KAT N26
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Unavailability of suitable varieties for drier green gram producing areas
What is it? (TIMP description)	Kat N26 is a fairly early maturing variety (matures in 80-90 days) and has potential yields of 1000-1500kg/ha (4-6, 90 kg bags/acre). The variety has a determinate growth habit, is tolerant to aphids, resistant to yellow mosaic and moderately resistant to powdery mildew. Dry pods are black in colour. 85% of the grains are shiny green and bold hence some farmers call it nylon

	 
Justification	Farmer varieties are late maturing and unsuitable for the drier green gram producing areas. N26 is suited to both semi-arid and well-watered areas of between 50-1600m above sea level. Due to its earliness it will increase yields and improve livelihoods in the drier areas such as lower Machakos, Kitui, Mwingi, Tharaka, Mbeere and Makueni districts.
B. Assessment of dissemination and scaling up/out approaches	
Users of TIMP	• Farmers • Seed companies/Agro-dealers • Traders/Exporters, • Research organizations and universities • Agro-processors • Extension Agents (Public and Private)
Approaches to be used in dissemination	• Agricultural Innovation platforms • On-farm demonstration • Field days • Agricultural shows and exhibitions • Farmer to farmer visits • Digital platforms (e.g KALRO, Digifarm, Weather information Apps) • Mass Media Radio/TV programmes (e.g. Mkulima programme, Smart Farmer and Seeds of Gold), Magazines and Newspapers articles • Extension publications (posters/ brochures/leaflets) • Partners –NGOs
Critical/essential factors for successful promotion	• Seed availability, accessibility and affordability • Strong linkage among Green Gram value chain actors – producers to market • Strong partnership linkages • Awareness campaigns

Partners/stakeholders for scaling up and their roles	• Public and private extension service providers- To help in the technology dissemination • FAO- Facilitate in the promotion of the technology and linking farmers to market • ICRISAT –Partner in technology dissemination • NGOs:–Partner in technology dissemination through on-farm demonstrations • KILIMO trust-Capacity building of farmers and linking farmers to markets and credit facilities • Seed companies –Agri-business and marketing of the technology • Traders/exporters –Marketing of the technology • Processors –For value added products • Educational institutions- Providing the market • County governments –Assist in the dissemination of the technology, Linking farmers to external markets
C: Current situation and future scaling up	
Counties where already promoted, if any	Some parts of Makueni, Machakos, Kitui, and Tharaka Nithi.
Counties where TIMPs will be up scaled	Isiolo, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited seed systems hinder farmers from obtaining seed for new varieties • Unavailability of quality seed and high seed cost • Limited access to rural finance for pulse production • Limited processing technologies at the household level
Suggestions for addressing the challenges	• Establish sustainable seed systems • Avail breeder seed for seed multiplication • Upscale innovations to reduce production costs • Capacity building on Good Agronomic Practices • Involve credit facility providers in green gram value chain • Capacity build on value addition
Lessons learned in up scaling, if any	• Partnership and awareness creation are important in technology dissemination and adoption
Social, environmental, policy and market conditions necessary for development and upscaling	• Continued acceptance of variety for local and foreign consumption • Favourable weather • Enforcement of green gram production and marketing policies by county and national governments • Market availability
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 54,035/ha-
Estimated returns	Total returns under improved management were estimated at KES 120,000/ha and gross margins of KES 66,445/ha

Gender issues and concerns in development, dissemination adoption and scaling up	• Women do most of the green grams activities such as weeding and winnowing. Green gram farming therefore may initially increase their work burden unless there are labour-saving technologies • This heavy workload may limit green grams adoption and scaling up for women farmers who may not afford to hire labour for weeding • Need for gender responsive mechanization tools to ease drudgery at harvesting • Women's participation in groups is important to access services, technology, information. However, Socio-cultural norms may limit women's participation and leadership in groups which are important in accessing technology and information • Women's double and triple roles means they may not have time to participate in group activities • Women's status, age, wealth level may limit their influence and participation in groups • In some cultures women may not be able to travel away from their homes to meetings, without permission • Not recognizing women as farmers, therefore services and information are not tailored to address their priority enterprises • Women's time and mobility constraints mean that they may not be able to attend extension activities such as field days, farmer field schools, innovation platforms and agricultural shows far from home or held at times when they have other roles • Low literacy rates may limit use extension materials by women. • Women have limited access to improved seeds, fertilizer/ manure and other inputs • Women have less access to markets than men • Women have less access to resources such as land and capital
Gender related opportunities	• The variety is high yielding therefore will lead to increased productivity that will benefit all the gender categories (men, women and the youth) • The technology has high international and local demand therefore offers an opportunity for men and the youth who are mostly involved in marketing especially in far markets therefore generating more income • As an early maturing and high yielding variety it will meet the food and nutrition security of all the gender categories in the household • The variety being early yielding will offer stable supplies and markets for women and youth • There will be increased sales for women and youth

	• Proper timing of agricultural meetings/field days/seminars to enhance participation by all the gender categories as informed by daily /seasonal calendars
VMG issues and concerns in development, dissemination adoption and scaling up	• Some VMGs might not be able to participate in some agronomic activities • Not recognizing VMG's as farmers, when designing TIMPs such as the farm implements. There is need to come up with tailor made implements that meet the VMG's needs and concerns • The VMGs have less access to resources such as land and credit • VMGs have less access to extension services due to prejudice and their social status • VMGs have Limited access to improved inputs such as seeds, fertilizer/ manure and other inputs • VMGs have less access to markets than the other gender categories • Strict rules of entry and requirements of producers' organizations may limit VMG 's participation • Green gram activities are labour intensive and thus there is need for gender responsive mechanization/ labour saving interventions for increased production
VMG related opportunities	• The technology can improve food and nutrition security and an opportunity for increased income • As an early maturing and high yielding variety it will meet the food and nutrition security of the VMGs in whole household. • It offers a good opportunity for income generation for the VMGs • The crop is rich in protein and folate thus important in improving nutrition and health for the VMGs
E: Case studies/profiles of success stories	
Success stories	
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya Guidelines available in extension publications (Green gram brochures available at KALRO-Katumani)
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for upscaling 2-Requires validation 3-Requires further research
G: Contacts	
Contacts	The Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos Email: cd.katumani@kalro.org

	Phone: 0736333294
Lead organization and scientists	Kenya Agricultural and Livestock Research Organization (KALRO) Rael Karimi, Daniel Mutisya, Arnold Njaimwe (KALRO Katumani), Catherine Muriithi (KALRO Embu)
Partner organizations	• World Vegetable Centre • MoALF&I • Seed companies e.g. Dryland seed Ltd, East African Seed company • FAO • ICRISAT • KILIMO trust • East African Grain Council

Gaps for further researcher:

1. Need for mechanization to ease the harvesting – Thresher
2. Need to improve KAT N26 variety on disease resistance
3. Explore bio-control of insect pests – white flies and aphids
4. Postharvest handling – protection against pests e. g rat-proof cages for protection of hermetic bags
5. Value added green gram based products – formulation of weaning diets

2.1.2 TIMP name	**Green gram variety Biashara (KAT 00308)**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram yields that do not meet the market demand (quality and quantity) due to unavailability of improved varieties
What is it? (TIMP description)	Biashara is an early maturing (65 –75 days), high yielding (1800-2100 kg/ha ([8-9, 90 kg bags/acre]) green gram variety. It is tolerant to aphids, resistant to yellow mosaic virus and moderately resistant to powdery mildew. The variety is tolerant to drought and suitable for the ASALs. Pods are large and cream in colour when dry. Seeds are large in size (8 –10 g/100 seeds) making it easy to harvest. Grains are shiny green, non-stony and preferred by the market.

	 
Justification	ASALs are characterized by frequent droughts. Green grams is a short season legume and can fit into cropping patterns practiced in ASALs (two season cropping). Farmer available varieties are low yielding and late maturing. Conventional varieties, however have small pods and small seeds that are difficult to harvest. The small seed is undesirable in the market. This early maturing, high yield, pest and disease tolerant variety will increase yields and improve livelihoods. The non-stony grains will increase market acceptance. Due to its short growing cycle (65-75 days), the variety is considered less risk-prone and suitable for increasing resilience to impacts of climate change in the ASALs
Users of TIMP	• Farmers, Seed companies, Agro-dealers, ProcessorsTraders/Exporters • Other research organizations/institutions (universities)
Approaches to be used in dissemination	• On-farm trials • Demonstration plots • Agricultural Innovation platforms • Farmer field days • Farmer to farmer visits • Agricultural shows and exhibitions • Digital platforms (e.g KALRO, Digifarm, Weather information Apps) • Social electronic platforms • Mass media (Radio and Television programmes, Magazines and Newspapers articles) • Promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Establishment of sustainable seed system to ensure accessibility • Gender mainstreaming in green gram production • Strong linkage among green gram value chain actors –producers to market • Strong Partnership linkages • Sustainable funding
Partners/stakeholders for scaling up and their roles	- KALRO to provide seed for the variety and backstopping services - Extension service providers (Public and private) to help in the technology dissemination - FAO to facilitate in the promotion of the technology and linking farmers to market - ICRISAT –Partner in technology dissemination

	- NGOs: –Partner in technology dissemination through on-farm demonstrations - KILIMO trust- Capacity building of farmers and linking farmers to markets and credit facilities - Seed companies –Agri-business and marketing of the technology - Traders/exporters–Marketing of the technology - Processors - Create demand for variety through value addition - Farmers - Test/validate and produce the variety - County governments –Assist in the dissemination of the technology, Linking farmers to external markets
C: Current situation and future scaling up	
Counties where already promoted, if any	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	- Limited seed systems hinder farmers from obtaining seed for new varieties - Unavailability of quality seed and high seed cost - Limited access to rural finance for pulse production - Limited processing technologies at the household level; is mainly known for making stew served with cereal-based meals
Suggestions for addressing the challenges	- Need for information dissemination on GAPs - Participation of stakeholders along the value chain in technology development and on-farm validation - Promoting awareness among farmers about the loss of varietal vigor associated with recycling of saved seed - Upscale innovations to reduce production costs - Develop value added products – need to strengthen linkages between green gram production and consumption in local food systems (develop weaner diet)
Lessons learned in up scaling, if any	- Partnerships are important in technology dissemination and adoption - Increased yield can be achieved through application of water harvesting techniques and agro-ecological technologies (conservation farming like minimum tillage, mulching)
Social, environmental, policy and market conditions necessary for development and upscaling	● -Re-establish linkage between green gram production and consumption -importance in the local diet ● -Use of contract management to guarantee consistent supply ● -Increase public-private dialogue to agree on a model that will ensure compliance with international standards ● Provide market information on volume, quality and supply consistency requirements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	

Basic costs	The basic cost was estimated at KES 92,035/ha
Estimated returns	Total returns under improved management were estimated at KES 180,000/ha and a gross margin of KES 91,445/ha
Gender issues and concerns in development, dissemination, adoption and scaling up	• Women do most of the green grams' activities such as weeding and winnowing. Green gram farming therefore may initially increase their work burden unless there are labour-saving technologies • This heavy workload may limit green grams' adoption and scaling up for women farmers who may not afford to hire labour for weeding • Participation in groups is important to access services, technology, information. However • Socio-cultural norms may limit women's participation and leadership in groups which are important in accessing technology and information • Women's double and triple roles means they may not have time to participate in group activities • In some cultures women may not be able to travel away from their homes to meetings, without permission • Not recognizing women as farmers, therefore services and information are not tailored to address their priority enterprises • Women's time and mobility constraints mean that they may not be able to attend extension activities far from home or held at times when they have other roles • Low literacy rates limits use extension materials among women. • Limited access to improved seeds, fertilizer/ manure and other inputs • Women have less access to markets than men • Women have less access to resources such as land and capital • Women may not be able to hire labour due to limited finances as they have limited credit facilities
Gender related opportunities	• The variety is high yielding therefore will lead to increased productivity that will benefit all the gender categories (men, women and the youth) • The technology has high international and local demand therefore offers an opportunity for men and the youth who are mostly involved in marketing especially in far markets therefore generating more income • As an early maturing and high yielding variety it will meet the food and nutrition security of all the gender categories in the household • There will be increased incomes for women due to increased sales resulting in women and youth empowerment
VMG issues and concerns in development, dissemination, adoption and scaling up	- Not recognizing VMG's as farmers, when designing TIMPs such as the farm implements. Therefore, need to come up with tailor made implements that meets the VMG's needs and concerns - The VMGs have less access to resources such as land and credit

	- VMGs have less access to extension services due to prejudice and their social status - VMGs have Limited access to improved inputs such as seeds, fertilizer/ manure and other inputs - VMGs have less access to markets than the other gender categories - Strict rules of entry and requirements of producers' organizations may limit VMG 's participation
VMG related opportunities	- There will be increased employment for VMGs - As an early maturing and high yielding variety it will meet the food and nutrition security of the VMGs in whole household. - There is potential of having stable products of Green grams in the markets - It offers a good opportunity for income generation for the VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Samuel Mukosa, an early adopter who is now growing and selling to other farmers in Mbuvo, Makueni county
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya Guidelines available in extension publications (Green gram brochures available at KALRO-Katumani)
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for upscaling 2-Requires validation in some counties
G: Contacts	
Contacts	Institute Director, KALRO-Katumani P.O. Box 340-90100 Machakos Email: director,amri@gmail.com Phone: 0710906600
Lead organization and scientists	KALRO, Rael Karimi, Arnold Njaimwe and D aniel Mutisya (Katumani), Catherine Muriithi (Embu)
Partner organizations	● World Vegetable Centre ● Ministry of agriculture ● Seed companies – Dryland seed ltd, East African Seed company ● FAO ● ICRISAT ● KILIMO trust ● East African Grain Council

Gaps for further researcher:

1. Need for mechanization to ease the harvesting – Thresher
2. Explore bio-control of insect pests – white flies and aphids
3. Postharvest handling – protection against pests e. g rat-proof cages for protection of hermetic bags
4. Value added green gram based products – formulation of weaning diets

2.1.3 TIMP name	**Green gram variety Ndengu Tosha (KAT 00301)**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low yields and a high demand for green grams for domestic and export market
What is it? (TIMP description)	Ndengu Tosha is early maturing (65 –70 days) and thus able to escape drought conditions that are common in the ASALs. It is high yielding (1800-2300 kg/ha (8-10, 90 kg bags/acre)) and tolerant to major green gram diseases. Its characteristic features include cream pod colour when dry and shiny green grains. The green gram variety grows in a wide range of climatic conditions from sea level to 1600 m above sea level. It is both heat and drought tolerant and thus can be grown in both semi-arid and well-watered areas. Seeds are non-stony and large in size (6-7g/100 seeds).  
Justification	ASALs are characterized by frequent droughts. Ndengu Tosha is a high yielding, drought tolerant and short duration crop and can fit into cropping patterns practiced in ASALs (two season cropping).. It has shinny large, non-stony grains that are preferred in the market. It's drought tolerance and high yielding potential make it suitable for commercial green gram production. The variety will improve household income and resilience to impacts of climate change in the ASALs.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	- Farmers - Seed companies/Agro-dealers - Traders/Exporters - Other research organizations/institutions (universities)

	- Processors
Approaches used in dissemination	● On-farm trials ● Demonstration plots ● Agricultural Innovation platforms ● Farmer field days ● Farmer to farmer visits ● Agricultural shows and exhibitions ● Digital platforms (e.g KALRO, Digifarm, Weather information Apps) ● Social electronic platforms ● Mass media (Radio and Television programmes, Magazines and Newspapers articles)
Critical/essential factors for successful promotion	● Establishment of sustainable seed system to ensure accessibility ● Gender mainstreaming in green gram production ● Strong linkage among green gram value chain actors –producers to market ● Strong Partnership linkages ● Sustainable funding
Partners/stakeholders for scaling up and their roles	● Public and private extension service providers-To help in the technology dissemination ● FAO- Facilitate in the promotion of the technology and linking farmers to market ● ICRISAT –Partner in technology dissemination ● NGOs: Partner in technology dissemination through on-farm demonstrations ● KILIMO trust capacity building of farmers and linking farmers to markets and credit facilities ● Seed companies –Agri-business and marketing of the technology ● Traders/exporters –Marketing of the technology ● Processors –For value added products ● Educational institutions –Providing the market ● County governments –Assist in the dissemination of the technology, Linking farmers to external markets
C: Current situation and future scaling up	
Counties where already promoted, if any	● Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Counties where TIMPs will be upscaled	● Other parts of Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot
Challenges in development and dissemination	- Limited seed systems hinder farmers from obtaining seed for new varieties - Unavailability of quality seed and high seed cost - Limited access to rural finance for pulse production - Limited processing technologies at the household level; it is mainly known for making stew served with cereal-based meals
Suggestions for addressing the challenges	- Need for information dissemination on GAPs

	- Participation of stakeholders along the value chain in technology development and on-farm validation - Promoting awareness among farmers about the loss of varietal vigour associated with recycling of saved seed - Upscale innovations to reduce production costs - Develop value added products – need to strengthen linkages between green gram production and consumption in local food systems (develop weaner diet)
Lessons learned	- Partnership is important in technology dissemination and adoption - Involvement of end-user in technology development process eliminates the problem of fitting the crop to both the target environments and users' preferences
Social, environmental, policy and market conditions necessary for development and upscaling	- Farmer acceptance and utilization of the variety - Favourable prevailing weather conditions - Favourable policies that comply with the local and international standards - Provision of improved market information on volume, quality and supply consistency requirements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The basic cost was estimated at KES 92,035/ha
Estimated returns	Total returns under improved management were estimated at KES 180,000/ha and a gross margin of KES 91,445/ha
Gender issues and concerns in development dissemination adoption and scaling up	• Women have limited access to productive resources such as land, credit and equipment • Women do most of the green grams' activities such as weeding and winnowing. Green gram farming therefore may initially increase their work burden unless there are labour-saving technologies • This heavy workload may limit green grams' adoption and scaling up for women farmers who may not afford to hire labour for weeding • Need for mechanization to ease drudgery at harvesting • Some social -cultural norms may limit women's participation in agricultural marketing groups hindering them from accessing new technologies and information • Women's double and triple roles means they may not have time to participate in group activities • In some cultures women may not be able to travel away from their homes to meetings, without permission • Not recognizing women as farmers, therefore services and information are not tailored to address their priority enterprises • Women's time and mobility constraints mean that they may not be able to attend extension activities far from home or held at times when they have other roles • Low literacy rates may limit use extension material among women.

	• Limited access to improved seeds, fertilizer/ manure and other inputs due to lack of finances
Gender related opportunities	- The variety is high yielding and therefore will lead to increased productivity that will benefit all the gender categories (men, women and the youth) - The technology has high international and local demand therefore offers an opportunity for men and the youth who are mostly involved in marketing especially in far markets therefore generating more income - As an early maturing and high yielding variety it will meet the food and nutrition security of all the gender categories in the household
VMG issues and concerns in development, dissemination adoption and scaling up	- Not recognizing VMG's as farmers, when designing TIMPs such as the farm implements. Therefore, need to come up with tailor made implements that meets the VMG's needs and concerns - The VMGs have less access to resources such as land and credit - VMGs have less access to extension services due to prejudice and their social status - VMGs have Limited access to improved inputs such as seeds, fertilizer/ manure and other inputs - VMGs have less access to markets than the other gender categories - Strict rules of entry and requirements of producers' organizations may limit VMG 's participation The VMGs might not be able to perform some activities therefore there is need for mechanization/ labour saving interventions for increased production
VMG related opportunities	- Mechanization will make the work easy for VMGs - The technology can improve food and nutrition security and an opportunity for increased income - As an early maturing and high yielding variety it will meet the food and nutrition security of the VMGs in whole household. - It offers a good opportunity for income generation for the VMGs - The crop is rich in protein and folate thus important in improving nutrition and health for the VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya Guidelines available in extension publications (Green gram pamphlets available at KALRO-Katumani)
F: Status of TIMP readiness (1-Ready for upscaling, 2-	1-Ready for upscaling 2-Requires validation in some counties,

requires validation, 3-requires further research)	
G: Contacts	
Contacts	The Institute Director, KALRO-Katumani P.O. Box 340-90100, Machakos Email: director.amri@gmail.com Telephone: 0710906600
Lead organization and scientists	Kenya Agricultural and Livestock Research Organisation (KALRO) Rael Karimi, Arnold Njaimwe and Daniel Mutisya (KALRO Katumani), Catherine Muriithi (KALRO Embu)
Partner organizations	- World Vegetable Centre - M0ALF&I - Seed Companies-Dryland Seed Ltd, East African Seed company - FAO - ICRISAT - KILIMO trust - East African Grain Council

GAPs for further research

1. Need for mechanization to ease the harvesting – Thresher
2. Explore bio-control of insect pests – white flies and aphids
3. Postharvest handling – protection against pests e. g rat-proof cages for protection of hermetic bags
4. Value added green gram based products – formulation of weaning diets

2.1.4 TIMP name	**Green Gram variety Karembo (KAT 00309)**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low yields and inability to meet market demand for green gram due to use of poor quality seeds
What is it? (TIMP description)	Karembo is an improved early maturing (65-75 days), high yielding (1800-2100 kg/ha 8-9, 90 kg bags/acre) green gram variety that is tolerant to major green gram diseases. Its other characteristic features include green shiny grains and large seed size (8 –10 g/100 seeds). Dry pods are brown in colour. It can grow in a wide range of climatic conditions. It is also both heat and drought tolerant and thus can be grown in both semi-arid and well-watered areas.

	 
Justification	ASALs are characterized by frequent drought. The early maturing, high yielding, drought tolerance qualities of this climate-smart variety makes it suitable for commercial green gram production in dry land conditions. The large seed size (8-10g/100seeds) and non-stony grain qualities make it favourable for the market
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	- Farmers - Seed companies/Agro-dealers - Traders/Exporters - Other research organizations/institutions (universities) - Processors
Approaches to be used in dissemination	● On-farm trials ● Demonstration plots ● Agricultural Innovation platforms ● Farmer field days ● Farmer to farmer visits ● Agricultural shows and exhibitions ● Digital platforms (e.g KALRO, Digifarm, Weather information Apps) ● Social electronic platforms ● Mass media (Radio and Television programmes ● Magazines and Newspapers articles)
Critical/essential factors for successful promotion	● Establishment of sustainable seed system to ensure accessibility ● Gender mainstreaming in green gram production ● Strong linkage among green gram value chain actors –producers to market ● Strong partnership linkages ● Sustainable funding
Partners/stakeholders for scaling up and their roles	- Public and private extension service providers- To help in the technology dissemination - FAO- Facilitate in the promotion of the technology and linking farmers to market - ICRISAT –Partner in technology dissemination - NGOs: Partner in technology dissemination through on-farm demonstrations - KILIMO trust- Capacity building of farmers and linking farmers to markets and credit facilities - Seed companies –Agri-business and marketing of the technologies - Traders/exporters – marketing of the technology

	- Processors - For value added products - Educational institutions –Providing of the market - County governments –Assist in the dissemination of the technology, Linking farmers to external markets
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Makueni, Kitui, Tharaka Nithi
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Tana River, Baringo
Challenges in dissemination	- Limited seed systems hinder farmers from obtaining seed for new varieties - Unavailability of quality seed and high seed cost - Low participation of male farmers - Limited access to rural finance for pulse production - Limited processing technologies at the household level reduce adoption of the technology
Suggestions for addressing the challenges	● Establishment of sustainable seed system to ensure accessibility ● Avail breeder seeds for commercial seed multiplication ● Gender mainstreaming in green gram value chain ● Strong linkage among green gram value chain actors from producers to the market ● Capacity building on value addition ● Sustainable funding
Lessons learned in up scaling, if any	- Partnership is important in technology dissemination and adoption - Involvement of end-user in technology development process eliminates the problem of fitting the crop to both the target environments and users' preferences
Social, environmental, policy and market conditions necessary for development and upscaling	- Farmer acceptance and utilization of the variety - Favourable prevailing weather conditions - Favourable policies that comply with the local and international standards - Provision of improved market information on volume, quality and supply consistency requirements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The basic cost was estimated at KES 92,035/ha
Estimated returns	Total returns under improved management were estimated at KES 180,000/ha and a gross margin of KES 91,445/ha
Gender issues and concerns in development, dissemination adoption and scaling up	• Women have been having low yield due to planting poor seeds • Most of the activities within the green grams value chain are labour intensive increasing work burden for women

	• This heavy workload may limit green grams adoption and scaling up by women farmers who may not afford to hire labour for weeding • Need for mechanization to ease drudgery at harvesting • Women's double and triple roles means they may not have time to participate in group activities • Women's status, age, wealth level may limit their influence and participation in groups • In some cultures women may not be able to travel away from their homes to meetings, without permission • Not recognizing women as farmers, therefore services and information are not tailored to address their priority enterprises • Low literacy rates may limit use of extension materials among women. • Limited access to improved seeds, fertilizer/ manure and other inputs • Women have limited access to markets than men
Gender related opportunities	- The variety is high yielding therefore will lead to increased productivity that will benefit all the gender categories (men, women and the youth) in terms of providing employment - The technology has high international and local demand therefore offers an opportunity for men and the youth who are mostly involved in marketing especially in far markets therefore generating more income - As an early maturing and high yielding variety it will meet the food and nutrition security of all the gender categories in the household
VMG issues and concerns in development and dissemination	- Not recognizing VMG's as farmers, when designing TIMPs such as the farm implements. Therefore, need to come up with tailor made implements that meets the VMG's needs and concerns - The VMGs have less access to resources such as land and credit - VMGs have less access to extension services due to prejudice and their social status - VMGs have Limited access to improved inputs such as seeds, fertilizer/ manure and other inputs - VMGs have less access to markets than the other gender categories - Strict rules of entry and requirements of producers' organizations may limit VMG 's participation
VMG related opportunities	If mechanization is introduced there will be increased participation by all VMGs since the work will be made easy - The technology can improve food and nutrition security and an opportunity for increased income - As an early maturing and high yielding variety it will meet the food and nutrition security of the VMGs in whole household.

	- It offers a good opportunity for income generation for the VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Samuel Mukosa, an early adopter who is now growing and selling to other farmers in Mbuvo, Makueni county
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya Guidelines available in extension publications (Green gram pamphlets available at KALRO-Katumani)
G: Contacts	
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for upscaling 2-Requires validation in more counties
Contacts	The Institute Director, KALRO-Katumani P.O. Box 340-90100, Machakos Email: director.amri@gmail.com Phone: 0910906600
Lead organization and scientists	KALRO Rael Karimi (Katumani)
Partner organizations	- World Vegetable Centre - MoALF&I - Seed companies – Dryland seed ltd, East African Seed company - FAO - ICRISAT - KILIMO trust - East African Grain Council

GAPs for further research

1. Need for mechanization to ease the harvesting – Thresher
2. Explore bio-control of insect pests – white flies and aphids
3. Postharvest handling – protection against pests e. g rat-proof cages for protection of hermetic bags
4. Value added green gram based products – formulation of weaning diets

2.1.5 TIMP name	**Green gram variety KS 20**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	

Problem addressed	Low yields and poor quality grain due to unavailability of high value seeds
What is it? (TIMP description)	KS20 is a green gram variety that matures in 80-90 days and has a potential yield of 1600 - 2200 kg/ha (7-9, 90 kg bags/acre). Its characteristic features include large seed size (6-7g/100 seeds), dull green grains and pods that turn brown when dry. The variety is tolerant to aphids, resistant to yellow mosaic virus and moderately resistant to powdery mildew. Grains are dull green in color. Seeds are non-stony. 
Justification	KS 20 is high yielding, large seeded and non stony and will increase production and household livelihoods in the ASALs.
Users of TIMP	- Farmers - Seed companies and Agro-dealers - Traders/Exporters - Other research organizations/institutions (universities) - Processors
Approaches to be used in dissemination	● On-farm trials ● Demonstration plots ● Agricultural Innovation platforms ● Farmer field days ● Farmer to farmer visits ● Agricultural shows and exhibitions ● Digital platforms (e.g KALRO, Weather information Apps) ● Social electronic platforms ● Mass media (Radio and Television programmes Magazines and Newspapers articles)
Critical/essential factors for successful promotion	- Need for good seed system to ensure accessibility - Strong linkage among green gram value chain actors –producers to market - Strong partnership linkages
Partners/stakeholders for scaling up and their roles	- SIMLAW Seed Company to provide seed for the variety - Extension service providers (Public and private) to help in the technology dissemination - FAO facilitate in the promotion of the technology and linking farmers to market - Processors

	- County governments –Help in the dissemination of the technology, Linking farmers to external markets
C: Current situation and future scaling up	
Counties where already promoted, if any	● Meru, Machakos, Makueni, Kitui, Tharaka Nithi, Baringo
Counties where TIMPs will be upscaled	● Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	- Limited seed systems hinder farmers from obtaining seed for new varieties - Unavailability of quality seed and high seed cost - Limited access to rural finance for pulse production - Limited processing technologies at the household level; is mainly known for making stew served with cereal-based meals
Suggestions for addressing the challenges	- Need for information dissemination on GAPs - Participation of stakeholders along the value chain in technology development and on-farm validation - Promoting awareness among farmers about the loss of varietal vigour associated with recycling of saved seed - Upscale innovations to reduce production costs - Develop value added products – need to strengthen linkages between green gram production and consumption in local food systems (develop weaner diet)
Lessons learned in up scaling, if any	- Partnership is important in technology dissemination and adoption - Involvement of end-user in technology development process eliminates the problem of fitting the crop to both the target environments and users' preferences
Social, environmental, policy and market conditions necessary for development and upscaling	- Farmer acceptance and utilization of the variety - Favourable prevailing weather conditions - Favourable policies that comply with the local and international standards - Market information on volume, quality and supply consistency requirements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The basic cost was estimated at KES 89,035/ha
Estimated returns	Total returns under improved management were estimated at KES 160,000/ha and a gross margin of KES 71,445/ha
Gender issues and concerns in development and dissemination	• Women and youth 's limited access to production resources such as land, knowledge, information, extension training, credit and quality seed. • 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 • Limited participation in decision making at the community and County level • Women do most of the green grams activities such as weeding and winnowing. Green gram farming therefore may initially increase their work burden unless there are labour-saving technologies • This heavy workload may limit green grams adoption and scaling up for women farmers who may not afford to hire labour for weeding • Need for mechanization to ease drudgery at harvesting • Women's double and triple roles means they may not have time to participate in group activities • In some cultures women may not be able to travel away from their homes to meetings, without permission • Not recognizing women as farmers, therefore services and information are not tailored to address their priority enterprises • Women's time and mobility constraints mean that they may not be able to attend extension activities far from home or held at times when they have other roles • Lower average literacy rates limits women's use extension material. • Limited access to improved seeds, fertilizer/ manure and other inputs
Gender related opportunities	- The variety is high yielding therefore will lead to increased productivity that will benefit all the gender categories (men, women and the youth) - The technology has high international and local demand therefore offers an opportunity for men and the youth who are mostly involved in marketing especially in far markets therefore generating more income - As an early maturing and high yielding variety it will meet the food and nutrition security of all the gender categories in the household
VMG issues and concerns in development and dissemination	- Not recognizing VMG's as farmers, when designing TIMPs such as the farm implements. Therefore need to come up with tailor made implements that meets the VMG's needs and concerns - The VMGs have less access to resources such as land and credit - VMGs have less access to extension services due to prejudice and their social status - VMGs have Limited access to improved inputs such as seeds, fertilizer/ manure and other inputs - VMGs have less access to markets than the other gender categories

	- Strict rules of entry and requirements of producers' organizations may limit VMG 's participation - Due to their social status VMGs are often excluded from decision making in development and dissemination activities - VMGs have limited access to education, training and extension services than men - Due to prejudices associated with their social status, VMGs are excluded from access to and benefits from improved technologies
VMG related opportunities	- The technology can improve food and nutrition security and an opportunity for increased income - As an early maturing and high yielding variety it will meet the food and nutrition security of the VMGs in whole household. - It offers a good opportunity for income generation for the VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya Guidelines available in extension publications (Green gram brochures available at KALRO-Katumani)
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for upscaling 2-requires validation
G: Contacts	
Contacts	Simlaw seed Co. Ltd P.O Box 40024-00100 Nairobi Email: kariuki@simlaw.co.ke
Lead organization and scientists	Simlaw Seed Co. Ltd, Michael Ngugi and Thomas Kariuki
Partner organizations	County Governments

GAPs for further research

1 Need for mechanization to ease the harvesting – Thresher

2 Explore bio-control of insect pests – white flies and aphids

3 Postharvest handling – protection against pests e. g rat-proof cages for protection of hermetic bags

4 Value added green gram based products – formulation of weaning diets

2.1.6 TIMP name	Green Gram variety KAT N22
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	Lack of green gram varieties for food diversification and income generation
What is it? (TIMP description)	This green gram variety is tolerant to aphids, resistant to yellow mosaic virus and moderately resistant to powdery mildew. It matures in 80-90 days and has a potential yield of 1000-1300kg/ha (4-5, 90 kg bags/acre). Pods are yellow in colour when dry. Grains are golden yellow in colour and preferred for stews. 
Justification	Yellow gram is can fit into cropping patterns practiced in ASALs (two season cropping). The variety is suitable for improving household nutrition, income generation and resilience to climate change in the ASALs.
B.Assessment of dissemination and scaling up/out approaches	
Users of TIMP	- Farmers - Seed companies/Agro-dealers - Traders/Exporters, - Research organizations and universities - Agro-processors - Extension Agents (Public and Private)
Approaches to be used in dissemination	- Farmer participatory evaluation - On-farm demonstration - Field days - Agricultural shows - Farmer to farmer - Mass Media – e.g. Mkulima programme, Smart Farmer and Seeds of Gold - Extension publications (posters/ brochures/leaflets) - Partners –NGOs
Critical/essential factors for successful promotion	- Production of breeder seed - Seed availability of pre-basic and basic seed, accessibility and affordability - Strong linkage among green gram value chain actors – producers to market - Strong partnership linkages

	- Awareness campaign
Partners/stakeholders for scaling up and their roles	- Extension service providers (Public and private) to help in the technology dissemination - FAO facilitate in the promotion of the technology and linking farmers to market - ICRISAT –technology dissemination - NGOs:–technology dissemination through on-farm demonstrations - KILIMO trust capacity building of farmers and linking farmers to markets and credit facilities - Seed companies -marketing of the technologies - Traders/exporters –marketing of the technology - Processors –For value added products - Public institutions – schools (Providing the market) - County governments –Help in the dissemination of the technology, Linking farmers to external markets
C: Current situation and future scaling up	
Counties where already promoted, if any	Some parts of Makueni, Kitui, and Tharaka Nithi.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	- Lack of breeder seed of yellow grams - Limited seed systems hinder farmers from obtaining seed for new varieties - Unavailability of quality seed and high seed cost - Limited access to rural finance for pulse production - Limited processing technologies at the household level; is mainly known for making stew served with cereal-based meals
Suggestions for addressing the challenges	- Yellow gram breeder seed production - Support informal seed system (community seed bulking) to ensure timely seed availability, access and affordability - Capacity building on Good Agronomic Practices - Participation of stakeholders along the value chain in technology development and on-farm validation - Involvement of credit facility providers in the value chain - Capacity build on value addition
Lessons learned in up scaling, if any	- Partnership is important in technology dissemination and adoption
Social, environmental, policy and market conditions necessary for development and upscaling	- Farmer acceptance and utilization - Favourable weather conditions - Policies for yellow green gram production and utilization - Market information on volume, quality and supply consistency requirements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The basic cost was estimated at KES 53,535/ha
Estimated returns	Total returns under improved management were estimated at KES 100,000/ha and a gross margin of KES 46,445/ha

Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth ‘s limited access to production resources such as land, knowledge, information, extension training, credit and quality seed. • 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 • Limited participation in decision making at the community and County level • Women do most of the green grams activities such as weeding and winnowing. Green gram farming therefore may initially increase their work burden unless there are labour-saving technologies • This heavy workload may limit green grams adoption and scaling up for women farmers who may not afford to hire labour for weeding • Need for mechanization to ease drudgery at harvesting • Women’s double and triple roles means they may not have time to participate in group activities • In some cultures women may not be able to travel away from their homes to meetings, without permission • Not recognizing women as farmers, therefore services and information are not tailored to address their priority enterprises • Women’s time and mobility constraints mean that they may not be able to attend extension activities far from home or held at times when they have other roles • Lower average literacy rates limits women’s use extension material. • Limited access to improved seeds, fertilizer/ manure and other inputs
Gender related opportunities	- The variety is high yielding therefore will lead to increased productivity that will benefit all the gender categories (men, women and the youth) in terms of providing employment - The technology has high international and local demand therefore offers an opportunity for men and the youth who are mostly involved in marketing especially in far markets therefore generating more income - As an early maturing and high yielding variety it will meet the food and nutrition security of all the gender categories in the household
VMG issues and concerns in development, dissemination adoption and scaling up	- Not recognizing VMG’s as farmers, when designing TIMPs such as the farm implements. Therefore, need to come up with tailor made implements that meets the VMG’s needs and concerns - The VMGs have less access to resources such as land and credit

	- VMGs have less access to extension services due to prejudice and their social status - VMGs have Limited access to improved inputs such as seeds, fertilizer/ manure and other inputs - VMGs have less access to markets than the other gender categories - Strict rules of entry and requirements of producers' organizations may limit VMG 's participation - Due to their social status VMGs are often excluded from decision making in development and dissemination activities - VMGs have limited access to education, training and extension services than men - Due to prejudices associated with their social status, VMGs are excluded from access to and benefits from improved technologies
VMG related opportunities	- The technology can improve food and nutrition security and an opportunity for increased income - As an early maturing and high yielding variety it will meet the food and nutrition security of the VMGs in whole household. - It offers a good opportunity for income generation for the VMGs
E: Case studies/profiles of success stories	
Success stories	
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for upscaling 2-requires validation
G: Contacts	
Contacts	The Institute Director, KALRO-Katumani P.O. Box 340-90100, Machakos Email: director.amri@gmail.com Phone: 0710906600
Lead organization and scientists	KALRO, Rael Karimi, David Karanja (KALRO Katumani), Catherine Muriithi (KALRO Embu)
Partner organizations	- World Vegetable Centre - MoALF&I - Seed companies like Dryland Seed Ltd, East African Seed company - FAO - ICRISAT

	- KILIMO trust - East African Grain Council

GAP for further research

1 Need for mechanization to ease the harvesting – Thresher

2 Explore bio-control of insect pests – white flies and aphids

3 Postharvest handling – protection against pests e. g rat-proof cages for protection of hermetic bags

4 Value added green gram based products – formulation of weaner diets

5 Need to improve KAT N22 variety on drought resistance/maturity period

2.2 Green Gram Seed System

2.2.1 TIMP Name	Green gram Own Seed Selection and Production
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Green gram farmers grow green grams from grain harvested from the previous season. This method of recycling of seed leading to mixing and lower yields in subsequent growing seasons as well as loss of quality and originality of the variety.
What is it? (TIMP description)	Own seed selection is a process of identifying and carefully picking quality seed plants before harvesting of the entire crop. Since green gram is self-pollinated crop with a minimal cross pollination, farmers maintain their own variety through proper seed selection method. Own seed selection involves observation of health, true to type plants in the middle of the farm were pollen from other farms cannot reach. The selected plants are then harvested early and well dried. These plants are threshed and the seed stored in a dry, clean well ventilated place for planting next season. Own seed selection should only be practiced on one variety for a maximum of three seasons then the farmer should get certified seed 

Justification	Selection of high quality seeds is a prerequisite for achieving high greengram yields. Planting high quality seed ensures varieties are maintained in a relatively better genetic purity leading to farmers maintaining good seed for longer before they are required to acquire certified seed from seed dealers.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, seed dealers, researchers, Extension service providers.
Approaches used in	On farm and on station research trials and demonstrations
Dissemination	• Training workshops, seminars, meetings • Field days • MoA/Extension officers • Farmer research networks • Farmer to farmer exchange • Mass media – Agricultural program • Promotional materials (posters/brochures/leaflets, manuals) • Web materials
Critical/essential factors for successful promotion	• Development of certified seed systems to backstop own seed selection • Seed availability and accessibility through green gram research • Well organized farmer groups and networks • County and central government support • Funding to research, validate and promote new green gram varieties and seed production
Partners/stakeholders for scaling up and their roles	• KALRO, National Agricultural Research Institutes (NARIs) and International research organizations e.g. The International Food Policy Research Institute (IFPRI) for provision of appropriate variety seed and production information • Seed companies for quality seed multiplication • Market players to create a demand and provide production incentives • Farmers/farmer groups to adopt and produce • County governments, central government e.g. Chiefs, Agricultural Extension (Formal and informal) for policy, awareness and dissemination • NGOs to promote greengram • .Financial institutions e.g. Banks, donors and other credit facilitators for financial solutions
C: Current situation and future scaling up	
Counties where already promoted if any	Tana River , Tharaka Nithi, Kwale, Machakos, West Pokot, Isiolo, Makueni and Kitui
Counties where TIMP will be up scaled	Isiolo, Garrissa, Tana River, Tharaka Nithi, Kitui, Siaya, Makueni, Migori, Homabay,
Challenges in dissemination	• Poor seed distribution networks • Inadequate knowledge on importance of using good quality seed • Financial constraints • Unwillingness of farmers to buy quality seed

Suggestions for addressing the challenges	• Research to develop high yielding superior varieties with quality seed • Information dissemination on importance of using good seed to increase yield • Train farmers on seed selection and facilitate their ability to access seed • Involve county governments, extension, marketers and processors
Lessons learned in up scaling if any	• Creation of awareness through demonstrations and farmer workshops helps in adoption of technologies and innovations • Availability of market is key
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of community awareness on nutritional qualities in food systems • Raise awareness on the soil fertility improvement using greengrams (N-Fixation). • Harmonious gender and social consideration in research, consumption and marketing. • It is an already "a climate smart ready crop" due to its wide adaptation
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 51,800
Estimated returns	KES 39,350(Gross margins)
Gender issues and concerns in development, dissemination, adoption and scaling up	• Women have been having low yields due to poor quality of seeds as they have been using recycled seeds • Green gram production is labour intensive especially in planting, weeding, threshing which are mostly done by women and youth • Land is owned mainly by men who may have not have interest in green gram production • Financial empowerment, the poor farmers lack funds to acquire seed • Slow information and awareness flow to female farmers due to academic levels • The training materials and strategies are not favorable to women farmers • Markets /agro vets for clean seeds may not be available for women and their mobility is limited by their domestic roles
Gender related Opportunities	• There is potential for quality seeds for women improving the quality of crop yields for women • There is increased production of green grams leading to improved incomes for women and youth • The is creation o**f** employment for women and youth

VMG issues and concerns in development, dissemination, adoption and scaling up	• Dissemination methods and documents that are not always easy to understand or access • VMGs have Low access to seed sources • Financial constraints by VMGs to purchase quality seeds • Limited access to production resources such as land, knowledge, information, extension training, credit and quality seed. • Some of the agronomic practices are not easy for VMGs to undertake since they are laborious • VMGs may have limited access to finances to buy the required inputs such as quality seedlings • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to education, training and extension services than men
VMG related opportunities	• Well organized seed systems enable the VMGs to access quality seeds • There is improved quality of green grams hence improved markets • There is increased food security and nutrition for VMGs

E: Case studies/profiles of success stories	
Success stories from previous similar projects	Not Known
Application guidelines for Users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Ready for outscaling
G. Contacts	
Contacts	The Institute Director, KALRO-AMRI Katumani; P.O. Box 340. Machakos Email: cd.katumani@kalro.org Phone: 0711369535, Katumani
Lead organization and scientists	KALRO Rachel Kirimi, Kirigua, V.O., Wasilwa, L.
Partner organizations	KALRO – Perkera, MoAL , Agricultural University Colleges, ICRISAT.

Research Gaps

1. Testing of a well-organized seed production, multiplication and delivery system

2.2.2. TIMP Name	Green gram informal seed system

Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Green gram seed systems are not well established and this has hindered promotion of the crop to the target areas. Promotion of Green gram to farmers in the various counties requires enough seed to reach the targeted number of farmers. The weak Green gram formal seed system has not be able to achieve the quantities
What is it?(TIMP description)	It is a systematic multiplication of basic seed sourced from the formal seed sector into quality seed that more farmers in the community can access and improve their crop production. It involves community seed bulking which is a process of engaging selected individuals or farmer groups to multiply green gram seed under technical supervision following seed multiplication guidelines.
Justification	There is inadequate certified green gram seed to meet demand. Consequently, there need for informal seed system which will involve community seed bulking. Individual farmers or farmer groups are selected to multiply green gram seed under technical supervision of seed companies and KEPHIS. They follow the requisite seed production guidelines to reach more farmers with the available green gram varieties.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, seed companies, seed merchants, researchers, Extension service.
Approaches used in Dissemination	• On farm trials and demonstrations • Training workshops, seminars, meetings • Field days • MoA/Extension officers • Farmer research networks • Lead farmers and farmer groups • Promotional materials (posters/brochures/leaflets, manuals) • Web material's
Critical/essential factors for successful promotion	• Development of robust seed systems to backstop community seed bulking • Availability of early generation seed through research • Well organized farmer groups and networks • County and central government support • Funding for research, validation and promotion of new green gram varieties and seed production

Partners/stakeholders for scaling up and their roles	• KALRO National Agricultural Research Institutes (NARIs) and • International research organizations e.g. The International Food Policy Research Institute (IFPRI)- to provide varieties, seed and production information • Seed companies for quality seed multiplication • Market players to create demand and market pull to stimulate production • Farmers/farmer groups to adopt and produce certified seed under supervision • County governments, central governments e.g. Chiefs, Agricultural Extension (Formal and informal) for policy, awareness and dissemination • NGOs to organize and mobilize farmer groups and assist them acquire seed • Financial institutions e.g. Banks, donors and other credit facilitators for financial solutions
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Makueni, Tharaka Nithi
Counties where TIMP will be up scaled	Machakos, Makueni, Tharaka Nithi, Isiolo, Tana river, Kitui
Challenges in Dissemination	• High cost of inspection (transport, frequency of inspection) • Inadequate knowledge on seed production practices • Unwillingness of farmers to buy quality seed • Low awareness of importance of green gram in most parts of Kenya
Suggestions for addressing the challenges	• Research to develop high yielding superior varieties with quality seed • Information dissemination on importance of using quality seed to increase yield • Train farmers on seed production and empower their ability to access seed • Involve County governments, extension, marketers and processors
Lessons learned in up scaling if any	• Creation of awareness through demonstrations and farmer workshops helps in adoption of technologies and innovations • Availability of seed market to create demand
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on nutritional benefits to human and livestock feed. • The use of green gram as a catch crop • Nitrogen fixing ability of green gram to improve soil quality • Harmonious gender and social consideration in research, consumption and marketing. • It is an already “a climate smart crop” due to its wide adaptation and drought tolerance
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 51,800/acre

Estimated returns	The gross margins under improved management were estimated at KES 39,350/acre
Gender issues and concerns in development ,dissemination, adoption and scaling up	• Women have been having low yields due to poor quality of seeds as they have been using recycled seeds • Green gram production is labour intensive especially in planting, weeding, threshing which are mostly done by women and youth • Land is owned mainly by men who may have not have interest in green gram production • Financial empowerment, the poor farmers lack funds to acquire seed • Slow information and awareness flow of new seed varieties to female farmers due to academic levels • The training materials and strategies are not favorable to women farmers • Markets /agro vets for clean seeds may not be available for women and their mobility is limited by their domestic roles • Men are not fully involved in the production of green grams as it is perceived to be a woman's crop
Gender related Opportunities	• There will be increased production of green grams leading to improved food and nutritional security for women and entire household • There will be increased employment for women and the youth • Women will get appropriate information relating to quality seeds
VMG ssues and concerns In development dissemination, adoption and scaling up	• Dissemination methods and documents that are not always easy to understand or access • VMGs have low access to seed sources due to their limited mobility • VMGs have financial constraints so they are not able to purchase quality seeds • Limited access to production resources such as land, knowledge, information, extension training, credit and quality seed. Some of the agronomic practices are not easy for VMGs to undertake since they are laborious • VMGs may have limited access to finances to buy the required inputs such as quality seeds • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to education, training and extension services than men
Gender related Opportunities	• There will be increased production of green grams leading to improved food and nutritional security for VMGs • There will be increased employment for VMGs • VMGs will get appropriate information relating to quality seeds
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Green gram production has been very successful and economically important in Kitui and Tharaka Nithi counties. It is an important income earner for communities in these counties

Application guidelines for Users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	1. Ready for upscaling 2. Requires validation
G. Contacts	
Contacts	The Institute Director, KALRO-AMRI Katumani; P.O. Box 340. Machakos Email: cd.katumani@kalro.org Phone: 0711369535,
Lead organization and Scientists	KALRO Karimi, R., Kirigua, V.O., Wasilwa, L.
Partner organizations	KALRO – Perkera, MoAL , Agricultural Universities

Research Gaps

1. Validate a well-organized seed production, multiplication and delivery syste

2.2.3. TIMP Name	Green gram Formal seed system
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low grain yields due to use of poor quality green gram seed
What isit?(TIMP description)	Formal seed system is the process of producing quality seed starting from release of varieties, production of early generation seed and certified seed up to the stage where the farmers can access it through seed merchants for planting. The main stakeholders in formal seed systems include breeders, seed companies and retailers among others.
Justification	The selection of quality and high yielding seeds is a prerequisite for improved green gram grain yield. The success of the green gram value chain in Kenya will require the establishment of a strong formal seed system and seed access channels for quality seed to reach the green gram farmers.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, seed stockists, seed merchants, researchers, extension service.
Approaches used in dissemination	• On station research, on farm trials and demonstrations • Training workshops, seminars, meetings • Field days • MoA/Extension officers • Farmer research networks • Lead farmers and farmer groups • Promotional materials (posters/brochures/leaflets, manuals) • Web material's

Critical/essential factors for successful promotion	• Development of good seed systems to backstop community seed bulking and own seed selection • Seed availability and accessibility through green gram research • Well organized farmer groups and networks • County and central government support • Funding for research, validation and promotion of new Green gram varieties and seed production
Partners/stakeholders for scaling up and their roles	• KALRO, Breeders, National Agricultural Research Institutes and • International research organizations e.g. The International Food Policy Research Institute (IFPRI) to provide varieties, seed and production information • Seed companies for quality seed multiplication • KEPHIS for quality control • Market players to create a demand and market pull for production

	• County governments, central governments e.g. Chiefs, Agricultural Extension (Formal and informal) for policy, awareness and dissemination • NGOs to take up green gram promotion Catholic Relief services, for farmer organization and mobilization • Financial institutions e.g. Banks, donors and other credit facilitators for financial solutions
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Makueni, Mbeere, Kajiado
Counties where TIMP will be up scaled	Tana River, Tharaka Nithi, Kitui, Makueni, Machakos,
Challenges in Dissemination	• High cost of inspection (transport, frequency of inspection) • Inadequate knowledge on seed production practices • Unwillingness of farmers to buy quality seed • Low awareness of importance of green gram in most parts
Suggestions for addressing the challenges	• Research to develop high yielding superior varieties with quality seed • Information dissemination on importance of using good seed to increase yield • Train farmers on certified seed production practices and empower their ability to access quality seed • Develop good seed policy for the green gram crop • Involve County governments, extension, marketers and
Lessons learned in up scaling if any	• Creation of awareness through demonstrations and farmer workshops helps in adoption of technologies and innovations • Availability of seed market to create demand
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on nutritional benefits to human and livestock feed. • The use of green gram as a catch crop • Nitrogen fixing ability of green gram to improve soil quality • Harmonious gender and social consideration in research, consumption and marketing. • It is an already “a climate smart crop” due to its wide
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 60,000/acre
Estimated returns	KES 48,000/ha under good management (Gross margins/acre)

Gender issues and concerns in development ,dissemination, adoption and scaling up	• Women have been having low yields due to poor quality of seeds as they have been using recycled seeds • Green gram production is labour intensive especially in planting, weeding, threshing which are mostly done by women and youth • Land is owned mainly by men who may have not have interest in green gram production • Financial empowerment, the poor farmers lack funds to acquire seed
	• Financial empowerment, the poor farmers lack funds to acquire seed • Slow information and awareness flow of new seed varieties to female farmers due to academic levels • The training materials and strategies are not favorable to women farmers • Markets /agro vets for clean seeds may not be available for women and their mobility is limited by their domestic roles • Men are not fully involved in the production of green
Gender related Opportunities	• There will be increased production of green grams leading to improved food and nutritional security for women and entire household • There will be increased employment for women and the youth • Women will get appropriate information relating to
VMG issues and concerns in development, dissemination, adoption and scaling up	• Dissemination methods and documents that are not always easy to understand or access • VMGs have low access to seed sources due to their limited mobility • VMGs have financial constraints so they are not able to purchasequality seeds • Limited access to production resources such as land, knowledge, information, extension training, credit and quality seed. • Some of the agronomic practices are not easy for VMGs to undertake since they are laborious • VMGs may have limited access to finances to buy the required inputs such as quality seeds • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to education, training and extension services

VMG related opportunities	• There will be increased production of green grams leading to improved food and nutritional security for VMGs • There will be increased employment for VMGs • There will be improved food security and nutrition for VMGs especially the sick • The micro-nutrients in green gram are particularly healthy for persons with HIV/AIDS • There will be quality seeds for VMGs to plant.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Green gram production has been very successful and economically important in Kitui county. It is now a major and priority crop in kitui county where it is grown as an export commodity
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Ready for upscaling Requires validation
G. Contacts	
Contacts	The Institute Director, KALRO-AMRI Katumani; P.O. Box 340. Machakos Email: cd.katumani@kalr o.org Phone:
Lead organization and scientists	KALRO Karimi R., Kirigua, V.O., Wasilwa, L.
Partner organizations	MoAL, Agricultural Universities and Colleges

Research Gaps

1. Certified seed production, multiplication and deliveryunder small holder systems

2.3. Good Agricultural Practices and Food Safety Management System

2.3.1 TIMPs name	**Good Agr.icultural Practices (GAP)**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Loss of markets due to threat to environment, worker safety and health due to unverrifiability of application of standardized food safety measures taken along the Green gram value chain. Detection of food contaminants in both fresh produce and cereals, including Green gram, has been rampant. This results in declining food safety and quality, therefore frustrating sustainable farming of these crops for both food and income generation. Most market continue to impose more stringent measures (to ensure safety of consumers) for those wishing to access the said markets. These contaminants also impact negatively on the environment, worker safety and health, and 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.
Justification	Loss of markets due to the rampant detection of food contaminants in Green grams threatens the production of the crop. Good Agricultural Practice (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. 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 actually cover varies widely. Commercialization of Green grams on the domestic and export level highly depends on compliance to these market standards

B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	All value chain players including producers, extension staff, processors, transporters and market outlet operators such as wholesale and retail chains, domestic markets and farm gate handlers
Approaches to be used in dissemination	FFBS On-farm experimentation field days, shows Training of trainers Publications Media Digital platforms
Critical/essential factors for successful promotion	Policy support from government particularly 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) • Mobilization of individual producers for training on GAP • Expertise for training from institutional QMS (Quality Management Systems) and standards officers • They hold franchises from Global GAP international Certifying bodies (eg BVQ, SGS, Africert, KenCert) • Offering certification services to trained producers and prescribing corrective actions • Training Partner MoALID, Council of Governors' and County Governments, AFA, KEPHIS, HCD • Policy framework and operationalization of Commodity codes of conduct requiring GAP compliance and KS 1758 • Legal enforcement particularly from competent authorities NGO's, Private extension providers and other value chain players • Mobilization and organization of producer groups and organizations • Mobilization of farmers Support for the training and support services
C: Current situation and future scaling up	
Counties where already promoted, if any	For other fresh produce crops, already promoted in Meru, Embu, Nyeri, Nyandarua, Muranaga, Embu, Kirinyaga, Kisii, Uasin gishu, Nakuru, Kericho, Bomet and other horticultural hot spots

Counties where TIMP will be up scaled	All counties in Kenya particularly where green grams is grown
Challenges in dissemination	• Inadequate funds to reach value chain actors • New concept not very well known among the primary stakeholders and market outlets • 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 for development and promotion	The GAPs will be acceptable to the target communities 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,	• 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 ▪ There is need for all the stakeholders to be sensitized in GAPs to achieve good profits from their green grams products
Gender related opportunities	• Agro-enterprise development by youth, females and males based on GAPs • Increased income due to improved income as a result of using GAPs by the youth, females and males
VMG issues and concerns in development, dissemination, adoption and scaling up	• 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 organizations • VMGs have less access to farm implements VMGs have limited access credit to meet the cxtra cost of implementing the required GAPs • VMGs have limited access to training on GAPs and extension services • Due to their social status VMGs are often excluded from decision making in development and dissemination of GAPs

	• There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Agro-enterprise development by VMGs based on GAPs • Increased income due to improved yield because of using GAPs, market access for the VMGs • Employment opprtunities in GAP activities for VMGs and improved food security
E: Case studies/profiles of success stories	
Success stories from previous similar projects	This has not been done for Green grams. However, Small, holders in groups in the counties of Kirinyaga, Nyeri, Meru, Nakuru and other counties have been able to produce and export produce that is certified after adopting and complying with GAP's.
Application guidelines for users	• Global GAP Version 6 (Code Ref: IFA V5.2_Feb19; English Version Versionn /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	Ready for up scaling
G: Contacts	
Contacts	• Director, KALRO Seed –Thika info.ptc@kalro.org • Centre Director, KALRO Kandara KALRO.KANDARA@kalro.org • Centre Director, KALRO NSRC KALRO.SERICULTURE@kalro.org • CD FCRI NJORO CD.NJORO@kalro.org
Lead organization and scientists	KALRO: Nyaga A., Ndungu J., Gatambia E.,
Partner organizations	MoALF&I, AFA, FPEAK, FPC, PCPB, AAK, KEPHIS, County governments, NGO's, Universities

2.3.2 TIMP Name	Food Safety Management System: Hazard Analysis Critical Control Points (HACCP) Plan for Green Grams Chain in Kenya
Category (i.e. technology, Innovation or management practice)	Management Practice

A: Description of the technology, innovation or management practice	
Problem addressed	Loss of product market due to risk to human health through presence of chemical, biological and physical hazards within the Green gram value chain in Kenya. have a direct effect on consumer's health. There is increasing demand for high quality of the crop and other products where it is incorporated, from consumers and public health departments in counties. The biological contaminations previously reported on this value chain include presence of *Escherichia coli* (E. coli), *Salmonella* spp., *Aspergillus flavus* and *Aspergillus parasiticus*. The chemical hazards are mainly due to heavy metal presence such as lead/mercury/cadmium; while exceedance of MRLs 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 Green gram 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 Green Gram 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 crop products, from consumers and public health departments in counties. Presence of contaminants in foods pose serious risks to human health and trade. The biological contaminations previously reported in green grams include presence of Escherichia coli (E. coli), Salmonella spp., Aspergillus flavus and Aspergillus parasiticus. Chemical hazards are mainly due to heavy metal presence such as lead/mercury/cadmium; while exceedance of MRLs 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 Green gram value chain. Such tools are used globally and even adapted by Codex Alimentarius as a global acceptable 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	Green gram value chain actors from farmers, traders, food vendors and consumers.
Approaches used in dissemination	FFBS On-farm experimentation Field days, shows

	Training of trainers Publications Media Digital platforms
Critical/essential factors for successful promotion	• Formation of "experts" team composed of HACCP specialists, food scientists, microbiologists, representative of the Green gram (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
Partners/stakeholders for scaling up and their respective roles.	• KALRO, National Agricultural Research Institutes (NARIs) and International research organizations: Support with research on Food safety Matters • Market players, Farmers/farmer groups: Recipients of training and implementers within the value chain • County governments, central governments e.g. Chiefs, Agricultural Extension (Formal and informal) for policy, awareness and dissemination, National competent authorities: Policy development, enforcement, mobilization and dissemination • NGOs/private companies/other public service providers: Farmer organizing and mobilization and support e.g. SACDEP • Analytical testing services by public/private laboratories • Processors and local traders
C: Current situation and future scaling up	
Counties where already promoted if any	• Not promoted in any county of Kenya
Counties where TIMPs will be up scaled	• All counties growing and consuming Green gram in Kenya.
Challenges in development and dissemination	• 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	• Funding of dissemination platforms • Training of all stakeholders on food safety
Lessons learned in up scaling, if any	• None since scaling up has not been done
Social, environmental, policy and market conditions necessary for development and up-scaling	• The practice will be acceptable to target communities • The market will accept and recompense the certified produce • The policy environment will be supportive of the practice, requirements of the system and apprppriate pricing
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	• Women and youth might not be aware of the existing hazards, their preventive measures and control • Women and youth might not be aware of the impact

	identified hazards could have to their health • In harvesting and processing green grams to meet the acceptable national standards, women and youth play critical roles. • Therefore, there is need to build the capacity of women and youth in the identifications of food safety hazards/risks and the control measures along green grams value chain • Women and youth lack finances to implement the sytem
Gender related opportunities	Opportunities exist for women and youth in employment in the activities of the system.
VMG issues and concerns in development, dissemination, adoption and scaling up	• 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 green grams value chain.
VMG related opportunities	• Opportunities exist for VMGs in employment in the activities of the system. • Healthy produce for he household to he benefit of the VMGs
○ **E: Case studies/profiles of success stories**	
Success stories	N/A
Application guidelines for users	• 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)	Ready for up scaling;
○ **G: Contacts**	
Contacts	The Institute Director, FCRI Njoro; Email director.fcrinjoro@kalro.org The Institute Director, KALRO-HRI Thika; E-mail: director.hri@kalro.org Director, KALRO Seeds, E-mail: info.ptc@kalro.org The Centre director, KALRO-Muguga Email: kalro.FCRC@kalro.org The Centre director, KALRO-Kabete; E-mail: cd.narl@kalro.org The Institute director, KALRO-FCRI Kitale; E-mail: director.fcri@kalro.org
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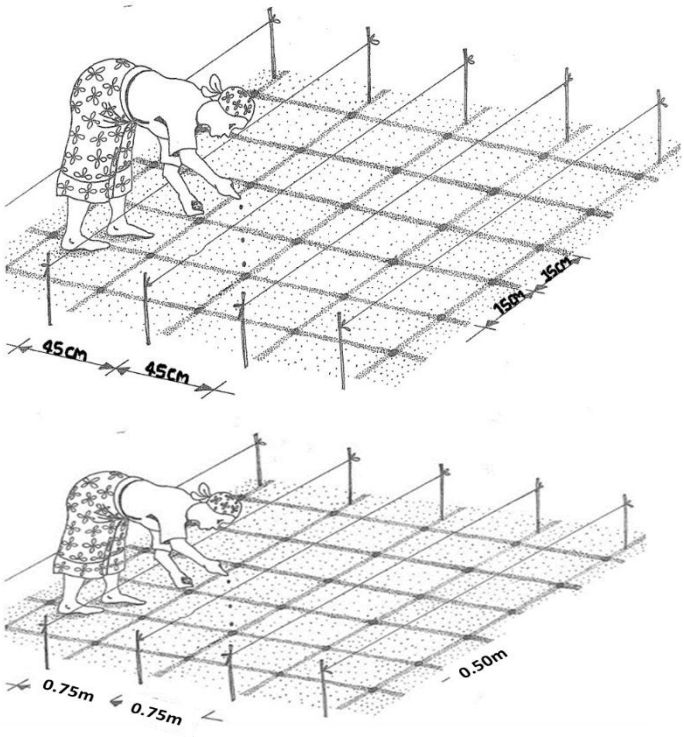
	Dr. Lusike Wasilwa, Crops Director, KALRO Headquarters 2. Mrs. Violet Kirigua, KALRO Headquarters 3. Beatrice Wanjiku, KALRO Njoro
Partner organizations	MoA, AFA, FPEAK, PCPB, AAK, KEPHIS, KEBS, County governments, NGO's and Universities.

2.4. Agronomy

2.4.1 TIMP name	**Plant spacing**
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 due to belo or above optimal crop spacing (leading to low or high plant population per unit area).
What is it? (TIMP description)	Plant spacing is the distance within and between rows at which seeds are planted. Green gram is planted at the soacing of 0.4. m x 0.15m One plant is maintained plant per station. . Over seeding reduces yield lowers quality of grains because of competition for light and nutrients.  A farmer seeding medium maturity (105 – 150 days) green gram variety at 0.45m by 0.15m
Justification	Low green gram grain yield is attributed to poor seed rate among other crop husbandry problems. The most common method of

	planting is dibbling, which is sowing in lines/rows of known spacing. However, some farmers also plant by broadcasting and drilling the seeds which are not gapped (in case of poor emergence) or never thinned (in case of high population). Use of recommended spacing is advantageous as it requires less seed, ensures optimum plant population, high yield and quality grain/seed.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	- Farmers - Research organizations and universities - Extension Agents (Public and Private)
Approaches used in dissemination	- On-farm demonstrations, - Farmer field schools - Agricultural Innovation platforms - Digital platforms - Media - Trainings - Shows/Exhibitions/Field days
Critical/essential factors for successful promotion	- Capacity building on the importance of GAPs
Partners/stakeholders for scaling up and their roles	County government: Link to farmers Extension services Providers mobilise farmers and facilitate engagement with farmers Farmer platforms (farmer groups, AIPs, FFBS, etc): mobilise farmers and facilitate engagement with farmers
C: Current situation and future scaling up	
Counties where already promoted, if any	Machakos
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo and Tana River
Challenges in dissemination	- Inadequate funding of dissemination activities - Limited knowledge on importance of correct crop spacing
Suggestions for addressing the challenges	- Information dissemination of climate smart agriculture - Participation of producers in on-farm activities/extension activities - Promoting awareness among farmers on the importance of climate smart agronomic practices for improved crop productivity
Lessons learned in up scaling, if any	- Alternative method (mechanization - planter) may lessen the work.

	- Capacity building and awareness campaign on climate smart agronomic practices is required
Social, environmental, policy and market conditions necessary for development and up scaling	- Commodity is socially acceptable - Conducive environment for production of green grams - Ability of market to absorb increased productivity - Supportive frameworks and policies are available
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	• Women have limited access to production resources such as land, knowledge, information, extension training, and credit and quality seed. • The Practice is laborious and further burden the already overburdened women.
Gender related opportunities	Both gender can benefit from the increased production and incomes
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited access to production resources such as land, knowledge, information, extension training, and credit and quality seed. • The Practice is laborious and not be amenable to VMGs • The practice will lead to increased green gram production and increased incomes tonthe nbenefit of the VMGs
VMG related opportunities	The increased production will provide VMGs with better income, increased food and nutrition security
E: Case studies/profiles of success stories	
Success stories from previous similar projects	The practice has been adopted by many farmers as part of the Good Agricultural Practices
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling Requires further research (testing for location specific spacing)
Application guidelines for users	Brochures available
G: Contacts	
Contacts	The Centre Director, KALRO-Embu P.O. Box 27-60100 Embu Email: kalro.embu@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO, Micheni, A V. Wasike, E. Njiru, D. Karanja, W. Nasirembe
Partner organizations	County Governments

2.4.2 TIMP name	No-till (zero) tillage
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed:	Decreased crop yields due to soil erosion.
What is it? (TIMP description)	 Green gram sowing holes made on non-ploughed field (left picture); green gram emerging from non-ploughed mulched plot (right picture) No-till, also referred to as zero tillage is a conservation agriculture tillage method whereby seed is planted into holes drilled into the soil of an otherwise undisturbed soil. It is characterized nil soil disturbance during land preparation, sowing and weeding operations. Only seeding or/and fertilizer holes are dug in the field. In case of weeds at sowing time, they are eradicated using non-selective post-emergence herbicides. For weeds occurring after after the crop has emerged, weed are controlled using selective post-emergence herbicides. Alternatively the weeding may be achieved through up-rooting weeds or slashing weed at ground level without soil disturbance. Over 75% of residues is left on the soil surface after the crop harvest.
Justification	Land degradation characerised by declining soil fertility (physical, chemical and health) is a common scenario witnessed by farmers in semi-arid ecologies. The situation leads to low land productivity, crop yields, and whole farm sustainability. At farm level, land degradation is mainly attributed to continuous land operations (ploughing, seeding and weeding) using conventional tools. The approach leads to increased soil erosion, loss of soil carbon and greenhouse gases (GHGs) in the environment. As a conservation agriculture practice, the zero tillage (no-till) has potential to: • Enhance soil fertility and organic matter, and improvement of the efficiency of nutrient inputs, helping to produce more with proportionally less fertilizer. • Reduce GHG emissions from thr soil. • Minimize the net losses of carbon dioxide by microbial respiration and oxidation of the soil organic matter and build soil structure and bio-pores through soil biota and roots

	• Protect the soil surface from direct sun rays and rain drops, winds leading to more moisture being retained in the soil environment. • Reduce soil compaction caused by ploughing implements(s)
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension Agents, Researchers and students
Approaches to be used in dissemination	• FFBS • On-farm experimentation • Demonstrations • Field days/shows/exhibitions • Training of trainers • Publications Media • Digital platforms
Critical/essential factors for successful promotion	• Awareness creation on importance of the practices • Suitability of the TIMP to the agro-climatic and socio-economic condition of the farmer • Accessibility of the TIMP by the farmers • Model demonstrations
Partners/stakeholders for scaling up, their roles and stage of involvement	• County Extension officers - Dissemination of information, capacity building • NGO's (African Conservation Network, One Acre Fund)- Capacity Building, Dissemination of information • CIAT, FAO – capacity building • On-going CA based projects – Capacity building • County Governments - Funding CA activities, support capacity building, enabling environment and supportive policies • Universities- lecturers and students validating other arrangements • Farmer platforms (e.g. AIPs and FFBS) – provide land, security for demonstrations and exploratory trials
C: Current situation and future scaling up	
Counties where already promoted if any	Bungoma, Meru, Embu, Tharaka-Nithi, Laikipia, Kakamega
Counties where TIMP will be scaled	Machakos for green gram production
Challenges in dissemination	• Land tenure (farmers reluctant to invest in CA where they do not have clear land rights) • Inadeeqaute trained personell on CA • Inadequate fund for dissemination activities
Suggestions for addressing the challenges	• Enhance Public Private Partnerships (PPP) to support increased adoption • Improve KALRO and county government capacity to train and re-tool technical team so as to enhance uptake of the technology • Allocate more funds for continued research and dissemination of the TIMP
Lessons learned in scaling if any	• Uptake of CA technology increases with the realized incremental benefits over time

	• Continuous capacity building increases CA technology uptake
Social, environmental, policy and market conditions necessary for development and dissemination	• The practice will be appropriate for and acceptable by target communities • The environment will be suitable and appropriate for implementation of the TIMP • Reliable technology adoption and suitable price and market access for produce under CA • County policies that support households investing in CA with inputs like implements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	• Costs related to ripping services and herbicides amount to KES 6000 per acre.
Estimated returns	• Reduction of costs associated with tillage-induced soil erosion and degradation i.e. 60% of land degradation • Returns on conserving soil exceeding 150 ton/hectare annually and associated increased productivity
Gender issues and concerns in development, dissemination, adoption and scaling up	• Woment may not have access to training and sensitisation for a due to rolse in the household • Reduces labour demands across all gender, hence good for all gender
Gender related opportunities	The Timp may free women from land preparation tasksa and allow them opportunities for other activities
VMG issues and concerns in development, dissemination, adoption and scaling up	• Limited decision making on land use may limit the adoption by VMGs • Limited access to zero tillage implements planting implements may limit the VMGs adoption
VMG related opportunities	• Reduces labour demands across may free VMGs for other income generating activities
E: Case studies/profiles of success stories	
Success stories from previous similar projects	• Wide adoption of the CA principles and practices in Laikipia County, - large and small-scale farmers are using CA in growing different crops. • For approximately 8 year (2010 – 2018), the CA principles were tested, promoted and adopted in some villages of Bungoma, Siaya, Embu and Tharaka-Nithi Counties. This was achieved under ACIAR financial support.
Application guidelines for users	When implementing the 3 principles of CA, one needs to note the following: • Timely operations - preparing the land in good time before the rains start; planting soon after an effective rainfall event; weeding at appropriate times and intervals; doing effective pest and disease control before either spread too widely. • Precise operations - Precise measurements of row and plant spacing, evenness of depth and placement of soil amendments and covering of

	seed are also important. Planting should be done on the same lines each season • Inputs (equipment, seeds, herbicides, manures/fertilizers), use the right inputs, time and source. • Livestock - try to keep livestock out of the fields, even after harvesting the crop. References • Micheni, A. (2015). *Dynamics of Soil Properties and Crop Yields und Conservation Agriculture Practices in a Humic Nitisol, Eastern Ken* Unpublished Ph.D Thesis, Jomo Kenyatta University of Agriculture a Technology (JKUAT), Nairobi. • Okoba, B. (2018), Climate-Smart Agriculture: Training Manual for Agricultural Extension Agents in Kenya. • Esilaba, E.O (2019), KCEP-CRAL CSA Extension Manual • SUSTAINET EA 2010. Technical Manual for farmers and Field Extension Service Providers: Conservation Agriculture. Sustainable Agriculture Information Initiative, Nairobi
F: Status of TIMP readiness (1. Ready for scaling; 2. Requires validation; 3. Requires further research)	1. Ready for scaling 2. To be validated only in areas where it has not reached. 3. Some research may be done on the TIMP on it feasibility in different soil types and climatic ecologies.
G: Contacts	
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Lead organization and scientists	KALRO, Alfred Micheni, Anthony Esilaba and Emirita Njiru
Partner organizations	County government, Private Public Partnerships, FAO, APNI, SIMLESA AIPs, ACIAR, CIMMYT and CIAT.

2.4.3 TIMP name	**Conventional tillage**
Category (i.e. technology, innovation or management practice)	Management practice  Manual land preparation or weeding tools

	   Conventional land preparation methods (tractor ploughing-left picture, oxen-ploughing-centre picture) and manual digging-left picture)
A: Description of the technology, innovation or management practice	
Problem to be addressed:	Low land productivity due to weed competition with a crop and poor distribution of soil nutrients within the crop rooting zone.
What is it? (TIMP description)	Conventional tillage is a land preparation system using cultivation as the major means of seedbed preparation and weed control. Typically includes a sequence of soil tillage (ploughing and harrowing) to provide a fine seedbed for seeding. The system also removes most of the plant residue from the previous crop. Later on after the crop has emerged, weed control is done using conventional tools that digs out weeds which are removed from the farmland. Over 75% of residues is removed from the farm land after the crop harvest. Conventional ploughing is normally done either using oxen or tractor pulled ploughs. The operation can also be done manually using hand tools (jembes, folk jembes and pangas).
Justification	Weed competition with a crop and poor distribution of soil nutrients with the crop rooting zone is one of challenges faced by green gram farmers. This results in reduced land productivity. Conventional land preparation enables to overcome the problem by turning over the upper layer of the soil, bringing fresh nutrients to the surface and burying weed seeds deep in the soil surface. Higher percentage of planted seeds is expected to germinate and emerge from such soil resulting in higher productivity. Convention tillage involve ploughing, harrowing and using heavy tools to dig out weeds from the farmland. Since tillage disturbs the soil, the process may disrupt soil structure, - accelerating surface runoff and soil erosion. Splashed particles clog soil pores, effectively sealing off the soil's surface, resulting in poor water infiltration. Therefore, conventional tillage needs to be combined with management measures that prevent soil erosion and surface crusting.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension Agents, Researchers and students
Approaches to be used in dissemination	• Agricultural shows/Exhibitions/Field days • Media • Meetings (Chief's Baraza) • Exhibitions • Farmer field Schools (FFS) • Field demonstrations • AIPs • Digital platforms • Farmer visits

	• Trainings
Critical/essential factors for successful promotion	• Awareness creation on importance of the practices • Capacity building on the importance of the practices • Accessibility of the TIMP by the farmers training on principles and benefits of CA. • Model demonstrations
Partners/stakeholders for scaling up, their roles and stage of involvement	• County extension officers - Dissemination of information, capacity building • NGO's (African Conservation Network, One Acre Fund)- Capacity Building, Dissemination of information • CIAT, FAO – capacity building and conducting demonstration • On-going CA based projects- to provide/share experiences • County Governments - Funding CA activities, support capacity building, enabling environment and supportive policies • Universities- lecturers and students validating other arrangements or TIMPs. • Farmer platforms (e.g. AIPs and FFBS) – provide land, security for demonstrations and exploratory trials
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
Counties where TIMP will be scaled	Machakos, Isiolo, Taita Taveta, Tharaka Nithi, West Pokot, Baringo and Tana River
Challenges in dissemination	• Limited labour for carrying conventional land preparation operations • Limited funds to fund land preparation (ploughing and harrowing) and weeding • Limited knowledge on the merit and demerit of conventional tillage systems • Limited access to land preparation implements
Suggestions for addressing the challenges	• Enhance Public Private Partnerships (PPP) to support increased adoption • Improve KALRO and county government capacity to train and re-tool technical team so as to enhance uptake of beneficial parts of the technology. • Allocate more funds for further research and dissemination of the TIMP
Lessons learned in scaling if any	• Uptake of conventional land preparation has gone on for years, thus, is taken by majority of farmers • Continuous capacity building on key benefits of the TIMP and on any other appropriate tillage/weeding method(s).
Social, environmental, policy and market conditions necessary for development and dissemination	• Suitability of the TIMP to the agro-climatic and socio-economic condition of the farmer • Reliable technology adoption and suitable price and market access for farm produce. • County policies that support households investing in farming to give supports where necessary.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	

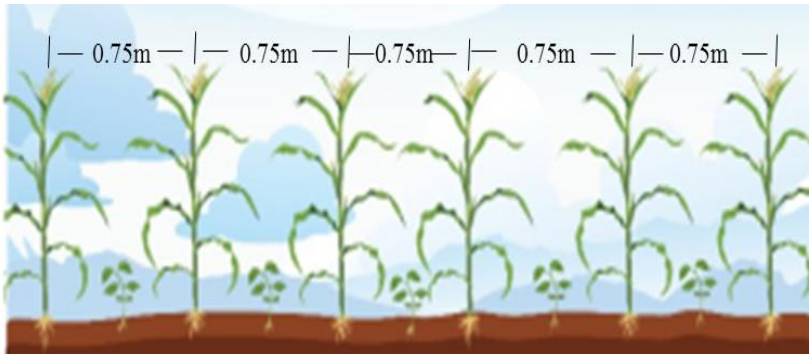
Basic costs	• Costs related to conventional land preparation and weeding amount to KES 15,000 per acre. This is apart from the normal inputs of seed and fertilizer when establishing. But the costs do not reduce over the years.
Estimated returns	• Embarking on the TIMP the farmer may be able to gain up to 20% of the total cost of investment.
Gender issues and concerns in development, dissemination, adoption and scaling up	• If well taken and right tools availed, the TIMP is easily adopted by men, women, youth and vulnerable individuals in the community.
Gender related opportunities	Being a known and widespread technology, conventional tillage renders itself to easy adoption by all in the households. It will even be more appreciated by women, aged and vulnerable members of the community if gender suitable tools are availed through credits, insurances or subsidies.
VMG issues and concerns in development, dissemination, adoption and scaling up	• Limited decision making on land use may limit the adoption of the TIMP by VMGs. • Limited access to conventional tillage inputs such as farming tools, seed and pesticides may limit the TIMP adoption by VMGs.
VMG related opportunities	• Opportunity to for farming "soft loans", insurances and subsidies increased resilience.
E: Case studies/profiles of success stories	
Success stories from previous similar projects	• The conventional tillage TIMP includes some of the key farming practices that for many years have been promoted and adopted by farmers and other stakeholders in agricultural industry.
Application guidelines for users	When implementing conventional tillage systems, one needs to note the following: • Timely operations - preparing the land in good time before the rains start; planting soon after an effective rainfall event; weeding at appropriate times and intervals; doing effective pest and disease control before either spread too widely. • Precise operations - Precise measurements of row and plant spacing, evenness of depth and placement of soil amendments and covering of seed are also important. • Inputs (equipment, seeds, manures/fertilizers), use the right inputs, time and source.
F: Status of TIMP readiness (1. Ready for scaling; 2. Requires validation; 3. Requires further research)	1. Ready for upscaling
G: Contacts	
Contacts	Director

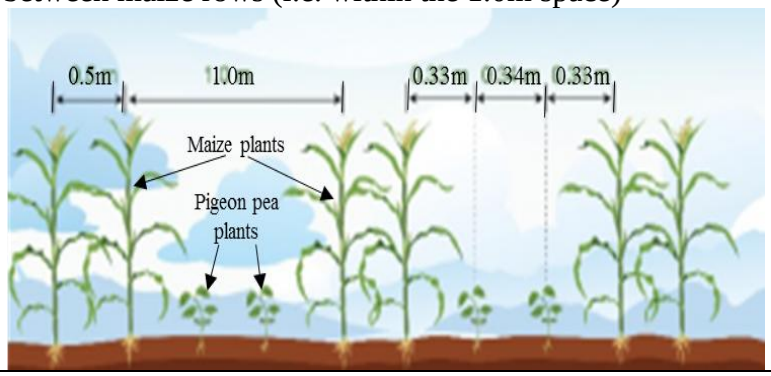
	Environment & Natural Resources KALRO Secretariat
Lead organization and scientists	KALRO, Alfred Micheni, Anthony Esilaba and Emerita Njiru
Partner organizations	County government, Private Public Partnerships, FAO, APNI, CIMMYT, SIMLESA AIPs, ACIAR and CIAT

GAPS

Require further validation by researchers and university students to confirm what may not be clear or on basis of emerging issues e.g. mechanization.

There may be cases for further research because of emerging issues

2.4.4 TIMP name	**Intercropping (also Soil and water conservation technology)**
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problems addressed:	• Low crop yields, hence low farm returns • Declining soil fertility • Soil erosion problems • Weeds infestation – managed using increased soil cover • Vulnerability to crop pests - practice helps slow the proliferation of pests and protect yields
What is it? (TIMP description)	Intercropping is a farming method that involves planting or growing more than one crop at the same time and on the same piece of land. The practice offers a potential to increase yields, enhance soil fertility and minimize the effects of climate change. There are two methods of intercropping: **i. Moja-moja intercropping method:** One green gram row is alternated with that of a cereal (maize), thus referred to as 'moja moja' intercropping system. The spacing for either crop is maintained at 75 cm between rows.  **ii. Mbili Intercropping method.** Two green gram rows are alternated with two cereal (maize) rows, thus referred to as 'mbili intercropping system. The spacing between the two main maize rows is 1.0m, then two green gram rows are equal distance planted

	in-between maize rows (i.e. within the 1.0m space) 
Justification	Climate change is negatively impacting on agricultural production. Farmers are experiencing low yields, crop failures, declined soil fertility and generally low farm returns from their investments. As a semi-arid suited crop, green gram is intercropped with cereal crops such as maize, millet and sorghum. Intercropping is one of the potential management practice of enhancing climate change adaptation. It offers the potential to increase yield, enhance soil fertility and environmental biodiversity. The practice is known to build healthy soils, control pests and harness a variety of benefits to increase yields. The practice encourages biodiversity by providing a habitat for a variety of insects and soil microbes that would not be present in a single-crop environment (sole cropping system). Intercropping has several advantages. First, an intercrop may use resources of light, water, and nutrients more efficiently than single crops planted in separate areas, and this can improve yields and income. Secondly, crop mixtures frequently have lower pest densities, especially of insect pests. This occurs both because the mixture confuses the insects and, if chosen carefully attracts beneficial predators. Finally, intercropping allows for more effective management of cover crops. The practice works very well in regions where land for cultivation is limited. The two common methods of intercropping are the *Moja-Moja* and *Mbili-Mbili* intercropping methods (see illustrations above)
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers and wide range of users in the rural and urban areas
Approaches to be used in dissemination	On-farm and on-station demonstrations, agricultural shows, students and extension service providers
Critical/essential factors for successful promotion	• Awareness creation on the benefits and contribution of the practice to all stakeholders. • Easy access of crop varieties that are compatible with the intercropping systems. • Technical packages describing appropriate schedules of planting intercrops. • Package on fertilizer rates and regimes under the practice.
Partners/stakeholders for scaling and their roles	• County governments – to provide extension services, farmer mobilization and policy formulation • NGOs – to provide support on capacity building and micro-financing services • Universities- lecturers and students validating for other

	arrangements • Farmer platforms (e.g. AIPs and FFBS) – provide land, security for demonstrations and exploratory trials
C: Current situation and future scaling up	
Counties where already promoted	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 other agronomic practices, hence do not fully benefit from the undertaking.
Counties where TIMP will be scaled	Machakos, Isiolo, Taita Taveta, Tharaka Nithi, West Pokot, Baringo and Tana River
Challenges in dissemination	• Limited access and wide distribution of clean planting materials (crop species, varieties feasible for intercropping systems) • Inadequate access of technical materials on the establishment, operations and management of intercrop management practice by farmers • The increased effects of climate change hindering adoption. • Farmer high poverty levels coupled with illiteracy especially in deep rural areas of Kenya.
Suggestions for addressing the challenges	• Enhance access of 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, AIPs and FFBS for demonstrations and wider scaling. • Develop a comprehensive manual on the intercropping practices to guide the farmers during the adoption and implementation processes.
Lessons learned in up-scaling, if any	• The practice is important as a biological pest management. This is where farmers can use trap crops to attract pests or keep them away from the other crop. Therefore, farmers can easily adopt this method to significantly cut down on pesticides input costs • The number of ecological benefits provided by this practice can also accelerate scaling to the other regions. Intercropping promotes interactions between crops and pollinators, thus supporting biodiversity, beneficial pests, and wildlife species. • Intercropping offers diverse source of nutrition, including minerals. This is due presence of more than one crop species in the farming system.
Social, environmental, policy and market conditions necessary	• Socially accepted by both male and female gender categories. • The practice is environmentally friendly as it enhances soil nutrients and biodiversity. • The system controls erosion and minimizes use of pesticides
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 control pest through intercropping
Estimated returns	Dependent on the value chain crops in the intercrop case.
Gender issues and concerns in development, dissemination	• The practice integrates participation of both male and female gender roles during field implementation • The management practice is labour intensive, and may place a higher demand on women labour compared to men.

	• It is important to know the demands of the technology product end users for ease of acceptability • Gender disparities in access to information may impact on adoption decisions. Access to information is a pre-requisite for informed decisions on adoption.
Gender related opportunities	• Intercropping offers good opportunities to both men and women to grow diverse crops for economic gains, nutrition and at the same time offers enhanced biodiversity benefits.
VMG issues and concerns in development, dissemination, adoption and scaling up	Low access to knowledge, technology and innovation information Less access to education and training Some are physically challenged and may not implement the practice efficiently Less access to productive resources e.g. quality seed credit, and land Labour burden increase for the VMGs
VMG related opportunities	Intercropping places emphasis on the importance of using available land space to grow a diverse of food, increase biodiversity, pest management thus the practice is economically viable. The practice can therefore increase food security for the VMGs.
E: Case studies/profiles of success stories	
Success stories	Farmers have reported improved soil conditions, reduced runoff and buildup of nutrient loss, soil moisture retention in the soil and generally an increased crop production following application the practice.
Application guidelines for users	• Intercropping scheme is aimed at improving the overall economics of the farm. It is for this reason any new intercropping idea should first be tested on a relatively small area for evaluations • Observe careful timing of field operations (sometimes necessitating special interventions) to keep competition between the intercropped species in balance • A crop mix that works well in one year may fail the next if weather favors one crop over another. • A mixture of crops with different growth forms or timing of development may make cultivation and use of mulches more difficult and less effective • Planting crops in alternate rows or strips greatly simplifies management and captures some of the benefits of intercropping for pest control • Intercropping poses a special problem for crop rotation. This is because if plants from two families are mixed in the same bed or field, achieving a substantial time lag before replanting either of those families may be difficult • Intercropping requires extra care and effort in planning and maintaining a viable crop rotation.
F: Status of TIMP readiness (1=Ready for scaling: 2=Requires validation; 3=Requires further research	1. Ready for scaling/being scaled 2. May be validated by researchers and university students to confirm what may not be clear or on basis of emerging issues. 3. There may be cases for further research because of emerging issues

G: Contacts	
Contacts	Director Environment & Natural Resources KALRO Secretariat
Lead organization and scientists	KALRO, Alfred Micheni, Anthony Esilaba and Emirita Njiru
Partner organizations	County government, Private Public Partnerships, FAO, APNI, CIMMYT, SIMLESA AIPs, ACIAR and CIAT

2.5. Integrated Soil and Water Management

2.5.1 Technology name	Manure Management
Category (i.e. technology, innovation or management practice)	• Complementary technology
A: Description of the technology, innovation or management practice	
Problem addressed	Land degradation characterized by the declining soil fertility, low yields, increased soil moisture stress, increased soil erosion and poor soil health Poor manure management and handling leading to increased GHG emissions and low quality manure
What is it? (TIMP description)	Manure Management is the optimal, site-specific handling of livestock manure from collection, through treatment and storage up to application to crops (and aquaculture).
Justification	The decline in soil fertility in smallholder system is a major factor inhibiting agricultural development on farms. It is estimated that soils are being depleted at annual rate of 22 kg/ha for nitrogen, 2.5kg/ha for phosphorous, and 15 kg/ha for potassium. Manure plays an essential role in the nutrient cycle where crops grow on land to feed livestock, which in return feeds the land with their manure. Recycling the (macro and micro) nutrients in manure reduces the need for additional fertilizer purchase. In general, adding manure to soils enhances soil fertility and soil health that leads to increased agricultural productivity, improved soil structure and biodiversity. Given the acute poverty and limited access to mineral fertilizers, manure has the potential of providing the limiting nutrients and improving the soil health.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches used in dissemination	Open and field days Exchange visits Demonstration farms

Critical/essential factors for successful promotion	• Training on feeding, management and use of manure • Dissemination approach used to reach target farmers • Model demonstration plots using cereal crops
Partners/stakeholders for scaling up and their roles	County governments, Provide extension services, farmer mobilization and policy formulation ILRI, technical backstopping NGOs – micro financing services
C: Current situation and future scaling up	
Counties where already promoted if any	Tharaka Nithi, Kajiado, Uasin Gishu
Current extent of reach	Though small scale farmers in the counties apply manures and composts on their farms, they do not optimize on usage.
Counties where TIMP will be promoted	Machakos, Bomet, Kericho, Laikipia, West Pokot, Taita Taveta, Nyandarua, Lamu, Tana river, Baringo, Marsabit, Garissa, Siaya, Kisumu
Challenges in dissemination	- Lack of model demonstration farms - Cultural challenges -Lack of interest 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	• Establishment of many demonstration plot 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	- Proper use of manures improves soil fertility - Use of manures enhances crop productivity - Skills in manure preparation, storage and application
Social, environmental, policy and market conditions necessary	Applying manure to soils saves on purchase of inorganic fertilizer, increases crop yield and saves water. Propagation of invasive species when the seed is ingested by the animal and passed to crop field Manure can harbor pathogens which can cause disease outbreaks to livestock Contamination of water sources by leaching of nutrients Organic manures when poorly handled increase GHG emissions. However, IMM provides practices that are able to minimize GHG emissions.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Proper handling of manure needs labour for collecting the manure, building a compost heap, maintaining it and finally transporting and applying it field which take a lot of effort and time

	Using locally available manure/composts saves on purchase of inorganic fertilizer.
Estimated returns	Returns on green gram value chain is high because of the low nutrient status of soils in the growing areas.
Gender issues and concerns in development, dissemination, adoption and scaling up	It is labour intensive in terms of handling and application (often by broadcasting) hence may disadvantage women
Gender related opportunities	Manure is locally available for farm households with keep livestock, hence opportunities available for both men and women.
VMG issues and concerns in development, dissemination, adoption and scaling up	It is labour intensive in terms of handling and application hence may disadvantage VMGs. The VMGs are also resource poor, hence may not have access adequate manures, e.g. need many livestock
VMG related opportunities	Manure is locally available for those farm households with livestock and can build on what they already own
E: Case studies/profiles of success stories	
Success stories	Farmers who adopt manure management practice have reported improved soil health and increased crop yield, and sustainable source of income
Application guidelines for users	The guideline focus on the following areas: - Animal feeds Livestock housing and manure collection Manure storage to preserve nutrient and avoid loses Manure treatment for ease of transport and application in the field Timing of application for maximum utilization by the crop Anaerobic digestion for biogas production Regular analysis of manure to ascertain the quality Manure/Composts take a long time to cure, hence need good planning prior to use
F: Status of TIMP readiness (1=Ready for upscaling: 2=Requires validation; 3=Requires further research	Requires validation
G: Contacts	
Contacts	Director Environment & Natural Resources KALRO Secretariat
Lead organization and scientists	KALRO: A. Esilaba, E. Njiru, A. Micheni and V. Wasike
Partner organizations	County government, Private Public Partnerships

Research gaps

1. Promote manure management complementary technology in counties that have not practiced it.

2. Conduct nutrient budget study on selected farms utilizing manures (including composts).

2.5.3 TIMP name	**Integrated Nutrient Management (INM)**
Category (i.e. technology, innovation or management practice)	Complementary technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low soil organic matter, declining soil fertility and conserving the limited available moisture in crop production.
What is it? (TIMP description)	Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner  Inorganic fertilizers +  Organic manures +  Bio-fertilizers +  Green manures Integrated nutrient management places emphasis on soil fertility status and special management needs, if any, local availability of nutrients resources (organic, inorganic and biological sources), economic conditions of farmers and profitability of proposed INM option. It emphasizes on the importance of using available organic fertilizers and micro-dosing with inorganic rates. This reduces costs from purchase of inorganic fertilizers, improves soil organic matter, fertility, texture and soil moisture retention while at the same time conserving the environment by ensuring nutrient recycling in the farms.

Justification	Soils within the farming system are low in organic carbon, fertility and moisture contents. . Most of the farming systems in KCSAP target project counties are integrated cropping livestock systems. Crop residues are often used for livestock feed and bedding as farmyard manure (FYM) from livestock wastes are used in crop and pasture production. Other than the characteristic slow release of nutrients, the FYM produced is low nutrient quality due to poor management. Incorporating application of FYM with low or half doses of recommended inorganic fertilizers ensures quick availability of nutrients for crop growth and a long time improvement of soil conditions from effects of manure.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches to be used in dissemination	Training in workshops On-farm visits Farmer field schools (FFS) On-farm demonstrations (during FFS)
Critical/essential factors for successful promotion	- Availability of affordable and quality manure and inorganic fertilizers - Take into account variability between farms, in terms of farming goals and objectives, size, labour availability, ownership of livestock, importance of off-farm income; 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	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 if any	Machakos, Busia, Siaya, Kisumu, Kakamega, Tharaka Nithi, Isiolo, Nyeri, Uasin Gishu, Elgeyo Marakwet
Current extent of reach	Practiced in some value chains in the 10 counties above
Counties where TIMP will be promoted	Machakos (some wards), Bomet, Kericho, West Pokot, Taita Taveta, Lamu, Nyandarua, Tana River, Baringo, Marsabit, Garissa, Kajiado, Laikipia
Challenges in dissemination	- Change of mindset in some regions/cultures that organic manures cannot be applied on crops - Misconceptions that chemical fertilizer damage the soils
Suggestions for addressing the challenges	- 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.
Social, environmental, policy and market conditions necessary	- 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 in areas where application of ISFM is non-responsive
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, dissemination adoption and scaling up	The practice integrates participation of male and female gender roles during field activities. Female gender are disadvantaged where application of heavy loads of manure are to be incorporated in the field. Adoption and scaling up of ISFM technologies could be affected by the ownership of the farm that are mainly male owned where the man does not own the technology
Gender related opportunities	Apart from the inorganic fertilizers and good seed, the practice adopts other locally available materials that saves on cost which is good for all gender in the farm household.
VMG issues and concerns in development, dissemination adoption and scaling up	VMGs are physically disadvantaged for a practice that seeks to incorporate manures, etc in the farm. They are also resource poor and may not have the resources to purchase seed and fertilizers as required for successful implementation of the practice.
VMG related opportunities	The technology if well-practiced can increase farm incomes of VMGs by upto 50%.
E: Case studies/profiles of success stories	
Success stories	ISFM successes have been reported in sorghum and millet value chains at Machakos where the productivities have been improved
Application guidelines for users	- Always use well-adapted, disease- and pest-resistant germplasm/seed to make efficient use of available nutrients. - Ensure that good agronomic practices are upheld - For sustainability, lone use of inorganic or organic materials should be avoided.
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 Kabete
Lead organization and scientists	KALRO: A. Esilaba, E. Njiru, A. Micheni and Victor Wasike
Partner organizations	County governments KEFRI

2.5.4 TIMP name	**Integrated Soil Fertility Management (ISFM)**
Category (i.e. technology, innovation or management practice)	Complementary technology

A: Description of the technology, innovation or management practice	
Problem addressed	Declining soil fertility, low organic matter, restoring soil structure and conserving the limited available moisture in crop production.
What is it? (TIMP description)	A set of soil fertility management practices that include the use of fertilizers, locally available organic inputs and improved seed combined to adapt practices to local conditions. The ISFM places emphasis on the importance of using often scarce resources like fertilizer and organic inputs efficiently 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 KCSAP target project counties are derived from some of the oldest land surfaces which, due to weathering and cropping, have low nutrients. Where younger, volcanic soils occur these are inherently richer in nutrients, but may have other soil fertility problems such as fixation of some critical nutrients such as phosphorus. Past management of the soils also 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	Farmers
Approaches to be used in dissemination	Training in workshops On-farm visits Farmer field schools (FFS) On-farm demonstrations (during FFS)
Critical/essential factors for successful promotion	- 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; 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	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 if any	Machakos, Busia, Siaya, Kisumu, Kakamega, Tharaka Nithi, Isiolo, Nyeri, Uasin Gishu, Elgeyo Marakwet
Current extent of reach	Practiced in some value chains in the 10 counties above
Counties where TIMP will be promoted	Machakos (some wards), Bomet, Kericho, West Pokot, Taita Taveta, Lamu, Nyandarua, Tana River, Baringo, Marsabit, Garissa, Kajiado, Laikipia
Challenges in dissemination	- Change of mindset in some regions/cultures that organic manures cannot be applied on crops - Misconceptions that chemical fertilizer damage the soils
Suggestions for addressing the challenges	- 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.
Social, environmental, policy and market conditions necessary	- 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 in areas where application of ISFM is non-responsive
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, dissemination adoption and scaling up	The practice integrates participation of male and female gender roles during field activities. Female gender are disadvantaged where application of heavy loads of manure are to be incorporated in the field. Adoption and scaling up of ISFM technologies could be affected by the ownership of the farm that are mainly male owned where the man does not own the technology
Gender related opportunities	Apart from the inorganic fertilizers and good seed, the practice adopts other locally available materials that saves on cost which is good for all gender in the farm household.
VMG issues and concerns in development, dissemination adoption and scaling up	VMGs are physically disadvantaged for a practice that seeks to incorporate manures, etc in the farm. They are also resource poor and may not have the resources to purchase seed and fertilizers as required for successful implementation of the practice.
VMG related opportunities	The technology if well-practiced can increase farm incomes of VMGs by upto 50%.
E: Case studies/profiles of success stories	
Success stories	ISFM successes have been reported in sorghum and millet value chains at Machakos where the productivities have been improved

Application guidelines for users	- Always use well-adapted, disease- and pest-resistant germplasm/seed to make efficient use of available nutrients. - Ensure that good agronomic practices are upheld - For sustainability, lone use of inorganic or organic materials should be avoided.
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 Kabete
Lead organization and scientists	KALRO: A. Esilaba, E. Njiru, A. Micheni and V. Wasike
Partner organizations	County governments KEFRI

Research Gaps

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

2.5.4 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	• Conventional methods for soil testing are not cheap to farmers, results take long and not reproducible. • Further, conventional methods have not provided solutions for paired soil and leaf testing to determine health of soil and crop simultaneously. • Current methods do not provide a framework for large scale assessment of geo-referenced sampled points using standardized protocols. • Limited access to soil testing services (centralized soil testing laboratories and cost).
What is it? (TIMP description)	• This is a dry method for soil testing using simplicity of light—the interaction of electromagnetic radiation with matter to characterize biochemical composition of a soil and/or plant tissue. • Requires partners involved (ICRAF, iSDA and SoilCares) to work closely with KALRO and county agricultural officers to sensitize farmers to embrace the testing method.

	• This innovation will involve working closely with agronomists to generate specific fertilizer recommendation driven by soil and crop data obtained.
Justification	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.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension officers
Approaches to be used in dissemination	• Farmer visits • Training in workshops • Publicity campaigns done at county levels.
Critical/essential factors for successful promotion.	1. Availability of the necessary equipment for rapid on the spot soil testing. 2. Established rapport between farmers and the technical personnel involved in soil testing. 3. Adequate qualified staff to cover the large number of samples from the target 24 counties before the planting season begins. 4. A well designed storage system for keeping information obtained at farm level including (GPS readings, physical description of the locations, raw measured scanned data, fertilizer recommendation according to crop type suitability) Availability a van to mount the equipment. 5. Farmers must understand, trust, and be willing to act upon the information provided
Partners/stakeholders for scaling up and their roles	• County government extension services; Providing the link to farmers given that agriculture is devolved. • Soilcares; Provides soil scanners technology and capacity building in collaboration with KALRO and ICRAF, • ICRAF and iSDA tests and validates the recommendation 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 farmers
C: Current situation and future scaling up	
Counties where already promoted	Technology has not been promoted though testing has been ongoing in a few counties
Current extent of reach	Minimal reach at Nyeri County
Counties where TIMP will be up scaled	All the 24 KCSAP counties

Challenges in dissemination	• It requires continuous updating methods to improve recommendations. • Lack of awareness on the importance of regular testing of soil quality
Suggestions for addressing the challenges	• Awareness creation, intensive farmer field training (capacity building) • Make the whole process cost efficient. Use of scanners (spectroscopy) and less wet chemistry analysis. • Automated pipelines for updating existing recommendation methods.
Lessons learned in upscaling 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 Sulphur.
Social, environmental, policy and market conditions necessary	• Socially acceptable-brings income, increases food production, nutrition security and family cohesion. • Environmentally friendly-farmers only apply the required amounts of fertilizers. No excess nutrients to contaminate ground and surface water. • Increased productivity will provide supply to the markets • Supporting frameworks/policies are available.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	• Soil testing equipment and consumables, sampling and packaging materials, personnel. The actual costs will be determined upon consultation. • Shipping selected soil and plant materials for further testing and results verification in a certified lab.
Estimated returns	Dependent on the enterprise adopting the service, but estimated at least 30% of current returns and no doubt will be making agronomy great again.
Gender issues and concerns in development, dissemination adoption and scaling up	By bringing services closer to the users saves time and resources to the farmers (men, women and youth).
Gender related opportunities	Offers employment especially for the youth where soil sampling champions will be trained to help the local community in sampling. Retooling of personnel at national and county levels.
VMG issues and concerns in development, dissemination adoption and scaling up	Willingness to adopt and scaling up technology by VMGs given that farmers have not adopted current soil testing services due to distances and costs
VMG related opportunities	This is a TIMP that will bring soil testing services nearer to this group of farmers and therefore is a saving and is also expected to improve productivity.
E: Case studies/profiles of success stories	
Success stories	Has been tested used successfully by other organizations like ICRAF, SoilCares & KESREF.

	It has been adopted at Kenya cane testing centre for checking maturity level and quality of sugarcane.
Application guidelines for users	• A handheld scanner to testing 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 upscaling: 2=Requires validation; 3=Requires further research	2 - Requires validation
G: Contacts	
Contacts	Director, Environment & Natural Resources, KALRO secretariat
Lead organization and scientists	KALRO: A. Esilaba, E. Njiru, A. Micheni and V. Wasike
Partner organizations	County governments in the 24 counties, 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 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 5.5 TIMP name	**Contour bunds**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	The risk of soil erosion and increased run off; low soil water retention capacity in most soils
What is it? (TIMP description)	Contour bunds are stone or earthen walls built across a slope to prevent runoff.

	  Stone wall contour bund Bunds constructed from earth walls Making furrows parallel to the contours ensures that rainfall and runoff are spread evenly over a field. The earthen bund is formed by excavating a channel and creating a small ridge on the downhill side. Thus contour bunds resemble narrow channel terraces commonly referred to as "fanya chini" terraces. The technology is highly suitable for areas with unpredictable rains especially the drought-prone areas (ASALs).
Justification	The impacts of climate change such as low and erratic rainfall continue to threaten agricultural production, food security and livelihoods especially in the ASALs. Contour bunds resemble narrow channel terraces commonly referred to as "fanya chini" terraces. The aim of contour bunds and hedgerows is to concentrate moisture into the ridge and furrow area where the crops are planted by trapping run off water from the catchment area between them. This also decreases the risk of erosion. Plants with higher water requirements, such as peas or beans, can be planted on the higher side of the furrow whereas cereal crops requiring less water, such as sorghum or millet, can be planted on the ridges.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches to be used in dissemination	Approaches to be used in the dissemination include: • On-farm demonstrations during farmer field schools • Training in workshops. • Extension information materials which will be distributed to farmers through farmer groups and the county extension service providers.
Most effective approach	Model farm demonstration
Critical/essential factors for successful promotion	• 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	• 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
Current extent of reach	Practiced extensively among households in Makueni and Machakos especially in the hilly regions
Counties where TIMP will be promoted	Busia, Kisumu, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Machakos, Taita Taveta, Isiolo, Lamu.
Challenge(s) in development and dissemination	• Increased risk of soil erosion if contours are improperly laid out • Labour intensive 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	• Farmers need to be supported with appropriate equipment for preparation of Contour for efficiency and increased output per man hour. • Training youthful farmers to be champions of Contour bunds construction at the Ward level/village level. • Training on site specific designs and construction of contour bunds • Fasttrack land registration
Lessons learned, if any	• Countor bunds ares popular due largely to the rapid benefits they give in terms of improved crop performance. • Existence of well-developed self-help groups can lead to successful soil and water conservation activities. • Conducting well publicized 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	• 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 *contour* preparation. The cost will depend on the land size and the landscape terrain/slope
Estimated returns	The returns depends on the value chain being addressed
Gender issues and concerns in development, dissemination, adoption and scaling up	• Ownership of or access to land may limit women in some regions • Making decisions on land use may limit women in some region where decision making is men dominated • Differing accessibility of the technology and information may disadvantage different gender • The technology is labour intensive hence may disadvantage women and members who cannot procure labour services • Differing accessibility of information between men and women because of gender norms that place access to new information and

	technologies in the hands of male heads will affect adoption and scaling up. • Ownership of or access to land and credit will affect adoption and scaling up.
Gender related opportunities	• Increased agricultural production will increase access to food and income among all gender. • Potential for employment creation - youthful male and women will provide labour during the implementation of the technology.
VMG issues and concerns in development, dissemination, adoption and scaling up	• Limited of access to information may limit the VMG from technology access and use • Limited attendance during awareness and sensitization campaigns due to physical body challenges or insecurity challenges limits use of technologies. • The technology is labour intensive and may be difficult for the VMG to implement in the field. • The labour cost of adopting this technology might be out of reach for the VMGs thus affecting adoption and scaling up. • The technology demands proper training and access to information to enable proper implementation. This might be lacking among the VMGs • Competing priorities and household decisions might hinder adoption and scaling up.
VMG related opportunities	• Application of contour ridge is expected to improve agriculture production thus, more food and income for the VGMs.
E: Case studies/profiles of success stories	
Success stories, if any	Mukethe Mbithi is a member of the Kyungu Mwethya group in machakos "Before making the terraces we didn't have good harvests because the soil was eroded. When we put fertilizer on, 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.
Application guidelines for users	Soil is excavated up-slope of the bund to a depth of 50 cm. Contour bunds should drain in one direction and can be manually or machine constructed. The length of a bund across a slope should be between 400 to 500 m. The height of a bund should be at least 25 cm and have an approximate spacing of 1-2 m. In arid areas, the distance between bunds can be increased to 5-10 m. Hedgerows grown to stabilize bunds should be spaced at 4 to 8 m across the slope. **References**
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 Katumani P.O. Box 340-90100, MAchakos.

	E-mail: director.amri@kalro.org
Lead organization and scientists	KALRO: E. Njiru, A. Esilaba, A. Micheni and V. Wasike
Partner organizations	County Governments extension offices.

GAPS

1. Develop site specific designs for construction – validation in other regions
2. Conduct trade off analysis (economic analysis) of contour bunds as a soil and water management technology in the various AEZs and along specific value chains
3. Develop low cost mechanized tools to ease labor demands in contour construction and maintenance

2.5.6 TIMP name	**Zai Pits**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Unreliable water to sustain a crop as a result of high seasonal rainfall variability leading to total crop failures. Decreased yields leading to food insecurity.
What is it? (TIMP description)	*Zai Pits* are small planting pits typically measuring 15-30 cm in width, 10-20 cm deep and spaced 60-80 cm. *Zai Pits h*arvests and stores water for prolonged crop use. Farmers plant seeds into the pits after filling one to three handfuls of organic material such as manure, compost, or dry plant biomass. The technology is highly suitable for areas with unpredictable rains especially the drought-prone areas (ASALs). It is also suited for reclamation of denuded land
Justification	The impacts of climate change such as low and erratic rainfall continue to threaten agricultural production, food security and livelihoods especially in the ASALs. *Zai Pits* technology has the potential to harvests and store rain water for prolonged crop use. This technology also contributes to improving the management of degraded lands, reducing soil erosion, vegetation loss and biodiversity as well as grains yield.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches to be used in dissemination	Approaches to be used in the dissemination include: • On-farm demonstrations during farmer field schools • Training in workshops. • Extension information materials which will be distributed to farmers through farmer groups, Agrovets and the county extension offices.
Most effective approach	Model farm demonstration

Critical/essential factors for successful promotion	• Availability of labour as the technology is labour intensive. • Farmers and extension service with skills to design and construct Zai pits. • Availability of affordable organic matter i.e manure, compost.
Partners/stakeholders for scaling up and their roles	• County government extension services –delivery of information inputs to farmers. • Community farmer groups – Provide on-farm demonstration plots to hold farmer field schools • NGOs – capacity building, policy support in soil and water conservation issues
C: Current situation and future scaling up	
Counties where already promoted if any	Makueni, Machakos, Tharaka Nithi, Kakamega, Nyeri, Meru
Current extent of reach	Limited adoption because of the costs involved
Counties where TIMP will be promoted	Busia, Kisumu, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Machakos, Taita Taveta, Isiolo, Lamu.
Challenge(s) in development and dissemination	The greatest challenge is that the technology is labour intensive and many farmers may find it difficult to implement at large scale.
Suggestions for addressing the challenges	• Farmers need to be supported with appropriate equipment for preparation of Zai Pits for efficiency and increased output per man hour. • Training youthful farmers to be champions of Zai pits construction at the Ward level/village level.
Lessons learned, if any	The technology has huge potential to increase farmers' resilience especially in ASALs. 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	• 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 • Provide support in the establishment of the Zai pits
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	The main input cost is the labour for *Zai pit* preparation. It is estimated at Ksh 40 to 100 per *Zai Pit*
Estimated returns	One acre of land can provide a total of 30 bags of maize (accommodate 1,778 plant pits each measuring 75 x 75 cm which gives plant population of 16,000.). One *Zai pit* yields a minimum of 1.5 kg of maize
Gender issues and concerns in development, dissemination, adoption and scaling up	• Ownership of or access to land, farming inputs and credit is an important gender issue in the adoption of ZAI pits. • Making decisions on land use, what to grow, expenditures and savings is an important gender consideration in Zai Pits. This may disadvantage women • Differing accessibility of the technology between men and women because of gender norms that place access to new information and technologies in the hands of male heads of households is big gender concern in adoption

	• Ownership of or access to land, farming inputs, information technologies (radios, cell phones) and credit will affect adoption and scaling up.
Gender related opportunities	• Increased agricultural produce will increase access to food and income among women, male and youth. • Youthful male and women will provide labour during the implementation of the technology.
VMG issues and concerns in development, dissemination, adoption and scaling up	• Limited of access to information due to factors like physical disability affects technology access • In attendance during awareness and sensitization campaigns due to physical body challenges or insecurity challenges. • The technology is labour intense and may be difficult for the VMG to implement in the field.
VMG issues and concerns in adoption and scaling up	• The labour cost of adopting this technology might be out of reach for the VMGs thus affecting adoption and scaling up. • The technology demands proper training and access to information to enable proper implementation. This might be lacking among the VMGs • Competing priorities and household decisions might hinder adoption and scaling up. • The technology involves carrying of heavy manure to the field during establishment which may be difficult for the physically weak VMGs.
VMG related opportunities	• Application of ZAI pits is expected to improve agriculture production thus, more food and income for the VGMs.
E: Case studies/profiles of success stories	
Success stories, if any	Two women groups in Kiliki, Matungulu sub-county of Machakos County through a representative Janet Ndunge reported having started using the Zai pit farming technology in 2013 after attending a farming workshop by the Institute for Culture and Ecology (ICE). "Ever since we started using Zai pits, we have seen an increase in our harvests as compared to the conventional methods of farming," she said. Farmers in Kathonzweni, Makueni County increased dug pits from 170 to 500 pits for crop production due to initial observed benefits. Communities in ASALs have also rehabilitated degraded lands and increased production by many folds.

Application guidelines for users	Zai pits are 5-15 cm deep, 15-50 cm wide and 80-100 cm apart (Figure 19). In dry areas the size of planting pits can be enlarged. Compost or manure is placed in the pits before planting to improve soil fertility. It is not necessary to follow the contour when constructing pits. Compost or manure is placed in the pits before planting to improve soil fertility. It is not necessary to follow the contour when constructing pits. Steps to follow in establishing ZAI pits for specific crops are:- *Sorghum and Millet.* The zai pits are during the dry season when labour constraints are minimal. Each pit is 20-30 cm wide, 10-30 cm deep, with the soil from the pit thrown downhill to form a crescent shaped dam. The spacing of the pits within a row, as well as the space between the rows of pits varies between 60 and 100 cm. At the beginning of the rains, 200-600 g of dung or compost (two handfuls of organic matter are approximately 300 g) are added to the pits. The organic matter is mixed, in the bottom of the hole, with approximately 5 cm soil. Each pit is then sown with 8-12 millet or sorghum seeds. *Maize.* While growing maize in Zai pits in Kenya, did circular or square holes 30 cm deep. A square hole measuring 75 x75 x 30 (cm) will accommodates nine maize plants. The top soil is mixed with farm yard manure at the ratio of 4:1 and returned. Manure ratio can be reduced while growing maize in Zai pits in Kenya depending on soil quality and use of artificial fertilizers. **References**
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 Katumani P.O. Box 340-90100, MACHAKOS. E-mail: director.amri@kalro.org
Lead organization and scientists	KALRO: A. Esilaba, E. Njiru, A. Micheni and V. Wasike.
Partner organizations	County Governments extension offices.

GAPS

1. Validation of the economic viability of the technology in counties where it has never been used.

2.5.7 TIMP name	**Bench terraces**
Category (i.e. technology, innovation or management practice)	Technology

A: Description of the technology, innovation or management practice	
Problem addressed	The risk of soil erosion and increased run off; low soil water retention capacity in most soils
What is it? (TIMP description)	Bench terraces consist of a series of beds which are more or less level running across a slope at vertical intervals, supported by steep banks or risers (walls or bunds). The flat beds created by bench terraces enable the cultivation of crops on medium to steep slopes. The technology is highly suitable for Semi-arid to humid regions of rainfall, 700 mm or more; medium to steep slopes (12- 47%) (Bench terraces are not recommended for slopes less than 12%); soil depth of greater than 50 cm; and areas with no gullies, nor stones.  Bench terraces in Mbooni, Makueni County, Kenya
Justification	Agricultural production is threatened in many parts of the Kenya by soil erosion and limited soil moisture. Conservation of soil and moisture through construction of terraces has led to better and more reliable crop yields especially in the ASAL counties of Kenya.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches to be used in dissemination	Approaches to be used in the dissemination include: • On-farm demonstrations during farmer field schools • Training in workshops. • Extension information materials which will be distributed to farmers through farmer groups and the county extension service providers.
Critical/essential factors for successful promotion	• 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	• 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 West Pokot
Current extent of reach	Practiced widely among households in Kakamega, Nyeri and Meru

Counties where TIMP will be promoted	To be validated in Busia, Kisumu, Bomet, Kericho Lamu.
Challenge (s) in dissemination	• 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	• 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, if any	• 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 well publicised 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	• 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 *Bench terrace* preparation. The cost will depend on the land size, labor costs and the landscape terrain/slope
Estimated returns	The returns depends on the value chain being addressed
Gender issues and concerns in development, dissemination, adoption and scaling up	• Making decisions on land use may limit specific gender • Differing accessibility between men and women because of gender norms places access to new information and technologies in the hands of male heads of will affect adoption and scaling up. • Ownership of or access to land and credit will affect adoption and scaling up.
Gender related opportunities	• Increased agricultural production will increase access to food and income among all gender. • Both men and women will provide labour during the implementation of the technology.
VMG issues and concerns in development and dissemination	• The labour cost of adopting this technology might be out of reach for the VMGs thus affecting adoption and scaling up. • The technology demands proper training and access to information to enable proper implementation. This might be lacking among the VMGs

	• Lack of access to information will limit the VMG accessing and adopting the technology • Competing priorities and household decisions might hinder adoption and scaling up.
VMG related opportunities	• Application of bench terraces is expected to improve agriculture production thus, more food and income for the VGMs.
E: Case studies/profiles of success stories	
Success stories, if any	Mukethe Mbithi is a member of the Kyungu Mwethya group in machakos "Before making the bench terraces we didn't have good harvests because the soil was eroded. When we put fertilizer on, 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.
Application guidelines for users	Terraces draining in one direction should be at least 100m or more. The length can be slightly increased in arid and semi-arid regions. The width of the bench (flat part) is determined by soil depth, crop requirements, and tools to be used for cultivation. Optimum width of terrace benches ranges from 2.5 to 5 m for manually constructed ones and from 3.5 to 8 m for machine built and tractor-cultivated ones. Terraces should drain runoff along the horizontal gradient of the slope, either in outward or reverse direction. The outward gradient can range from 0.5% in arid or semi-arid regions to 3% in humid regions with clay soils. Maximum gradients can be 5% for reverse terraces. In high rainfall areas (more than 1000 mm annually), it is necessary to make additional drainage provisions off the terraces – although this has a risk of causing erosion on very steep slopes. These additional drainage channels should be trapezoidal in shape and planted with grass to prevent erosion. Machine construction is possible on slopes of 12-36% while manual construction can be used on slopes of 12-47%.
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 Katumani P.O. Box 340-90100, MACHAKOS. E-mail: director.amri@kalro.org
Lead organization and scientists	KALRO: E. Njiru, A. Esilaba, A. Micheni and V. Wasike
Partner organizations	County Governments extension offices.

2.5.8 TIMP name	**Fanya juu terraces**
Category (i.e. technology,	Technology

innovation or management practice)	
A: Description of the technology, innovation or management practice	
Problem addressed	The risk of soil erosion and increased run off; low soil water retention capacity in most soils
What is it? (TIMP description)	*Fanya juu* terraces (juu is Swahili word for 'up') are constructed by excavating soil and throwing it up-slope to make an embankment. The embankment forms a runoff barrier and the trench (ditch) is used to retain or collect runoff. The embankments are usually stabilized with fodder grasses. Crops, such as bananas, pawpaws, citrus and guava, are grown in the ditches. Through gradual redistribution of soils within the field, the terraces level off.  Laying out *"Fanya juu"* terraces  *"Fanya juu"* terraces The technology is highly suitable in low annual rainfall areas (less than 700 mm); moderate slopes (less than 20%); deep soils (more than 60 cm); and hilly areas that are subject to widespread erosion.
Justification	The impacts of climate change such as low and erratic rainfall continue to threaten agricultural production, food security and livelihoods especially in the ASALs. Agricultural production is threatened in many parts of the Kenya by soil erosion and limited soil moisture. Conservation of soil and moisture through construction of terraces has led to better and more reliable crop yields especially in the ASAL counties of Kenya.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches to be used in dissemination	Approaches to be used in the dissemination include: • On-farm demonstrations during farmer field schools • Training in workshops. • Extension information materials which will be distributed to farmers through farmer groups and the county extension service providers.
Critical/essential factors for successful promotion	• 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	• 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
Current extent of reach	Practiced in many parts of Makueni, Machakos, Tharaka Nithi, Kakamega, Nyeri, Meru, especillay among households with steep sloppy land
Counties where TIMP will be promoted	Busia, Kisumu, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Machakos, Taita Taveta, Isiolo, Lamu.
Challenge(s) in development and dissemination	• Increased risk of soil erosion if terraces are improperly laid out • Labour intensive 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	• Farmers need to be supported with appropriate equipment for preparation of terraces for efficiency and increased output per man hour. • Training youthful farmers to be champions of fanya juu terraces construction at the Ward level/village level. • Training on site specific designs and construction of fanya juu terraces • Fasttrack land registration
Lessons learned, if any	• Fanya juu terracing is popular due largely to the rapid benefits it gives in terms of soil and water conservation. • Existence of well-developed self-help groups can lead to successful soil and water conservation activities. • Conducting well publicised 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	• 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 *terrace* preparation. The cost will depend on the land size and the landscape terrain/slope
Estimated returns	The returns depends on the value chain being addressed
Gender issues and concerns in development, dissemination, adoption and scaling up	• Ownership of or access to land may limit women in implementing the technology • Limited decision making power on land use may limit women in accessing and adopting the technology • Differing accessibility of the technology and information may disadvantage women and in some instances men • Limited access to credit will affect adoption and scaling up among women.
Gender related opportunities	• Increased agricultural production will increase access to food and income among all gender.

	• Youthful male and women will provide labour during the implementation of the technology.
VMG issues and concerns in development and dissemination	• Limited access to information will limit access to information and adoption • Limited decision making power on land use may limit VMG in accessing and adopting the technology • May not be in attendance during awareness and sensitization campaigns due to physical body challenges or insecurity challenges. • The technology is labour intense and may be difficult for the VMG to implement in the field. • The labour cost of adopting this technology might be out of reach for the VMGs thus affecting adoption and scaling up. • The technology demands proper training and access to information to enable proper implementation. This might be lacking among the VMGs
VMG related opportunities	• Application of contour ridge is expected to improve agriculture production thus, more food and income for the VGMs.
E: Case studies/profiles of success stories	
Success stories, if any	Over 50,000 smallholder farmers in lower eastern counties of Kenya are recording a more than doubling of yields and reduced soil erosion after embracing a soil conservation scheme that involves digging of trenches in hillside to trap runaway water and soil.
Application guidelines for users	The 'fanya juu' trench is 60 cm wide by 60 cm deep, and the bund 50 cm high by 150 cm across. In arid regions the trenches can be enlarged to 100 cm deep and 150 cm wide. Distance between bunds can be from 5 m on steep slopes to 20 m on gentle slopes. Stone terrace walls can be built to reinforce the bunds on very steep slopes to allow surplus water to pass between the stones without damaging the terrace. Excess water can be drained from the trenches using cut-off drains.
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 Katumani P.O. Box 340-90100, MACHAKOS. E-mail: director.amri@kalro.org
Lead organization and scientists	KALRO: E. Njiru, A. Esilaba, A. Micheni and V. Wasike.
Partner organizations	County Governments extension service.

2.5.9 TIMP name	**Tied ridges**
Category (i.e. technology,	Technology

innovation or management practice)	
A: Description of the technology, innovation or management practice	
Problem addressed	Crop water stresses in production; Increased water losses in the furrows
What is it? (TIMP description)	Tied ridges are small earthen ridges, 30 cm high, with an upslope furrow which accommodates water between the ridges.  Tied ridges  Green gram in Tied ridges Technology consist of water flowing down the small trenches/furrows running parallel and infiltrates into crop root zones. Water is applied to the top end of each furrow and flows down the crop field under the influence of gravity.
Justification	With limitations in soil moisture due to decreasing rainfall occasioned by climatic changes, tied ridges helps conserve soil moisture. In combination with furrow irrigation, the technology has potential to improve agricultural productivity and increase crop yields and cropping intensities. As a result, household food security, incomes and livelihoods are enhanced.
Region promoted	Tana River, Garissa, and West Pokot counties
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers
Approaches used in dissemination	Demonstrations; Farmer field schools
Critical/essential factors for successful promotion	• Proximity to water sources - close to permanent water sources • Suitable topography of area (level land) • Technical capacity for maintenance
Partners/stakeholders for scaling up and their roles	• County government – capacity building • Private sector – access to credit, capacity building • NGOs (Kenya Red Cross (KRC), Action Aid, World Vision, and OXFAM) – capacity building, credit facilities, facilitate technology access • National Irrigation Board – technology access and capacity building • Water Resources Management Authority – Water resources use management
C: Current situation and future scaling up	
Counties where already promoted if any	Makueni, Machakos, Tharaka Nithi, Kakamega, Nyeri, Meru
Current extent of reach	Practiced in many regions with soil moisture deficit or low rainfall levels

Counties where TIMP will be promoted	Busia, Kisumu, Bomet, Kericho Tharaka Nithi, West Pokot, Nyeri, Machakos, Taita Taveta, Isiolo, Lamu.
Challenges in dissemination	• Can be labour intensive during establishment phase • Poor management may lead to water use inefficiencies • Limited access to credit may limit uptake • Land tenure insecurity in some counties limits adoption and investments
Recommendations for addressing the challenges	• Enhancing farmers' capacity to see benefits • Enhance access to credit • Implement policy on land use and tenure
Lessons learned	• Use of tied ridges with furrow irrigation significantly increases yields • Poor management and designs may often result in flooding of low areas • Assessment of soil erosion and sediment is key to sustainability
Social, environmental, policy and market conditions necessary	• The economics of furrow irrigation needs to be well articulated • Enhanced land quality control to mitigate against soil salinity • Adequate policies and guidelines regarding water abstraction from the main water sources to minimize resource conflicts especially along river downstream. • Market for the crops produced under irrigation should be identified early enough to minimize losses and increase profitability from the system
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not known
Estimated returns	Not known
Gender issues and concerns in development, dissemination, adoption and scaling up	Being labour intensive, there is likelihood for male dominance hence development prototypes benefit specific gender
Gender issues and concerns in development, dissemination, adoption and scaling up	• Gender differences in access to credit will limit technology uptake and utilization • Construction is labor intensive, there is likely for male dominance • Gender differences in access to credit will limit technology access, development and uptake
Gender related opportunities	Opportunities for women and youth to increase income through application of technology in production of specific value chains that favor them
VMG issues and concerns in development and dissemination	• Adequate planning and apportioning of space in the irrigation system is necessary with special consideration for VMG to empower their opportunities • The cost can hinder the rapid adoption by the VMGs due to high poverty levels.
VMG related opportunities	VMGs can make business arising from the increased yields from furrow fields.
E: Case studies/profiles of success stories	
Success stories	There are successful model for such technology i.e. Mwea and Perkerra irrigation schemes where furrow irrigation systems have provided

	opportunities for local community to produce high value crops. A sound understanding of the roles and responsibilities of farmers and water user associations is a feature of successful system.
Application guidelines for users	• Sijali I V. Drip irrigation: options for smallholder farmers in eastern and southern Africa. 2001. RELMA Technical Handbook Series 24. Nairobi, Kenya: Regional Land Management Unit (RELMA), Swedish International Development Cooperation Agency, (Sida). 60 p. + x p.; includes bibliography • FAO CSA Manual • FAO Irrigation Water Management: Irrigation Manual • GoK MoALFI: Training Manual for Water Users Association and farmers
F: Status of TIMP readiness (1. Ready for upscaling; 2. Requires validation; 3. Requires further research)	1. Ready for upscaling
G: Contacts	
Contacts	Director Environment & Natural Resources KALRO Secretariat
Lead organization and scientists	KALRO: A. Esilaba, E. Njiru, A. Micheni, V. Wasike and I. Sijali
Partner organizations	National Irrigation Board (NIB), Water Resources Management Authority

Gaps

1. The economic viability of the technology in different agro-ecological zones

2.5.10 TIMP name	**Conservation Agriculture (CA)**
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed:	Land degradation characterized by the declining soil fertility, low yields, increased soil moisture stress, increased soil erosion and loss of biodiversity
What is it? (TIMP description)	Conservation agriculture is an approach to farming which can sustainably increase crop yields. The various practices that make up this approach follow key principles that target to conserve the soil, soil moisture, and soil-nutrients, and stabilise land production while reducing production costs. Conservation agriculture principles are: 1. Minimal soil disturbance

	 Minimum tillage 2. Permanent ground cover - maintenance of a mulch of carbon-rich organic matter covering and feeding the soil (e.g. straw and/or other crop residues including cover crops)  Permanent soil cover 3. Crop rotation or sequences and associations of crops including trees, which could include nitrogen-fixing legumes  Crop diversification
Justification	Land productivity is decreasing leading to decreased yield. Continuous land operation continues to emit more GHGs (Carbon) responsible for the climatic changes. Conservation agriculture (CA) has potential to: • Enhance management of soil fertility and organic matter, and improvement of the efficiency of nutrient inputs, helping to produce more with proportionally less fertilizer. • Rotations and crop associations that include legumes are capable of hosting nitrogen-fixing bacteria in their roots; this contributes to optimum plant growth without increased GHG emissions induced by fertiliser production • Avoidance of tillage minimises occurrence of net losses of carbon dioxide by microbial respiration and oxidation of the soil organic matter and builds soil structure and biopores through soil biota and roots

	• The protective soil cover of leaves, stems and stalks from the previous crop shields the soil surface from heat, wind and rain, keeps the soil cooler and reduces moisture losses by evaporation • Helps to reduce soil compaction and plough pans and regenerates degraded lands
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension Agents, Researchers
Approaches to be used in dissemination	Agricultural shows, Mass media, Chief's Baraza, Exhibitions, Farmer field Schools (FFS), On-farm and on-station demonstrations, Field Days, Extension Officers
Critical/essential factors for successful promotion	• Training on principles and benefits of CA • Model demonstration using crops
Partners/stakeholders for scaling up, their roles and stage of involvement	• County Extension officers - Dissemination of information, capacity building • NGO's (African Conservation Network, One Acre Fund)- Capacity Building, Dissemination of information • CIAT, FAO – capacity building • County Governments - Funding CA activities, support capacity building, enabling environment and supportive policies
C: Current situation and future scaling up	
Counties where already promoted if any	Bungoma, Meru, Embu, Tharaka Nithi, Laikipia, Kakamega
Current extent of reach	Practiced in several counties but among very few households due to various constraints
Counties where TIMP will be upscaled	Bungoma, Meru, Embu, Tharaka Nithi, Laikipia, Kakamega, Machakos, Makueni
Challenges in dissemination	• Non-availability of crop residue in suitable quantities • Competition for crop residues with other uses like wood fuel and livestock • Land tenure (farmers reluctant to invest in CA where they do not have clear land rights) • Limited knowledge on the incremental benefits of CA • Limited access to CA implements
Suggestions for addressing the challenges	• Enhance Public Private Partnerships (PPP) to support increased production and market access • Improve KALRO and 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 of CA with agroforestry
Lessons learned in upscaling if any	• Uptake of CA technology increases with the realized incremental benefits over time • Continuous capacity building increases CA technology uptake

Social, environmental, policy and market conditions necessary for development and dissemination	• Develop Integrated Herbicide Management Plan – pre-emergence and post-emergence herbicides • Reliable technology adoption and suitable price and market access for produce under CA • Continuous capacity building of the community on the benefits of CA technology • County policies that support households investing in CA with inputs like implements
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Costs related to ripping services and herbicides amount to KES 5000/acre. This is apart from the normal inputs of seed and fertilizer when establishing. But the costs of reduce over the years, while the returns increase
Estimated returns	• Reduction of costs associated with tillage-induced soil erosion and degradation i.e. 40% of land degradation • Returns on conserving soil exceeding 150 ton/hectare annually and associated increased productivity
Gender issues and concerns in development, dissemination, adoption and scaling up	• CA with trees is a management practice that that can be easily adopted by women • Reduces labor demands across all gender, hence good for all gender • Land ownership is mainly by men therefore reducing wider adoption • Women are usually left out of decision making thereby reducing uptake
Gender related opportunities	CA with agroforestry provides opportunities for Small Medium Enterprises (SMEs) e.g. tree nurseries. The technology therefore renders itself to easy adoption by women
VMG issues and concerns in development, dissemination, adoption and scaling up	• Limited decision making on land use may limit the adoption by VMGs • Limited access to CA inputs like planting implements may limit the VMGs adopting
VMG related opportunities	• Opportunity to run SMEs such as tree nurseries for increased resilience
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Farmers and agro-pastoralists who adopt the technology have had sustainable source of income and increased resilience
Application guidelines for users	When implementing the 3 principles of CA, one needs to note the following Timely Operations - preparing the land in good time before the rains start; planting soon after an effective rainfall event; weeding at appropriate times and intervals; doing effective pest and disease control before either spread too widely. Precise Operations - Precise measurements of row and plant spacing, evenness of depth and placement of soil amendments and covering of seed are also important. Planting should be done on the same lines each season Inputs – Equipment, seeds, herbicides, manures/fertilizers – use the right inputs

	Livestock - try to keep livestock out of the fields, even after harvesting the crop. References • Okoba, B. (2018), Climate-Smart Agriculture: Training Manual for Agricultural Extension Agents In Kenya. • Esilaba, E.O (2019), KCEP-CRAL CSA Extension Manual • SUSTAINET EA 2010. Technical Manual for farmers and Field Extension Service Providers: Conservation Agriculture. Sustainable Agriculture Information Initiative, Nairobi
F: Status of TIMP readiness (1. Ready for upscaling; 2. Requires validation; 3. Requires further research)	1 Ready for upscaling
G: Contacts	
Contacts	Director Environment & Natural Resources KALRO Secretariat
Lead organization and scientists	KALRO: A. Micheni, A. Esilaba, E. Njiru and V. Wasike
Partner organizations	County government, Private Public Partnerships

Gaps

1. Identification of the most suitable diversified crop rotations and suitable crops for biomass for the different counties.
2. Development of suitable CA implements/field equipment prototypes.
3. Capacity building on the benefits and operationalization of Conservation Agriculture systems – both among extension and technical staff, and at decision-making levels:

2.5.11 TIMP name	**Multiple cropping (Intercropping)**
Category (i.e. technology, innovation or management practice)	Complementary technology
A: Description of the technology, innovation or management practice	
Problem addressed:	• Decreased yields, hence low farm returns • Declining soil fertility, hence soil degradation • Soil erosion problems - runoff are minimized • Weeds infestation – manage using increased soil cover crops • Vulnerability to crop pests - practice helps slow the proliferation of pests and protect yields
What is it? (TIMP description)	

	 Intercropping is the growing of two or more crops in close proximity (in the same row or bed, or in rows or strips that are close enough) for biological interaction. It also includes the growing of two or more cash crops together. The practice offers the potential to increase yields, enhance soil fertility and minimize the effects of climate change.
Justification	Climate change is negatively impacting agricultural productions. Farmers are experiencing low yields, crop failures, declined soil fertility and generally low farm returns from their investments. Intercropping is one of the potential management practice of enhancing climate change adaptation. It offers the potential to increase yield, enhance soil fertility/biodiversity and minimize the effects of climate change. The practice is known to build healthy soils, control pests and harness a variety of benefits to increase yields. Intercropping of compatible plants encourages biodiversity by providing a habitat for a variety of insects and soil organisms that would not be present in a single-crop environment. The practice have several advantages. First, an intercrop may use resources of light, water, and nutrients more efficiently than single crops planted in separate areas, and this can improve yields and income. Secondly, crop mixtures frequently have lower pest densities, especially of insect pests. This occurs both because the mixture confuses the insects and, if chosen carefully attracts beneficial predators. Finally, intercropping may allow more effective management of cover crops.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers and wide range of users in the rural and urban areas
Approaches to be used in dissemination	Demonstrations, Agricultural shows and Extension services
Critical/essential factors for successful promotion	• Awareness creation on the benefits and contribution of the practice to all stakeholders. • Easy access of crop varieties that are compatible with associated crops planned for intercrop. • Technical packages describing appropriate schedules of planting intercrops. • Package on fertilizer rates and regimes under the practice.
Partners/stakeholders for scaling up	• County governments – to provide extension services, farmer mobilization and policy formulation

and their roles	• NGOs – to provide support on capacity building and micro-financing services
C: Current situation and future scaling up	
Counties where already promoted	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 upscaled	All the 24 KCSAP Counties
Challenges in dissemination	• Limited access and wide distribution of clean planting materials (intercrop varieties) • Inadequate access of technical materials on the establishment, operations and management of intercrop management practice by farmers • The increased effects of climate change hindering adoption. • Farmer high poverty levels coupled with illiteracy especially in deep rural areas of Kenya.
Suggestions for addressing the challenges	• Enhance access of 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 in up-scaling, if any	The practice is very important in pest management. Farmers can use a trap crop to attract pests, keeping them away from the main crop. Therefore, farmers can easily adopt this method to significantly cut down on pesticides input costs The number of ecological benefits provided by this practice can also accelerate up scaling. Intercropping promotes interactions between crops and pollinators, thus supporting biodiversity and wildlife species.
Social, environmental, policy and market conditions necessary	• Socially accepted by both male and female gender. • The practice is environmentally friendly as it enhances biodiversity, controls erosion and minimizes use of pesticides
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 control pest through intercropping
Estimated returns	Dependent on the value chain intercrop
Gender issues and concerns in development, dissemination	• The practice integrates participation of both male and female gender roles during field implementation • It is important to know the demands of the technology product end users for ease of acceptability

	• Gender disparities in access to information may impact on adoption decisions. Access to information is a pre-requisite for informed decisions on adoption.
Gender related opportunities	Intercropping 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	The technology can be practiced using locally available and low cost materials and hence enhances adoption by the vulnerable and marginalized farmers/users. However, for optimized benefits, the availability of the required inputs like clean planting materials and appropriate fertilizers can be a challenge to these vulnerable group of people.
VMG related opportunities	Intercropping places emphasis on the importance of using available land space to grow a diverse of food, increase biodiversity, pest management thus the practice is economically viable. The practice is available and cost effective to the advantage of VMG.
E: Case studies/profiles of success stories	
Success stories	Farmers have reported improved soil conditions, reduced runoff and nutrient loss, soil moisture retention in the soil and generally an increased crop production following application of this widely used and readily available management practice.
Application guidelines for users	• Intercropping scheme is aimed at improving the overall economics of the farm. It is for this reason any new intercropping idea should first be tested on a relatively small area for evaluations • Observe careful timing of field operations (sometimes necessitating special interventions) to keep competition between the intercropped species in balance • A crop mix that works well in one year may fail the next if weather favors one crop over another. • A mixture of crops with different growth forms or timing of development may make cultivation and use of mulches more difficult and less effective • Planting crops in alternate rows or strips greatly simplifies management and captures some of the benefits of intercropping for pest control • Intercropping poses a special problem for crop rotation. This is because if plants from two families are mixed in the same bed or field, achieving a substantial time lag before replanting either of those families may be difficult • Intercropping requires extra care and effort in planning and maintaining a viable crop rotation.
F: Status of TIMP readiness (1=Ready for upscaling: 2=Requires validation; 3=Requires further research	Requires validation and further research

G: Contacts	
Contacts	Director Environment & Natural Resources KALRO Secretariat
Lead organization and scientists	KALRO: E. Njiru, A. Micheni A. Esilaba and V. Wasike
Partner organizations	County governments, KCEP-CRAL project

Gaps

1. Major information gaps on intercropping performances in specific areas of Kenya. For example there hasn't been much research on optimal levels of fertilizer use for intercropping sorghum and peanuts in some areas – the need for site specific validation.
2. Little information on the interactions of various crop intercrops especially in the arid and semi-arid areas (ASALs).
3. Limited knowledge on resource-use efficiency particularly in regions with impoverished soils (ASALs) and economies where measured benefits is greatest.

2.6 Green Gram Diseases

2.6.1 TIMP name	Integrated Management of Rust disease of green grams
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to crop damage by the disease
What is it? (TIMP description)	Integrated management of Rust consists of several approaches applied in an integrated manner to break the disease cycle. These include: cultural management and chemical control. **Cultural management options**: • Plant early using certified seeds. • Practice crop rotation with non-legumes for a period of 2-3 seasons. • Uproot and destroy severely affected plants, including weeds and volunteer crops by deeply burying them. • Do not walk through your field during wet weather to prevent the spread of the disease from one plant to another. • Ensure that field sanitation and hygiene practices are adhered to by collecting and safely disposing infected plants by deeply burying them. **Chemical control options**: • Spray copper based products such as copper oxychloride (cuprocaffaro micro 37.5 at a rate of 50 gm/20 litres water or Isacop 50WP at a rate of 60 g/20 litres of water) once initial symptoms are observed.

	 **Bean rust** (*Uromyces phaseoli*) (Source; Ruth Amata, KALRO)
Justification	Rust is a major challenge in green gram production in Kenya, occurring in all major production areas. The disease is severe because the pathogen produces abundant spores which cover leaves reducing the plants photosynthetic area. This causes significant yield loss both in terms of quantity and quality. Integrated Disease Management is an environmental friendly approach to disease control which enables the alleviation of yield loss due to disease damage.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Farmers, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural Innovation Platforms
Critical/essential factors for successful promotion	• Strong partnership linkages • Carry out Applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices. • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	KALRO to continually undertake research in disease management KEPHIS to ensure seedling quality is maintained PCPB to promote registration of fungicides for disease management

	Farmers/farmer groups to adopt the technologies County governments, central governments for development of enabling policies and create awareness. Financial institutions to provide credit facilitators. Extension service providers (public and private) to help in the dissemination. CGIAR's NGOs: technology dissemination through on-farm demonstrations; capacity building of farmers
C: Current situation and future scaling up	
Counties where already promoted, if any	All counties with agro-ecological settings suitable for green gram production
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated disease management practices • Few farmer groups • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders.
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Dissemination of integrated disease management practices and safe use of pesticides
Lessons learned in up scaling, if any	• Adoption of good agricultural practices by the producers is key in management of the disease. • Chances of successful scaling are higher when many value chain stakeholders collaborate in an innovation platform • Partnership is important in dissemination and adoption of the management practice and this can be facilitated through innovation platforms. • More than one approach is used in management of major diseases. • IDM is environment friendly and the chemical option should be used as the last resort • Participatory, farmer-centered approaches, which encourage farmers to participate in the innovation process and the facilitation of experimentation among farmer communities in the evaluation of the technology enhances technology adoption.
Social, environmental, policy and market conditions necessary for development and up scaling	• Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices

	• Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain. • Regulatory bodies e.g. PCPBP, KBS to ensure fungicides sold to farmers are genuine and of high quality • Producers willing to adopt the disease 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.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**19,200/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 60% (**43, 200/=)**. Therefore, the estimated returns will be **72,000-43, 200= 28,800/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to agro-vets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge • Women might have limited knowledge on integrated management of rust disease
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production leading to stable markets for green gram
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited access to productive resources such as land, credit and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access agro-vets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due to lack of awareness
VMG related opportunities	The management practice can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-

Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800, Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	ICRAF, CABI, KEPHIS, FPEAK, Olivado Company, Extension service providers, CGIAR's, NGOs, County governments

2.6.2 TIMP name	**Integrated Management of anthracnose disease of green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss and low grain quality due to disease
What is it? (TIMP description)	Integrated management of anthracnose encompasses the use of various approaches in management of the diseases and are applied during pre-harvest stage. They include: cultural management, deployment of tolerant varieties and chemical control. **Cultural practices**: • Use certified seeds • Practice crop rotation with non-legumes. • Work in uninfected parts of the field first before the infected area. • Avoid unnecessary movement in infected areas to minimize spread of the disease, disinfect farm implements after working from one field before proceeding to the other. • Hot water treatment of grains at 54º for 10min. **Grow tolerant varieties**: • Grow varieties that are less susceptible to the disease such as BGS-9, TM-98-50 and TM-97-55.

	Chemical management: • Applying fungicides from flower-bud formation stage until when pods are fully developed. The most susceptible stage is bud-formation, flowering period and early pod development. • Spraying Carbendazim 500g or Mancozeb 2kg/ha soon after the appearance of disease and repeat after 15 days. • Spraying other fungicides such as Copper based fungicides e.g. Cuprocaffaro WP, Trifloxystrobin + Tebuconazole based fungicides e.g Nativo 300 SC or Carbendazim based fungicides e.g. Rodazim SC in strict adherence to manufacturer's instructions.  **Anthracnose on pods** (Source: Lusike Wasilwa, KALRO)
Justification	Anthracnose causes up to 40% grain losses and reduces market quality of green grams in Kenya. Losses occasioned by the diseases lead to reduced returns for the farmers and negatively impacts on food and national security of the country.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Farmers, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural Innovation Platforms

Critical/essential factors for successful promotion	• Carry out Applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	KALRO to continually undertake research in disease management KEPHIS to ensure seedling quality is maintained PCPB to promote registration of fungicides for disease management Farmers/farmer groups to adopt the technologies County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators • CGIAR • NGOs: technology dissemination through on-farm demonstrations; capacity building of farmers
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Farmers are not receptive to cultural methods of managing diseases e.g. Crop rotation is difficult to implement for farmers with small land holdings and limited economic resources. • Limited knowledge by farmers on integrated disease management practices • Few farmer groups • Lack of green gram Innovation Platforms to facilitate interaction of farmers with relevant stakeholders
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Dissemination of integrated disease management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Adoption of good agricultural practices by the producers is key in management of the diseases • 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 • More than one approach is used in management of the disease. • IDM is environment friendly and the chemical component should be used judiciously as the last resort

	• Participatory, farmer-centered approaches, which encourage farmers to participate in the innovation process and the facilitation of experimentation among farmer communities in the evaluation of the management practice enhances adoption
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. PCPBP, KBS to ensure fungicides sold to farmers are genuine and of high quality • Producers willing to adopt the disease 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. • Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**18,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 40% (**28,800/=)**. Therefore, the estimated returns will be **72,000-28,800= 43,200/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to agro-vets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge • Women might have limited knowledge on integrated management of anthracnose
Gender related opportunities	• Opportunities for youth employment in implementing IDM protocols • Opportunities in marketing pest traps
VMG issues and concerns in development, dissemination adoption and scaling up	The management practice reduces production costs therefore VMG's can afford to produce green grams
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-

Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling
G: Contacts	
Contacts	Centre Director KALRO Kabete, P.O. Box 14733 00800 NBI cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisys., Nzioki C., Rael Karimi Harun Odhiambo
Partner organizations	Extension service providers, ICRAF, CABI, KEPHIS, FPEAK, FAO, NGOs

Research Gaps:

1. Explore Bio-control option for pests and diseases
2. Explore the use of ITK's in disease management

2.6.3 TIMP name	**Integrated Management of powdery mildew disease of green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss of between 21% due to green gram infection by the disease
What is it? (TIMP description)	Integrated management of powdery mildew consists of several approaches applied in an integrated manner to break the disease cycle. These include: cultural management and chemical control. **Cultural management options**: • Plant early using certified seeds. • Practice crop rotation with non-legumes for a period of 2-3 seasons. • Uproot and destroy severely affected plants, including weeds and volunteer crops by burying them deeply. • Do not walk through your field during wet weather to prevent the spread of the disease from one plant to another. • Ensure that field sanitation and hygiene practices are adhered to by collecting and disposing infected plants by deeply burying them.

	Chemical management options: • Spraying copper based products such as copper oxychloride (cuprocaffaro micro 37.5 at a rate of 50 gm/20 litres water or Isacop 50WP at a rate of 60 g/20 litres of water) once initial symptoms are observed.  **Powdery mildew** (*Erysiphe polygoni*) (Source; Daniel Mutisya KALRO)
Justification	Powdery mildew disease is a major challenge in green gram production in Kenya, occurring in all major production areas. The disease is severe because the pathogen produces abundant spores which cover leaves reducing the plants photosynthetic area. This causes significant yield loss both in terms of quantity and quality. Integrated Disease Management is an environmental friendly approach to disease control which enables the alleviation of yield loss due to disease damage.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Exporters, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, seminars and meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms

Critical/essential factors for successful promotion	• Undertake applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices. • Have well organized farmer groups and networks. • Strong partnership linkages • Need for farmer involvement helps generate locally specific techniques and solutions suitable for their particular farming systems and integrating control components that are ecologically sound and readily available to them e.g. Use of Indigenous Traditional Knowledge (ITK) can be promoted and adopted faster. • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• KALRO to continua undertaking research in disease management • KEPHIS to ensure the quality of seedlings is maintained • PCPB to promote registration of fungicides for management of the disease and regulate the use of pesticides • Farmers/farmer groups to adopt these technologies • County governments, central governments develop enabling policies and create awareness. • Financial institutions to provide credit facilitators • Private pesticide companies to promote and sell registered pesticides
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated disease management • Limited number of extension staff • Limited green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders. • Farmers may not implement some of the practices e.g. Crop rotation small farms and limited economic resources.
Suggestions for addressing the challenges	• Disseminate and promote integrated disease management practices and safe use of pesticides • Establish spray teams/champions • Support extension services • Training on integrated disease management practices (use of clean seed, field sanitation, crop rotation, biological control, tolerant varieties and use of ITK's) in managing the disease.
Lessons learned in up scaling, if any	• Successful scaling up is possible if diverse value chain stakeholders collaborate in an innovation platform

	• Adoption of good agricultural practices by the producers is key in management of the diseases • More than one approach is used in management of major diseases • IDM is environment friendly and the chemical component should be used as the last resort • Participatory, farmer-centered approaches, which encourage farmers to participate in the innovation process and the facilitation of experimentation among farmer communities in the evaluation of the technology enhances technology adoption • IDM approaches are knowledge intensive and location-specific, farmers would need to understand the agro-ecological processes affecting the disease to be able to make informed decisions on how to manage crop to avoid disease occurrence, as well as how to manage the diseases once they become a problem.
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. PCPBP, KBS to ensure fungicides sold to farmers are genuine and of high quality. • Farmers' willingness to adopt the disease management practices • Farmers are organized in groups to ensure that management practices are effectively up-scaled • Farm input costs are within the reach of farmers. • Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**23,000/=**
Estimated returns	If the farmer doesn't apply the TIMP yield will be reduced by 21% (**15,120/=)**. Therefore, the estimated returns will be **72,000-15,120= 56,880/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to agro-vets as they sometimes cannot travel to far markets due to their domestic roles

	• Women have less access to agricultural information, technology and knowledge • Women might have limited knowledge on integrated management of powdery mildew
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production leading to stable markets for green gram
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access agro-vets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due to lack of awareness
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Some of the management options are ready for upscaling 2-Some management options require validation e.g the performance of new varieties need to be established across the counties
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	ICRAF, CABI, KEPHIS Extension service providers, CGIAR, NGOs

Research Gaps:

1. Explore Bio-control options for the disease
2. Explore the use of ITKs in disease management at different stages of the disease

2.6.4 TIMP name	**Integrated Management of *Cercospora* leaf spot disease of green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Yield loss of up to 95% due to infection of green gram by the disease
What is it? (TIMP description)	Integrated disease management for Cercospora leaf spot comprises of the use of cultural management practices, deployment of tolerant varieties and chemical control in the management of the disease in green gram. **Cultural practices**: • Practice good field sanitation and hygiene practices by collecting and safely disposing infected plants. • Regular weeding **Grow tolerant varieties**: • Grow varieties that are less susceptible to the disease such as LGG-460. **Chemical management**: • Spray Mancozeb 2kg/ha or Carbendazim 500 g/ha.  **Powdery mildew** (*Erysiphe polygoni*) (Source; Daniel Mutisya KALRO)
Justification	Integrated Disease Management enables the alleviation of yield loss due to green gram damage by Cercospora leaf spot disease which is a major challenge in green gram production in Kenya.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Farmers, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, seminars, meetings • Field days

	• Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages • Farmer involvement will be necessary for successful implementation of the IDM package. • Use of Indigenous Traditional Knowledge (ITK) can be promoted and adopted faster. • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• Extension service providers (public and private) to help in the dissemination • CGIAR's • NGOs: technology dissemination through on-farm demonstrations; capacity building of farmers • County governments-Help in the dissemination of the technology
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated pest management • Few farmer group organizations • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Hold mass campaigns to create awareness on integrated disease management practices and safe use of pesticides
Lessons learned in up scaling, if any	• Establish green gram innovation platforms • Foster more Partnership in technology dissemination and adoption through innovation platforms • Adoption of good agricultural practices by the farmers in management of diseases

Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. PCPBP, KBS to ensure pesticides being used by farmers are genuine and are of high quality • Farmer's willingness to adopt the disease management practices • Farmers are organized in groups to ensure that management practices are effectively up-scaled • Farm input costs are within the reach of farmers. • Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**23,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 95% (**68,400/=)**. Therefore, the estimated returns will be **72,000-68,400= 3,600/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• The management practice reduces the production costs and therefore women can afford to produce green grams • IDM protocols will not overburden any gender in implementation and are therefore has potential for adoption by both gender.
Gender related opportunities	• Opportunities for youth employment in implementing IDM protocols • Opportunities in marketing fungicides
VMG issues and concerns in development, dissemination adoption and scaling up	The management practice reduce the production costs therefore VMG's can afford to produce green grams
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	**References:** Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1-Ready for upscaling, 2-	Ready for upscaling

requires validation, 3-requires further research)	
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	Extension service providers, ICRAF, CABI, KEPHI, FPEAK, FAO, NGOs

Research Gaps:

1. Explore Bio-control options for disease
2. Explore the use of ITKs in disease management

2.6.5 TIMP name	**Integrated Management of Yellow Mosaic disease of green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to infection of green gram by the disease
What is it? (TIMP description)	Integrated management of Yellow Mosaic disease of green grams consists of various approaches that help to break the disease cycle. They include cultural management and chemical control. Yellow Mosaic disease of green grams is associated with insect infestations that transmit the pathogen while sacking sap from plant tissues. The disease is effectively managed by controlling insect infestations **Cultural practices**: • Use of certified seed • Monitoring insect vectors that transmit the viruses • Avoiding work on fields when wet to prevent spread • Uprooting weeds that could serve as alternative hosts • Increase the seed rate (25 kg/ha). **Use of resistant varieties** • Grow resistant green gram variety like Pant Moong-3, Pusa Vishal, Basanti, ML-5, ML337, PDM-54 and Samrat **Chemical management**: • Treat the seeds with Thiomethoxam-70WS or Imidacloprid-70WS @4g/kg • Spray Thiamethoxam-25WG @ 100g or Imidacloprid 17.8% SL @ 100 ml in 500 lit of water.

	• Get other control products from the PCPB (www.pcpb.or.ke) list of registered pest control products, and use them according to the manufacturer's instructions.  Yellow Mosaic disease of green grams (Source; Green gram farming. www.apnikheti.com)
Justification	Integrated Disease Management is an environmental friendly approach that enables the control of the disease through control of vectors and cultural practises that prevent on farm spread hence reducing yield loss.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmers
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, seminars, meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Carry out Applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management

	• Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated pest management • Limited number of Extension agents • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Farmers may not implement some of the practices e.g. Crop rotation small farms and limited economic resources.
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Dissemination of integrated disease management practices and safe use of pesticides in green gram production • Dissemination of agronomic practices • Training on integrated disease management practices (use of clean seed, field sanitation, crop rotation, biological control, tolerant varieties and use of ITK's) in managing the disease.
Lessons learned in up scaling, if any	• Establish green gram innovation platforms • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Adoption of good agricultural practices by the producers is key in management of the diseases
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. PCPBP, KBS to ensure fungicides sold to farmers are genuine and of high quality. • Farmer's willingness to adopt these disease management practices • Farmers are organized in groups to ensure that management practices are effectively up-scaled • Farm input costs are within the reach of farmers. • Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	

Basic costs	**19,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 40% (**28,800/=)**. Therefore, the estimated returns will be **72,000-28,800= 43,200/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• The management practices reduce the production costs and therefore women and youth can afford to produce green grams • IDM protocols will not overburden any gender in implementation and therefore have potential for adoption by both gender.
Gender related opportunities	- Opportunities for youth employment in implementing IDM protocols - Opportunities in marketing fungicides
VMG issues and concerns in development, dissemination adoption and scaling up	The management practices reduce the production costs therefore VMG's can afford to produce green grams
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	**Reference:** Mbeyagala K. E., Amayo R., Obuo J. P., Pandey A. K., War A.R. and Nair R. M. 2017. A manual for mung bean (green gram) production in Uganda. National Agricultural Research Organization (NARO), 32 pages. Esilaba, A.O. et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo

Partner organizations	Extension service providers, ICRAF, CABI, CGIAR's, NGOs, County governments

Research Gaps:

Explore bio-pesticide options for insect vector management

Explore the use of ITKs in disease management

2.6.6 TIMP name	**Integrated Management of halo blight disease of green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to disease
What is it? (TIMP description)	Integrated management of halo blight consists of various approaches that help to break the disease cycle. They cultural management and chemical control. **Cultural practices**: • Use of certified seed • Practicing crop rotation with non-legume crops for 3-4 years. • Uprooting and destroying infected plants/volunteers by burying deeply. • Disinfecting farm tools in jik solution (50 ml:litre) • Avoidance of working in wet fields will be validated **Chemical management**: • To suppress the disease, spray copper oxychloride (cuprocaffaro micro 37.5 at a rate of 50gm/20litres water or Isacop 50WP at a rate of 60g/20litres of water) • Get other control products from the PCPB (www.pcpb.or.ke) list of registered pest control products, and use them according to the manufacturer's instructions.

	 **Halo blight disease of green grams** (Source; Ruth Amata, KALRO)
Justification	Integrated Disease Management is an environmental friendly approach that enables the control of the disease through control of vectors and cultural practises that prevent on farm spread hence reducing yield loss.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmers
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Carry out Applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness.

	• Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated disease management • Limited number of extension agents • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Farmers may not implement some of the practices e.g. Crop rotation small farms and limited economic resources.
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Dissemination of integrated disease management practices and safe use of pesticides in green gram production • Dissemination of agronomic practices
Lessons learned in up scaling, if any	• More than one approach is used in management of major diseases • IDM is environment friendly and the synthetic chemical component should be used as the last resort • Participatory, farmer-centered approaches, which encourage farmers to participate in the innovation process and the facilitation of experimentation among farmer communities in the evaluation of the technology enhances technology adoption • IDM approaches are knowledge intensive and location-specific, farmers would need to understand the agro-ecological processes affecting the disease to be able to make informed decisions on how to manage crop to avoid disease occurrence, as well as how to manage the diseases once they become a problem. This will require a capacity building on crop monitoring and ecological principles.
Social, environmental, policy and market conditions necessary for development and up scaling	• Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**19,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by

	40% (**28,800/=)**. Therefore, the estimated returns will be **72,000-28,800= 43,200/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as credit • Women and youth have limited access to pest management training and extension services • Due to their social status women and youth are often excluded from decision making in development and dissemination activities • Youth applying synthetic pesticides should always wear Personal Protective equipment (PPE)
Gender related opportunities	• Young male and female youth may be employed to monitor (disease scouting) and identification. • Spraying of green gram to control halo blight will create employment opportunities for young male youths
VMG issues and concerns in development, dissemination adoption and scaling up	The management practices reduce the production costs therefore VMG's can afford to produce green grams
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	**Reference** Mbeyagala K. E., Amayo R., Obuo J. P., Pandey A. K., War A.R. and Nair R. M. 2017. A manual for mungbean (greengram) production in Uganda. National Agricultural Research Organization (NARO), 32 pages.
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	Extension service providers, ICRAF, CABI, CGIAR

Research Gaps:

Explore the use of ITKs in disease management

2.6.7 TIMP name	Integrated Management of bacterial leaf blight disease of green grams
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to infection of green gram by the disease
What is it? (TIMP description)	Integrated management of Bacterial leaf blight comprises the use of cultural management practices and chemical control in its management. **Cultural practices:** • Crop rotation with non-legumes for a period of 2 to 3 seasons • Rogueing out infected plants from the farm and burying then deeply. • Avoidance of working in the fields when plants are wet to minimize spread. • Disinfecting farm tools in jik solution (50 ml: litre). • Practicing good field sanitation and hygiene practices by collecting and disposing infected plants. **Chemical management:** • To suppress the disease, spray copper oxychloride (cuprocaffaro micro 37.5 at a rate of 50gm/20litres water or Isacop 50WP at a rate of 60g/20litres of water) • Get other control products from the PCPB (www.pcpb.or.ke) list of registered pest control products, and use them according to the manufacturer's instructions.  Bacterial leaf blight of green grams Source; Courtesy of EcoPort, J.W. Sheppard (http://www.ecoport.org

Justification	Bacterial leaf blight disease is a major challenge in green gram production in Kenya, occurring in all major production areas, but being more severe in some regions. It causes significant yield loss because it causes death of tissues, hence limiting the ability of the plant to photosynthesize. Integrated Disease Management is an environmental friendly approach that enables the control of the disease and cultural practises that prevent on farm spread hence reducing yield loss.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Farmers, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages • Need for farmer involvement helps generate locally specific techniques and solutions suitable for their particular farming systems and integrating control components that are ecologically sound and readily available to them e.g. Use of Indigenous Traditional Knowledge (ITK) can be promoted and adopted faster. • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	

Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	Farmers may not implement some of the practices e.g. Crop rotation small farms and limited economic resources.
Suggestions for addressing the challenges	Training on integrated disease management practices (use of clean seed, field sanitation, crop rotation, biological control, tolerant varieties and use of ITK's) in managing the disease.
Lessons learned in up scaling, if any	• More than one approach is used in management of major diseases • IDM is environment friendly and the synthetic chemical component should be used as the last resort • Participatory, farmer-centered approaches, which encourage farmers to participate in the innovation process and the facilitation of experimentation among farmer communities in the evaluation of the technology enhances technology adoption • IDM approaches are knowledge intensive and location-specific, farmers would need to understand the agro-ecological processes affecting the disease to be able to make informed decisions on how to manage crop to avoid disease occurrence, as well as how to manage the diseases once they become a problem. This will require a capacity building on crop monitoring and ecological principles.
Social, environmental, policy and market conditions necessary for development and up scaling	• Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**19,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 40% (**28,800/=)**. Therefore, the estimated returns will be **72,000-28,800= 43,200/=**

Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to agro-vets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge • Women might have limited knowledge on integrated management of green gram bacterial leaf blight.
Gender related opportunities	• Opportunities for youth employment in implementing IDM protocols • Opportunities in marketing pesticides
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access agro-vets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due to lack of awareness
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	**Reference:** Mbeyagala K. E., Amayo R., Obuo J. P., Pandey A. K., War A.R. and Nair R. M. 2017. A manual for mung bean (green gram) production in Uganda. National Agricultural Research Organization (NARO), 32 pages. Esilaba, A.O. et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling

G: Contacts	
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Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	Extension service providers, CGIAR, CABI, ICRAF

Research Gaps:

1. Explore Bio-control option for insect vector
2. Explore the use of ITKs in disease management

2.6.8 TIMP name	Integrated Management of root rot disease of green grams
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to disease
What is it? (TIMP description)	Integrated sooty mold management consists of various approaches that help to break the disease cycle. They cultural management and chemical control. Sooty mold is associated with insect infestations that excreta sugary excreta which provides sugars for fungal growth on the plant. Disease is effectively managed by controlling insect infestations **Cultural practices**: • Crop rotation with non-legumes for 6-8 seasons • Practising field hygiene. • Avoidance of excessive watering when irrigating, • Avoid surface run off as it spreads the pathogen to non-infected areas • Uprooting inffected plants and burying deeply to reduce inoculum • Disinfecting farm tools in jik solution (50 ml : litre) to prevent spread. • Apply farm yard manure or green leaf manure (Gliricidia maculate) at 10 t/ha **Biological management**: • Applying rootgard, Trianum P and Trichotech **Chemical management**

	• Treat the seeds with Carbendazim + Thiram at 2 g/kg or pellet the seeds with Trichoderma viride at 4 g/kg or Pseudonomas fluorescens @ 10g/kg of seed. • Applying neem cake at 150 kg/ha. • Get other control products from the PCPB (www.pcpb.or.ke) list of registered pest control products, and use them according to the manufacturer's instructions
Justification	Dry rot disease is a major challenge in green gram production in Kenya, occurring in all major production areas, but being more severe in some regions based on practises undertaken. Failure to observe crop rotation would lead to higher severity cases and spread of the disease. It causes significant yield loss because it blocks the vascular system of the plant preventing water and nutrient uptake. Integrated Disease Management is an environmental friendly approach that enables the control of the disease through recommended cultural practises, use of biopesticides and synthetic pesticides where high severity is observed.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmers
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Carry out applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management • Farmers/farmer groups to adopt the technologies

	• County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated disease management • Limited number of extension agents • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Farmers may not implement some of the practices e.g. Crop rotation small farms and limited economic resources.
Suggestions for addressing the challenges	• Limited knowledge by farmers on integrated disease management • Limited number of Extension agents • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Training on integrated disease management practices (use of clean seed, field sanitation, crop rotation, biological control, tolerant varieties and use of ITK's) in managing the disease.
Lessons learned in up scaling, if any	• Establish green gram innovation platforms • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Adoption of good agricultural practices by the producers is key in management of the diseases • More than one approach is used in management of major diseases • IDM is environment friendly and the synthetic chemical component should be used as the last resort • Participatory, farmer-centered approaches, which encourage farmers to participate in the innovation process and the facilitation of experimentation among farmer communities in the evaluation of the technology enhances technology adoption • IDM approaches are knowledge intensive and location-specific, farmers would need to understand the agro-ecological processes affecting the disease to be able to make informed decisions on how to manage crop to avoid disease occurrence, as well as how to manage the diseases once they

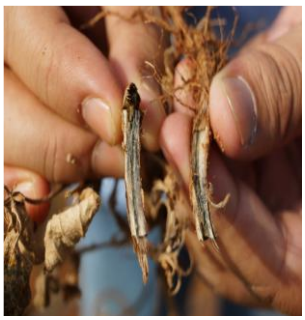
	become a problem. This will require a capacity building on crop monitoring and ecological principles.
Social, environmental, policy and market conditions necessary for development and up scaling	• Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices • Training on IDM to increase awareness and reduce possible negative impact on the environment resulting from wrong application • Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**30,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 60%. Therefore, the estimated returns will be **72,000-43, 200= 28,800/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to agro-vets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge • Women might have limited knowledge on integrated management of dry rot
Gender related opportunities	• Opportunities for youth employment in implementing IDM protocols • Opportunities in marketing pesticides
VMG issues and concerns in development, dissemination adoption and scaling up	The management practices reduce the production costs therefore VMG's can afford to produce green grams
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	**Reference:** Mbeyagala K. E., Amayo R., Obuo J. P., Pandey A. K., War A.R. and Nair R. M. 2017. A manual for mung bean (green gram) production in Uganda. National Agricultural Research Organization (NARO), 32 pages.

	Esilaba, A.O. et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Some options are ready for upscaling, while others e.g use of other Trichoderma based biocontrol products including Trichotech and Trianum_P. Some options require validation, while others require further research
G: Contacts s	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	Extension service providers, CABI, ICRAF, CGIAR

Research Gaps:

1. Explore the use of Trichoderma based products for biological control of the pathogen

2.6.9 TIMP name	**Integrated Management of scab disease of green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to disease
What is it? (TIMP description)	Integrated management of scab comprises of the use of cultural management practices and chemical control options in its management **Cultural practices**: • Practice good field sanitation and hygiene practices by collecting and disposing infected plants • Regular weeding and proper application of agronomic practices **Chemical management**: • Apply fungicides from flower-bud formation stage until when pods are half-grown. Fungicides that are effective are Copper based fungicides e.g. Demildex WP, Trifloxystrobin + Tebuconazole based fungicides e.g

	Nativo 300 SC and Carbendazim based fungicides e.g. Rodazim SC   **Dry Root rot** (*Macrophomina* sp.) **(Source;** World Vegetable Center, South Asia Hyderabad)
Justification	Green gram scab disease may cause significant yield losses if not well managed. The scarred tissues cause physical damage on the pods making it unappealing for the market. In addition, the scared tissue may become entry point of other pathogens leading to pod rots. This causes reduced returns for the farmers and negatively impacts on food and national security of the country.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Farmers, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Carry out Applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders

	• Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	KALRO to continually undertake research in disease management KEPHIS to ensure seedling quality is maintained PCPB to promote registration of fungicides for disease management Farmers/farmer groups to adopt the technologies County governments, central governments for development of enabling policies and create awareness. Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited knowledge by farmers on integrated disease management • Few farmer group organizations • Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Hold mass campaigns to create awareness on integrated pest management practices and safe use of pesticides
Lessons learned in up scaling, if any	• Establish green gram innovation platforms • Foster more Partnership in technology dissemination and adoption through innovation platforms • Adoption of good agricultural practices by the farmers in management of diseases
Social, environmental, policy and market conditions necessary for development and up scaling	- Understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices - Training on IDM to increase awareness of IDM and reduce possible negative impact on the environment resulting from wrong application of IDM - Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**23,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 21%. Therefore, the estimated returns will be **72,000-15,120= 56,880/=**

Gender issues and concerns in development, dissemination adoption and scaling up	• The management practices reduce the production costs and therefore women and youth can afford to produce green grams • IDM protocols will not overburden any gender in implementation and therefore have potential for adoption by both gender. • Setting of traps may create income generation opportunity for the youth
Gender related opportunities	- Opportunities for youth employment in implementing IDM protocols - Opportunities in marketing pest traps
VMG issues and concerns in development, dissemination adoption and scaling up	The management practices reduce the production costs therefore VMG's can afford to produce green grams
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	**Reference:** Mbeyagala K. E., Amayo R., Obuo J. P., Pandey A. K., War A.R. and Nair R. M. 2017. A manual for mung bean (green gram) production in Uganda. National Agricultural Research Organization (NARO), 32 pages.
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800Nairobi Email: cd.narl@kalro.org Phone: 0727624471
Lead organization and scientists	KALRO-Kabete, Ruth Amata., Daniel Mutisya., Nzioki C., Rael Karimi and Harun Odhiambo
Partner organizations	Extension service providers, CGIAR, CABI and ICRAF

2.7 Green Gram Pests

2.7.1 TIMP name	**Integrated Management of Root Knot nematodes in green grams**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield losses of up to 25.6% due to root knot nematodes
What is it? (TIMP description)	Root knot nematodes affecting green grams are controlled through cultural management practises and chemical control; **Cultural practices** • Crop rotation with non-leguminous crops i.e. crops in the grass family for 4-6 seasons. • Avoidance of surface run off as it spreads the pest to non-infected areas, uprooting affected plants and burying. • Soil solarization during dry months of the year on severely affected fields. • Cleaning of farm tools and equipment's after use • Incorporate Tithonia or Mexican marigold as green manure into the infested soil during planting **Biological control** • Drench infested soil with neem based products e.g. Nimbecidine at a rate of 60ml/20L **Chemical management** • Drench with *Trichoderma* spp based biopesticides in the rooting media.e.g.Trianum P at a rate of 45g/15L of water  **Root knot nematode (*Meloidogyne* spp.)** (Source; Miriam Otipa, KALRO)

Justification	Nematodes cause considerable reduction in yield and lower the grain quality of green grams. Where the nematode is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Exporters, Processors, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, seminars, meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages with green gram stakeholders • Undertake applied and adaptive research to validate and release improved green gram varieties • Create a platform for interaction of green gram value chain stakeholders • Farmers adopt appropriate agronomic practices have well organized farmer groups and networks e.g. Use of Indigenous Traditional Knowledge (ITK) can be promoted and adopted faster • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• KALRO to continue undertaking research in disease management • KEPHIS to ensure the quality of seedlings is maintained • Farmers/Farmer Groups to adopt these technologies • County governments, central governments develop enabling policies and create awareness.

	• Financial institutions to provide credit facilitators • Private pesticide companies to promote and sell registered pesticides
C: Current situation and future scaling up	
Counties where already promoted, if any	-
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**37,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 25.6% (**18,432/=).** Therefore, the estimated returns will be

	72,000 - 18,432 = 53,568/=
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as credit • Women and youth have limited access to pest management training and extension services • Due to their social status women and youth are often excluded from decision making in development and dissemination activities • Youth applying synthetic pesticides should always wear Personal Protective Equipment (PPE)
Gender related opportunities	• Young male and female youth may be employed to monitor (pest scouting) • Spraying of the crop will create employment opportunities for young male youths
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited access to productive resources such as credit and pest control products • 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 pest management information • There is low adoption by VMGs due lack of awareness • VMG may have a challenge in utilization of spraying equipment
VMG related opportunities	• Opportunities for unemployed rehabilitated male youths exist in pest scouting and cotton spraying programmes
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya CABI-Plantwise Knowledge Bank
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Ready for upscaling
G: Contacts	
Contacts	The Centre Director, KALRO-Kabete; P.O. Box 14733-00800 Nairobi Email: cd.narl@kalro.org Phone: 0727624471

Lead organization and scientists	KALRO-Kabete Ruth Amata., Miriam Otipa., Daniel Mutisya., Nzioki C., and Rael Karimi
Partner organizations	Extension service providers, CGIAR's, NGOs, County governments, Help in the dissemination of the technology,

Research Gaps:

1. Explore Bio-control option for insect vectors
2. Explore the use of ITKs in insect management
3. Explore the use of Trichoderma based products for biological control of the insect

2.7.2 TIMP name	**Integrated Management of White flies** *(Bemisia tabaci)*
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	The whitefly causes up to 85% yield loss.
What is it? (TIMP description)	Timely application of integrated management options is required. The following cultural and chemical strategies are involved: **Cultural practises;** • Ploughing in previous crop residue in the soil • Intercropping with non-host crop i.e. onion, garlic **Chemical management** • Limited chemical use pesticides will conserve black ants that are predators and feed on nymphal stages of the whiteflies • Use of yellow sticky traps at the rate of 10-12 traps/ha to trap • Neem-based derivative products such as Nimbecidine, Achook, Neemark that do not contaminate the environment  ***White flies, Bemisia tabaci (Genn.)***

Justification	White flies cause considerable reduction in yield and lower the grain quality of green grams. Where the white fly is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-85% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Exporters, Extension service providers, Researchers, Academia
Approaches to be used in dissemination	• On-farm demonstrations • Farmer training schools • Agricultural shows and exhibitions • Training workshops, Seminars, Meetings • Field days • Agricultural shows • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS)
Critical/essential factors for successful promotion	• KALRO to continua undertaking research on use of IPM in management of white flies • PCPB to promote registration of sticky pheromone traps for management of the insect and regulate their use • Farmers/farmer groups to adopt these technologies • County governments, central governments develop enabling policies and create awareness on IPM. • Financial institutions to provide credit facilities • Private pesticide companies to promote and sell registered pesticides only
Partners/stakeholders for scaling up and their roles	Farmers, Exporters, Extension service providers, Researchers, Academia

C: Current situation and future scaling up	
Counties where already promoted, if any	None at present.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market. Conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations.	
Basic costs	**28,600/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 85% (**61,200/=**). Therefore, the estimated returns will be **72,000-61,200= 10,800/=**

Gender, issues and concerns in development, dissemination adoption and up scaling	• Women and youth have limited access to productive resources such as land and credit than men to purchase inputs such as pesticides • Women and youth have limited access to education, training and extension services than men • Men dominant most decisions at the household and community levels including pest control • Women have limited access to markets as they sometimes cannot travel to far markets outlets to source for green grams inputs
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production of the crop leading to increased incomes
VMGs issues and concerns in development, adoption and scaling up.	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to green gram thrips information and their management strategies • There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop
E. Case studies/ profiles of success stories	
Success stories	Not yet achieved as this is new information roll out.
Application guidelines for users	**Reference:** Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya CABI-Plantwise Knowledge Bank
F. Status of TIMP readiness	
1-Ready for up scaling 2-Requires validation 3-Requires further research	2- Ready for up scaling
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535

	Centre Director KALRO Kabete, Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075
Lead Organization and Scientist(s)	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on white fly identification and management
- Validation of biopesticides and synthetic pesticides in the management of white fly
- Determine the effects of white fly on the yield, quality and implication on economic returns for the farmer

2.7.3 TIMP name	**Integrated Management of Flea beetles**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	The flea beetles feed on both the leaves and young pods causing leaf windowing leading to 15% yield loss
What is it? (TIMP description)	Integrated Flea beetle management consists of; **Cultural control** • Preventive control measures are sanitation by removal of plants and all debris as soon as harvesting is over. • Hand pick and destroy the beettles at the beginning of infestation as this will help to reduce the population density • Remove alternative host near the crop **Biological control** • Use natural enemies such as domestic chicken and allow perching birds to prey on beetles • Use biopesticides such as Nimbecidine EC (*Azadirachtin 0.03%).* **Chemical control**

	Use only pest control products recommended by Pest Control Products Board (PCPB) such as: • Bulldock star EC 262.5 *(Beta-cyfluthrin 12.5 g/L +Chlorpyrifos 250 g/L)* • Tata-alpha 10 EC (*Alpha-cypermethrin (10 g/L*) • Decis 2.5 EC *(Deltamethrin25g/L)* • Duduthrin 1.75 EC *(Lambdacyhalothrin 17.5 g/L)* Synthetic pesticides should be used as the last option since most of them are detrimental to the environment  Striped flea beetle, *Phylotreta striolata*
Justification	Beetles cause considerable reduction in yield and lower the grain quality of green grams. Where the beettle is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmers
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web material's

	• Digital platforms • Farmer field and business schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Farmers adopt appropriate agronomic practices • Form well organized farmer groups and networks
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	None at present.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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

Social, environmental, policy and market conditions necessary	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations.	
Basic costs	**33,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 15% (**10,800/=)**. Therefore, the estimated returns will be **72,000-10,800= 61,200/=**
Gender, issues and concerns in development, dissemination adoption and up scaling	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to information relating to management of stripped flea bettles • Women experience financial constraints due to limited access to credits hence might not be able to purchase inputs such as pesticides • Women have less access to agricultural information, technology and knowledge Men dominant most decisions at the household and community levels
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased yields leading to stable supply of cotton to the markets by women and youth
VMGs issues and concerns in development, adoption and scaling up.	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop

	• Increased yields leading to stable supply of cotton to the markets by VMGs
E. Case studies/ profiles of success stories	
Success stories	This is the first time the information is being rolled out.
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9 CABI-Plantwise Knowledge Bank
F. Status of TIMP readiness	
1-Ready for up scaling 2-Requires validation 3-Requires further research	1-Ready for up scaling
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535 Centre Director KALRO Kabete, Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075
Lead Organization and Scientist(s)	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on beetle identification and management
- Validation of biopesticides and synthetic pesticides in the management of beetle
  Determine the effects of beetle on the yield, quality and implication on economic returns for the farmer

2.7.4 TIMP name	Integrated Management of Aphids
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Aphids infestation causes up to 70% yield loss on green gram
What is it? (TIMP description)	This is an integrated approach of various control methods suppress the aphids below economic injury levels. **Cultural Control** • Prepare land well and apply 10 kg CAN/acre and 14 kgs/acre DAP to increase plant vigour • Control ants by ploughing and flooding the field to destroy the colonies, expose eggs and larvae to predators • 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. Avoid alternate host crops such as beans, lucerne, pigeon pea • Remove heavily infested plant parts and destroy by burning • Apply neem based products (e.g. neem oil 40ml/20lts of water, Achook) 2 times/month • 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 **Chemical Control** Use only pest control products recommended by Pest Control Products Board (PCPB) such as: • Use Danadim Blue 40 EC (Dimethoate 400 g/L) • Duduthrin 1.75 EC *(Lambdacyhalothrin 17.5 g/L)* • Spray using 10 - 15 mls/20lts of Karate, Atom or Decis at the rate of 10-15mls/20lts of water  .Aphids pest; *Aphis* sp Source; A.M. Varela, icipe

Justification	Aphid causes direct damage by sucking sap from plant tissues, leading to deformation, reduced plant height with few flowers and shrivelled pods. Aphids cause considerable reduction in yield and lower the grain quality of green grams. Where the aphid is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-70% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmers
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Farmers adopt appropriate agronomic practices have well organized farmer groups and networks e.g. Use of Indigenous Traditional Knowledge (ITK) can be promoted and adopted faster • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in pest management • PCPB to promote registration of bioinsecticides for integrated pest management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	

Counties where already promoted, if any	- None
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KEBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations.	
Basic costs	**44,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 70% (**50, 400/=)**. Therefore, the estimated returns will be **72,000-50, 400= 21,600/=**

Gender, issues and concerns in development, dissemination adoption and up scaling	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to markets than men • Women have less access to agricultural information, technology and knowledge such as integrated management of green gram aphids • Men dominant most decisions at the household and community levels
Gender related opportunities	Opportunities for youths exists in spraying the crop
VMGs issues and concerns in development, adoption and scaling up.	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access to markets where they could access pesticides as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques
VMG related opportunities	Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop
E. Case studies/ profiles of success stories	
Success stories	• This is the first time the information is being rolled out.
Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya • CABI-Plantwise Knowledge Bank
F. Status of TIMP readiness	
1-Ready for up scaling 2-Requires validation 3-Requires further research	1-ready for up scaling
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535

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Lead Organization and Scientist(s)	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on aphids identification and management
- Validation of biopesticides and synthetic pesticides in the management of Aphid
- Determine the effects of aphid on the yield, quality and implication on economic returns for the farmer

2.7.5 TIMP name	**Integrated Management of Yellow stripped blister beetle blisters beetle**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Blister beetle causes windowing on flower and leaf tissue with up to 40% yield loss
What is it? (TIMP description)	Integrated management of the beetle includes the use of various pest control strategies. The strategies include cultural, biological and chemical control. In order to realize an effective management program for this insect, one has to start chronologically from preventive to curative pest control measures i.e. from cultural to chemical control. The trend is such that you start with the most environmentally friendly (cultural) strategy as you move towards harsh (chemical) pest control methods. This management practice starts with pest scouting/ monitoring, pest identification and establishment of economic threshold and finally a decision is made on which of the following pest control measures to use

	Cultural control • Preventive control measures are sanitation by removal of plants and all debris as soon as harvesting is over. • Hand pick and destroy the beettles at the beginning of infestation as this will help to reduce the population density • Remove alternative host near the crop **Biological control** • Use natural enemies such as domestic chicken and allow perching birds to prey on beetles • Use biopesticides such as Nimbecidine EC (*Azadirachtin 0.03%).* **Chemical control** **Use** only pest control products recommended by Pest Control Products Board (PCPB) such as: • Bulldock star EC 262.5 *(Beta-cyfluthrin 12.5 g/L +Chlorpyrifos 250 g/L)* • Tata-alpha 10 EC (*Alpha-cypermethrin (10 g/L*) • Decis 2.5 EC *(Deltamethrin25g/L)* • Duduthrin 1.75 EC *(Lambdacyhalothrin 17.5 g/L)* Synthetic pesticides should be used as the last option since most of them are detrimental to the environment  Yellow stripped blister beetle, *Mylabris blistillat* Source; A.M. Varela, icipe
Justification	These yellow stripped beetles destroy flowers and buds causing flower defoliation. The beettles cause considerable reduction in yield and lower the grain quality of green grams. Where the beetle is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a

	combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmer
Approaches to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Farmers adopt appropriate agronomic practices Have well organized farmer groups and networks e.g. Use of Indigenous Traditional Knowledge (ITK) can be promoted and adopted faster • Accessibility and cost of the practice by farmers: low-cost agricultural practices are easily promoted and accepted
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	- None at present, this approach is new.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Farmers have not accepted to adopt IPM technologies • Inadequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain

Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations.	
Basic costs	**33,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 40% (**28,800/=)**. Therefore, the estimated returns will be **72,000-28,800= 43,200/=**
Gender, issues and concerns in development, dissemination adoption and up scaling	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to markets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge • Due to their social status women and youth are often excluded from decision making in pest management
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production of cotton leading to stable supply of cotton to the market

VMGs issues and concerns in development, adoption and scaling up.	• VMGs have limited access to productive resources such as land, credit, and quality seeds • 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 • VMGs have limited access to information such as in integrated management of blister bettles • There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Employment for youths and those recovering from drugs exists in spraying the crop • Improved production for VMGs
E. Case studies/ profiles of success stories	
Success stories	This is the first time the information is being rolled out.
Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya • CABI-Plantwise Knowledge Bank
F. Status of TIMP readiness	
1-Ready for up scaling 2-Requires validation 3-Requires further research	1-Ready for up scaling
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535
Lead Organization and Scientist(s)	KALRO-Katumani: Daniel Mutisya, M Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	International research agencies; ICIPE, ICRISAT, Real IPM, Dudutech

Research Gaps

- Capacity building on Yellow stripped blister beetle identification and management
- Validation of biopesticides and synthetic pesticides in the management of Yellow stripped blister beetle
- Determine the effects of Yellow stripped blister beetle on the yield, quality and implication on economic returns for the farmer

2.7.6 TIMP name	**Integrated Management of Desert locust (*Schistocerca gregaria*)**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	90% yield loss occasioned by feeding on foliage which occur in swarm of 5-20 million hoppers.
What is it? (TIMP description)	Integrated management of desert locust is a regional program involving multi-sectoral efforts as follows; • A global early warning system of preventive and control of DL is in place.Kenya is a member of Desert Locust Control Organization of Eastern and Central Africa (DLCO-EA). • DLCO-EA uses remote sensing technology and ground surveys to identify and control desert locusts (DL) in their breeding sites. It uses satelite imagery for the identification of potential breeding sites and locust infestations. • Prevention requires a collective effort across regions. • Scouting and control of DL in recession (traditional breeding) regions will prevent infestation in invation (non traditional) regions • Scouting should be synchronized with early warning systems reports from FAO • Spray hopper bands using Metarhizium anisopliae based products like Mazao achieve (rate 2l/ ha), Biomagic 1.5 LF (rate 20g/ 20lts water), Real metarhizium OD (rate 200ml/ ha) among others. Spray at intervals of 3 - 14 days depending on risk of pest damage • Spray with Chlorpyrifos ULV based products like Mursban 480 EC (rate 75ml/20lts water), Agropyrifos 48 EC (20ml/20lts water), Regulator 450 EC (20mls/20lts water), Gradomete R 480 EC. (rate is 1 ltr/ha) • Spray with Fenitrohion based products like Delta 1.01% Dust, Sumicombi 1.8% Dust, Sumithion super. (rate of 1ltr/ha)  The migratory locust, *Schistocerca gregaria* Source; cabi.org

Justification	Desert locust cause devastating total vegetative loss of many crops which calls for urgent action by the Ministry of Agriculture and all stakeholders in the region to prevent crop loss.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Producers, Exporters, Researchers, Academia, Farmers, Extension agents
Approaches to be used in dissemination	• Agricultural shows • MoA/Extension officers • Farmer research networks • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	Need for farmer involvement helps in test evaluation and up scaling of what they learn in the process.
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in disease management • KEPHIS to ensure seedling quality is maintained • PCPB to promote registration of fungicides for disease management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	- None at present, this approach is new.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing

Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations.	
Basic costs	**28,000/=**
Estimated returns	If the farmer doesn't apply the TIMP yield will be reduced by 90% (**64,800/=)**. Therefore, the estimated returns will be **72,000-64,800= 7,200/=**
Gender, issues and concerns in development, dissemination adoption and up scaling	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited finances to purchase pesticides • Women and youth have limited access to education, training and extension services than men • Women have limited access to markets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge for instance they might not have knowledge of integrated management of Migratory locust
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Inceased production leading to improved livelihoods
VMGs issues and concerns in development, adoption and scaling up.	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities

	• VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop • Increased production leading to improved livelihoods of VMGs
E. Case studies/ profiles of success stories	
Success stories	-This is the first time the information is being rolled out.
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya CABI-Plantwise Knowledge Bank
F. Status of TIMP readiness	
1-Ready for up scaling 2-Requires validation 3-Requires further research	1-ready for up scaling
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535
Lead Organization and Scientist(s)	KALRO-Katumani: Daniel Mutisya, M Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	Universities, ICIPE, ICRISAT, FAO, Dudutech, Real IPM

Research Gaps

- Capacity building on management of desert locusts
- Validation of biopesticides and synthetic pesticides in the management of desert locusts

2.7.7 TIMP name	**Integrated management of Bruchid on Green gram**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Bruchids cause up to 100% damage on green gram grain when in storage.
What is it? (TIMP description)	Integrated bean bruchid management consist of various approaches to prevent grain damage. **Cultural practises** • Sort grains and remove visibly damaged

	• Cover with plastic or store grains with husks • Use pheromone traps to attract weevils **Chemical management** • Use repellent neem powder to repel  The pulse beetle, *Callosobruchus chinensis* Source; A.M. Varela, icipe
Justification	Bruchids cause considerable reduction in yield and lower the grain quality of green grams. Where the bruchid is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMPs	Producers, Exporters, Researchers, Academia, Farmers
Approaches used to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web material's • Digital platforms

	• Farmer field and business schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages are required • Suitability of the TIMP to the agro climatic and socio-economic condition of the farmer • Accessibility of the TIMP by the farmers
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in pest management • PCPB to promote registration of insecticide for pest management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	None of the counties have any experience on the technology as this pest has just arrived in the eastern Africa region.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**29,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 100% (**72,000/=)**. Therefore, the estimated returns will be **72,000-72,000= 0/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to agro-vets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge knowledge • Women might have limited knowledge on integrated management of pulse beetle
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production leading to stable markets for greengram
VMG issues and concerns in development and dissemination	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access agro-vets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due to lack of awareness
VMG related opportunities	Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya CABI-Plantwise Knowledge Bank
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up scaling 2-requires validation 3-Requires further research
G: Contacts	
Contacts	Centre Director,

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Lead organization and scientists	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on red bruchids identification and management
- Validation of biopesticides and synthetic pesticides in the management of bruchid
- Determine the effects of bruchid on the yield, quality and implication on economic returns for the farmer

2.7.8 TIMP name	**Integrated management of Cut worms on green gram**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Cutworms cause up to 100% damage on green gram seedlings
What is it? (TIMP description)	Integrated cutworm management consist of various approaches to prevent grain damage. **Cultural practises** • Ploughing exposes caterpillars to predators and to desiccation by the sun. • Prepare field and vegetation and weeds destroyed 14 days before planting • Delaying transplanting slightly until the stems are too wide for the cutworm to encircle and/or too hard for it to cut may reduce cutworm damage. • Hand picking of caterpillars at night by torch or very early morning before they return into the soil is useful at the beginning of the infestation.

	• Flooding of the field for a few days before sowing or transplanting **Biological management** • Use repellent neem extract 3 times at weekly intervals • Use of ash on the seedbed • Use of molasses at the base of each plant  **The cutworm (*Agrotis spp*),** **Source: A.M. Varela, icipe**
Justification	Cut worms cause considerable reduction in yield and lower the grain quality of green grams. Where the cut worm is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-100% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMPs	Producers, Exporters, Researchers, Academia, Farmers
Approaches used to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web materials • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms

Critical/essential factors for successful promotion	• Strong partnership linkages are required • Suitability of the TIMP to the agro climatic and socio-economic condition of the farmer • Accessibility of the TIMP by the farmers
Partners/stakeholders for scaling up and their roles	KALRO to continually undertake research in pest management PCPB to promote registration of insecticide for pest management Farmers/farmer groups to adopt the technologies County governments, central governments for development of enabling policies and create awareness. Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	None of the counties have any experience on the technology as this pest has just arrived in the eastern Africa region.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**30,000/=**
Estimated returns	If the farmer doesn't apply the TIMP yield will be reduced by 100% (**72,000/=)**. Therefore, the estimated returns will be **72,000-72,000= 0/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women farmers might not be aware of the Integrated management of cutworms • Women have less access to agricultural information, technology and knowledge • Women and youth have limited access to credit facilities for them to purchase inputs • Women and youth have limited access to education, training and extension services than men • Women dominate in the production of greengram therefore there is need to ensure gender balance during trainings • The application of chemical to spray is usually associated with men
Gender related opportunities	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to agricultural knowledge and extension services such as integrated management of green gram cutworms leading to low adoption • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques
VMG issues and concerns in development and dissemination	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to agricultural knowledge and extension services such as integrated management of cutworms leading to low adoption • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure

	• Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques
VMG related opportunities	• Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9 CABI-Plantwise Knowledge Bank
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up scaling
G: Contacts	
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535 Centre Director KALRO Kabete, Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075
Lead organization and scientists	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on Cut worm identification and management
- Validation of biopesticides and synthetic pesticides in the management of cut worm
- Determine the effects of spider mites on the yield, quality and implication on economic returns for the farmer

2.7.9 TIMP name	Integrated Management of Flower Thrips on green gram
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Flower thrips cause up to 20-60% yield loss on green gram
What is it? (TIMP description)	Integrated management (IPM) of thrips involves the use of a combination of cultural, biological and chemical control methods. These are; **Cultural Control** • Maintain a healthy crop as it will tolerate thrips and keep the field weed free • Avoid planting new crop near an existing infected field • Mulch fields as this helps reduce thrips population • Use overhead irrigation where possible to reduce spread of thrips • Remove and destroy volunteer plants and debris that may harbour thrips • Uproot heavily infested plant material and burn • Apply soapy sprays (mix 5 teaspoon full of soap powder or chopped bar soap with cold water and dissolve and spray on the infested plants • Use blue sticky cardboard traps to attract thrips. **Biological control** • Apply biocontrol agents e.g Beauvitech WP (Beauveria bassiana) or Bio-Power 1.5L (Beauveria bassiana), or Botanigard ES (Azadirachtin), • Spray neem based products like neemroc EC and nimbecidine (Azadiractin) use 1 lts/acre (10 plastic bottle tops per 20 lts of water). **Chemical Control** • Spray with Spinosad based products eg tracer 480 SC at 4mls per 20lts of water or lambda cyhalothrin products at 7ml per 20l of water or duduthrin at 65mls per 20l of water or Karate at 20gms/ 20l • Use synthetic insecticides with PHI of 3 days or less since garden pea is harvesting at very short intervals.

	 Flower thrips (*Megalurothrips sjostedti*) Source; GTZ-IPM Horticulture, Kenya
Justification	Thrips cause considerable reduction in yield and lower the grain quality of green grams. Where the thrips are severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMPs	Producers, Exporters, Researchers, Academia, Farmers
Approaches used to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web material's • Digital platforms • Farmer field and business schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages are required. • Suitability of the TIMP to the agro climatic and socio-economic condition of the farmer. • Accessibility of the TIMP by the farmers.

Partners/stakeholders for scaling up and their roles	KALRO to continually undertake research in pest management PCPB to promote registration of insecticide for pest management Farmers/farmer groups to adopt the technologies County governments, central governments for development of enabling policies and create awareness. Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	None of the counties have any experience on the technology as this pest has just arrived in the eastern Africa region.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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

D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**36,600/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 60% (**43, 200/=)**. Therefore, the estimated returns will be **72,000-43, 200= 28,800/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as credit • Women and youth have limited access to pest management training and extension services • Due to their social status women and youth are often excluded from decision making in development and dissemination activities • Youth applying synthetic pesticides should always wear Personal Protective Equipments (PPE's)
Gender related opportunities	• Young male and female youth may be employed to monitor (pest scouting) • Spraying of the crop during the bollworm control will create employment opportunities for young male youths
VMG issues and concerns in development and dissemination	• VMGs have limited access to productive resources such as credit and pest control products • 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 pest management information • There is low adoption by VMGs due lack of awareness • VMG may have a challenge in utilization of spraying equipments
VMG related opportunities	• Opportunities for unemployed rehabilitated male youths exist in pest scouting and cotton spraying programmes.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9 CABI-Plantwise Knowledge Bank

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 AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535 Centre Director KALRO Kabete, Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075
Lead organization and scientists	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on thrip identification and management
- Validation of biopesticides and synthetic pesticides in the management ofthrips
- Determine the effects of spider mites on the yield, quality and implication on economic returns for the farmer

2.7.10 TIMP name	**Integrated management of pod sucking bugs on green gram**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Pod sucking cause up to 100% yield loss on green gram
What is it? (TIMP description)	Integrated management of Pod sucking bugs consist of various approaches to prevent plant damage. **Cultural Control**

	• Bugs can be collected by hand regularly and killed, especially during flowering and pod formation. • Conserve natural enemies such as assassin bugs, spiders, praying mantises and ants. **Biological control** • Spray Neem products in the morning when the immature stages are exposed.  Spiny brown bugs (*Clavigralla spp*.) Source; A.M. Varela, icipe
Justification	Pod sucking bugs cause considerable reduction in yield and lower the grain quality of green grams. Where the bug infestation is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMPs	Producers, Exporters, Researchers, Academia, Farmers
Approaches used to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals)

	• Web material's • Digital platforms • Farmer field and business schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages are required. • Suitability of the TIMP to the agro climatic and socio-economic condition of the farmer. • Accessibility of the TIMP by the farmers.
Partners/stakeholders for scaling up and their roles	KALRO to continually undertake research in pest management PCPB to promote registration of insecticide for pest management Farmers/farmer groups to adopt the technologies County governments, central governments for development of enabling policies and create awareness. Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	None of the counties have any experience on the technology as this pest has just arrived in the eastern Africa region.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market	• Favorable environmental conditions • Willingness of stakeholders to participate

conditions necessary for development and up scaling	• Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**30,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 100% (**72,000/=)**. Therefore, the estimated returns will be **72,000-72,000= 0/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land and credit than men to purchase inputs such as pesticides • Women and youth have limited access to education, training and extension services than men • Men dominant most decisions at the household and community levels including pest control • Women have limited access to markets as they sometimes cannot travel to far markets outlets to source for green grams inputs
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production of the crop leading to increased incomes
VMG issues and concerns in development and dissemination	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to spiny brown bugs information and their management strategies • There is low adoption by VMGs due lack of awareness
VMG related opportunities	Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop
E: Case studies/profiles of success stories	
Success stories	-

Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9 CABI-Plantwise Knowledge Bank
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up scaling 2-requires validation 3-Requires further research
G: Contacts	
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Lead organization and scientists	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on pod sucking bugs identification and management
- Validation of biopesticides and synthetic pesticides in the management of pod sucking bugs
- Determine the effects of spider mites on the yield, quality and implication on economic returns for the farmer

2.7.11 TIMP name	**Integrated management of Bean fly in Green gram**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Bean fly cause up to 30-60 % yield loss on green gram

What is it? (TIMP description)	Integrated bean fly management consist of various approaches to prevent grain damage. **Cultural practises** • Timely planting early in the season. • Planting after green manure crop. • Practise crop rotation with non-legumes such cereals. • Ridging the plants 2-3 weeks after germination helps to cover the adventitious roots produced by plants damaged by bean flies • Mulch with rice straw. • Remove and destroy crop residues and all plant parts with symptoms of damage by bean flies. **Biological management** • Use botanical insecticides such as neem (100 g of dried leaves in 1 litre warm water (30°C) and kept for 12 hours. Filter and spray) • Uproot infested plants from the field and destroy by burning.  Bean flies (*Ophiomyia phaseoli*) Source; A.M. Varela, icipe
Justification	Bean fly cause considerable reduction in yield and lower the grain quality of green grams. Where the bean fly infestation is severe and not controlled plants become greatly reduced in size and yield. Losses of above 30-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM

	approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMPs	Producers, Exporters, Researchers, Academia, Farmers
Approaches used to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals) • Web material's • Digital platforms • Farmer Field and Business Schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages are required. • Suitability of the TIMP to the agro climatic and socio-economic condition of the farmer. • Accessibility of the TIMP by the farmers.
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in pest management • PCPB to promote registration of insecticide for pest management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
• C: Current situation and future scaling up	
Counties where already promoted, if any	• None of the counties have any experience on the technology as this pest has just arrived in the eastern Africa region.
Counties where TIMPs will be up scaled	• Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations

	• Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**30,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 60% (**43, 200/=)**. Therefore, the estimated returns will be **72,000-43, 200= 28,800/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• The misconception in some regions that cotton is a man's crop whereas food crops belongs to women • Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to information relating to management of beanfly • Women experience financial constraints due to limited access to credits hence might not be able to purchase inputs such as pesticides • Women have less access to agricultural information, technology and knowledge

	• Men dominant most decisions at the household and community levels
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased yields leading to stable supply of cotton to the markets by women and youth
VMG issues and concerns in development and dissemination	• VMGs have limited access to productive resources such as land, credit, and quality seeds • VMGs have limited access to training and extension services • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to either their sickness, disability or lack of exposure • Due to their social status VMGs are often excluded from decision making in development and dissemination activities • VMGs have limited access to seed and information on new varieties and production techniques • There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Opportunities for unemployed youths and those recovering from drugs exists in spraying the crop • Increased yields leading to stable supply of green gram to the markets by VMGs
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9 CABI-Plantwise Knowledge Bank
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Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535 Centre Director KALRO Kabete, Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org The Centre Director Food Crops Research Centre – Muguga South

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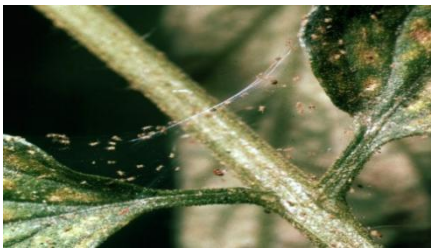
Lead organization and scientists	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on bean fly identification and management
- Validation of biopesticides and synthetic pesticides in the management of bean fly
- Determine the effects of spider mites on the yield, quality and implication on economic returns for the farmer

2.7.12 TIMP name	**Integrated management of red spider mites on green gram**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Red spider mites cause up to 100% damage on green gram grain when in storage.
What is it? (TIMP description)	Integrated management of spider mites consists of several approaches applied in an integrated manner to break the cycle of the insect. These include: **Cultural Control** • Keep the farm weed free from the alternative hosts such as solanum family crops that may habour red spider mites • Avoid planting tomato next to infested field or crops. • When moving through the farm, start with the healthy area before moving to infected section. • Conserve natural enemies or release purchased predatory *Phytoseilus* species from Real IPM or Dudutech Ltd. • Use overhead irrigation as it helps in drowning the mites hence reducing their population • Spray with neem extracts (500 grams of leaves in 5 litres of water) • Prun overcrowded plants and destroy the crop debris by burning. **Bio-control control** • Spray with neembicidine based products such as Achook • Release predatory mites (*Phytotech* and *Amblytech* from

	dudutech) *Phytoseiulus persimilis* species and *Amblyseius cucumeris* • Conserve natural enemies in the environment or release purchased predatory *Phytoseilus* species from Real IPM or Dudutech Ltd **Chemical Control** • Spray with abamectin 18g/kg based synthetic pesticides (Dynamec 20EC 5ml/20litres water, Knockbect 40EC, 10 ml/20 Litre water) or • Spray with Amitraz 200g/L based miticides (Kilitac 20EC, Mitac 20 EC. Rate 10ml/20Litre water)  Red spider mites, *Tetranychus spp* Source;: Bugwood.org
Justification	Red spider mites cause considerable reduction in yield and lower the grain quality of green grams. Where the spider mites infestation is severe and not controlled plants become greatly reduced in size and yield. Losses of above 20-60% are experienced due to the pest under high infestation levels. Marketing of such produce that is severely affected poses challenges and fetches low prices or is rejected. Integrated Management of pests considering food safety concerns should be highly advocated considering that the grain consumed very widely in Kenya. This involves the use of a combination of cultural and bio-control and biopesticides that are relatively safe. Soft synthetic pesticides are recommended as a last option. This minimizes overuse of synthetic pesticides. Adoption of an IPM approach would enhance food safety among the consumers and also contribute to environmental safety.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMPs	Producers, Exporters, Researchers, Academia, Farmers
Approaches used to be used in dissemination	• On farm and on station research trails and demonstrations • Training workshops, Seminars, Meetings • Field days • Agricultural shows • MoA/Extension officers • Farmer research networks • Farmer to farmer • Mass media – Agricultural programs • Promotional materials (posters/brochures/leaflets, manuals)

	• Web material's • Digital platforms • Farmer field and business schools (FFBS) • Agricultural innovation platforms
Critical/essential factors for successful promotion	• Strong partnership linkages are required. • Suitability of the TIMP to the agro climatic and socio-economic condition of the farmer. • Accessibility of the TIMP by the farmers.
Partners/stakeholders for scaling up and their roles	• KALRO to continually undertake research in pest management • PCPB to promote registration of insecticide for pest management • Farmers/farmer groups to adopt the technologies • County governments, central governments for development of enabling policies and create awareness. • Financial institutions to provide credit facilitators
C: Current situation and future scaling up	
Counties where already promoted, if any	None of the counties have any experience on the technology as this pest has just arrived in the eastern Africa region.
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Unwillingness of farmers to adopt IPM technologies • In adequate knowledge on IPM strategies on insect pests infesting green gram and losses attributed to them • Poor linkages among stakeholders in green gram value chain
Suggestions for addressing the challenges	• PCPB enhance registration of crop protection products • Training of stakeholders in IPM options • Establish green gram innovation platforms for technology disseminations • Dissemination of integrated pest management practices and safe use of pesticides • Promote appropriate marketing channels e.g. contract farming, collective production and marketing
Lessons learned in up scaling, if any	• Sensitization is necessary for people to appreciate the use of IPM in insect management • Adoption of good agricultural practices by farmers is key in management of the insects • 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
Social, environmental, policy and market conditions necessary for development and up scaling	• Favorable environmental conditions • Willingness of stakeholders to participate • Favorable environmental conditions • Regulatory bodies e.g. PCPBP, KBS to ensure insecticides sold to farmers are genuine and of high quality • Producers willing to adopt the insect 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
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	**47,000/=**
Estimated returns	If the farmer doesn't apply the TIMP, yield will be reduced by 100% (**72,000/=)**. Therefore, the estimated returns will be **72,000-72,000= 0/=**
Gender issues and concerns in development, dissemination adoption and scaling up	• Women and youth have limited access to productive resources such as land, credit, and quality seeds than men • Women and youth have limited access to education, training and extension services than men • Women have limited access to markets as they sometimes cannot travel to far markets due to their domestic roles • Women have less access to agricultural information, technology and knowledge • Due to their social status women and youth are often excluded from decision making in pest management
Gender related opportunities	• Opportunities for youths exists in spraying the crop • Increased production of cotton leading to stable supply of cotton to the market
VMG issues and concerns in development and dissemination	• VMGs have limited access to productive resources such as land, credit, and quality seeds • 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 • VMGs have limited access to information such as in integrated management of red spider mites • There is low adoption by VMGs due lack of awareness
VMG related opportunities	• Employment for youths and those recovering from drugs exists in spraying the crop • Improved production for VMGs
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	• Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya ISBN: 978-9966-30-037-9 CABI-Plantwise Knowledge Bank
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up scaling

G: Contacts	
Contacts	Centre Director, KALRO AMRI-Katumani. P.O. Box 340. 90100. Machakos Email: cd.katumani@kalro.org. Phone: 0711 369535 Centre Director KALRO Kabete, Box 14733-00800, NAIROBI. Tel: +254-020-2464435 Ext. 300 E-mail: cd.narl@kalro.org The Centre Director Food Crops Research Centre – Muguga South P. O. Box 30148-00100, Nairobi, Kenya. Email: fcrc.muguga@kalro.org Tel: +254-0722219075
Lead organization and scientists	KALRO-Katumani: Daniel Mutisya, Miriam Otipa., R. Karimi, H. Nzioki and R. Amata
Partner organizations	ICIPE, ICRISAT, CABI, Dudutech, Real IPM

Research Gaps

- Capacity building on red spider mites identification and management
- Validation of biopesticides and synthetic pesticides in the management of red spider mites
- Determine the effects of spider mites on the yield, quality and implication on economic returns for the farmer

2.8 Integrated Weed Management

2.8.1 TIMP Name	Integrated Weed Management in Green gram
Crop management practices	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Low and poor quality yields resulting from a variety of annual and perennial grass and broadleaved weed species infestation that damage the crop, combined with poor control methods.
What is it? (TIMP description)	Integrated Weed Management (IWM) is the management of weeds using two or more appropriate approaches such as preventive, land preparation before planting, use of mulch (biodegradable or synthetic), cultural, rotation, intercropping and chemical, among others, depending on the weed types and intensity in the field. Annual and perennial narrow leaved weeds include crab sanguinalis (*Digitaria sanguinalis*), goosegrass (*Eleusine indica* and difficult to

<table>
<tr><td></td><td>control couch grass (Cynodon dactylon) and sedges (such as yellow nutsedge (Cyperus esculentus). Broad leaved include Wondering jew (Commelina benghalensis) and Black jack (Bidens pilosa).
<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Wondering jew (Commelina benghalensis)</td><td>Black jack (Bidens pilosa)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Couch grass (Stellaria media)</td><td>Yellow nut sedge (Cyperus esculentus)</td></tr>
</table>
Cultural weed control refers to any technique (such as maintaining good soil fertility) that involves maintaining field conditions such that weeds are less likely to become established and/ or increase in number.

Physical control is the removal of weeds manually or by mechanical means, such as hand weeding or mowing. Weeding is done 2-3weeks after crop germination depending on the environment, weed type and density, weather condition and soils.

Chemical weed control is use of appropriate recommended herbicides to control weeds following instructions on the label. The weed composition needs to be identified and the data used to implement timely and the best management approach because one approach will be effective only on some species but not others.</td></tr>
<tr><td>Justification</td><td>Different annual and perennial grass and broadleaved weed species combined with inappropriate approaches used to control the weeds (because of limited knowledge) lead to yield losses and lack of profitability in green gram production. Weeds compete with the crop</td></tr>
</table>

	for growth resources such as nutrients, soil moisture, space and sunlight Some key weed grass species include goose grass (Eleusine indica), Craws foot (Dactyloctenium aegyptium) and difficult to control couch grass (Cynodon dactylon). Common broad leaved weeds include sow thistle (Sonchus oleraceae), Black jack (Bidens pilosa), Gallant soldier (Galinsoga parviflora), Goat weed (Ageratum conyzoides) and Starbur (Acanthospermum hispidum). Weeds such as Amaranthus species eg Red pigweed (A. retroflexus), Sedges such as Yellow nutsedge (Cyperus esculentus), Wondering jew (Commelina benghalensis), Witchweed (Striga hermonthica) and Ragweed (Parthenium hysterophorus) are a challenge and difficult to control in green gram growing fields or regions where they have succeeded because of their morphological and phenological characteristics. Although manual weeding mainly done by farmers can be effective for managing some weed species, it is time consuming and labour intensive. It can be ineffective when done under wet conditions for weeds such as wandering jew (Commelina benghalensis) and purslane (Portulaca oleraceae) as they get disseminated and re-grow through cuttings. A combination of more than one management practice has been reported to give a promising option for timely and efficient weed control in green gram cropping systems. There is therefore the need to apply IWM approach to control the biodiversity of weeds in green grams.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension workers, Agrodealers
Approaches used in dissemination	• Demonstrations and field days. • Mass Media • Manuals, pamphlets, fact sheets
Critical/essential factors for successful promotion	• Promote and train on integrated weed management (IWM) in green gram production. • Address environmental and safety concerns related to the use of herbicides • Accompany the promotion with demos and field days with farmers groups and various stakeholders on the effectiveness of the various weed management options using FFSB approach. • Train users on appropriate/ safe use of herbicides. • Train stakeholders on identification and biology of weeds and their dynamics in cropping systems. Farmers need training on timing with regard to conservation of biodiversity, to preserve pollinators for increased productivity of weed control.

Partners/stakeholders for scaling up and their respective roles.	• Agrochemical companies and Agrodealers- Dissemination of information • Research partners-(KALRO and CGIAR)-Research • County extension Officers and NGOs- Extension Services and dissemination of information
C: Current situation and future scaling up	
Counties where already promoted if any	Machakos, Makueni,
Counties where TIMPs will be up scaled	All counties suitable for growing green gram including Kakamega, Rift valley, Central, Eastern, and Coast.
Challenges in development and dissemination	• Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low use of the technology • Labour intensity and high cost of herbicides • Inadequate knowledge and information on which herbicides to use, when to use them and their persistence in the soil. • Myths on appropriateness of using herbicides
Suggestion for addressing the challenges	• Promotion of the IWM by 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 green gram. • Training on safe use of herbicides to address the issue of residues in the crop and persistence in different soil environment that can carried over to follow up crops during rotation.
Lesson learned in up scaling if any	• Integrated approaches of weed management are more effective than use of one control method. • Continuous use of herbicides is an environmental, health and social hazard hence the need to follow instructions on the label. • Vegetable rotations are very fast and intensive in many places and herbicide toxicity can affect next crop if the cycle of previous crops is short enough. • Consumers concerns regarding the safety of crops due to pesticide residues need attention.
Social, environmental, policy and market conditions necessary for development and up-scaling	• Train farmers to understand benefits of and how IWM works. • Have an environmental and safety plan when using herbicides. • Address the environmental and social concerns related to use of agrochemicals. • A functional agro-dealer network to supply registered herbicides when required by the farmers.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not Determined

Estimated returns	Not Determined
Gender issues and concerns in development and dissemination	• Women and youth have limited access to production resources such as land, capital to purchase herbicides • Women work is complicated by their multiple roles they do such as such domestic roles • Women and youth have limited access to education, training and extension services • Women have less access to agricultural information, technology and knowledge on IWM • Women and youth have less access to knowledge and information on IWM • Women and youth have less access to extension training • Make all gender understand the benefits of IWM. • Empower both men and women to make a judicious decision on IWM approach. • Use of IWM technology can reduce labour from manual weeding and save time for other activities for women and children
Gender related opportunities	• Women and youth to generate income from weeding • Women and youth to generate income from agro dealer business • Women and youth to generate income by starting cortege value addition factories due to enhanced yield • There will be improved food security and nutrition from for women • There will be increased job security for women and youth by spraying herbicides • There will be increased production since the weed competes with plants leading to low production
Vulnerable and marginalized groups (VMG) issues and concerns in development, dissemination, adoption and scaling up	• VMG groups could have limitations in accessing the knowledge, resources and exposed to many threats such as insecurity and land disputes. • VMG have less access to extension training as they are not given equal opportunities • VMG have less access to knowledge and information on IWM • VMG have less access to capital to purchase herbicides
VMG related opportunities	• VMG to generate income from agro dealer business • VMG to generate income by starting cortege value addition factories due to enhanced yield • There will be increased production leading to increase food security and nutrition for VMGs
E: Case studies/profiles of success stories	
Success stories	-

Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram 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)	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.
Partner organizations	Kenya Seed Company, Faida Seed, Agrosoy seed, NGOs, CBOs, County Governments, KEPHIS

2.8.2 TIMP name	**Mulching for weed management in greengram production**
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem addressed	Diversity of annual and perennial grass and broadleaved weed species infestation compete with green gram for growth resources and improper weed control measures that lead to low and poor quality yields.
What is it? (TIMP description)	The practice of covering the soil/ ground with natural or synthetic materials to effectively control germination of weed seeds in or at the soil surface using biodegradable or natural mulches. Biodegradable mulches include straw, grass and dead leaves. Organic mulches (maize stovers commonly used) should be between 2-4 inches deep to effectively prevent weed germination and suppress the growth in green gram fields. In addition organic mulches retain moisture in the soil; keep the soil cool; and help improve soil fertility and improve microclimate when they decompose. Synthetic mulches will solarize soils, suppress weed growth, prevent seed germination and retain soil moisture. Inspect and pull out emerging weeds timely.
Justification	Black polythene prevents weed seed germination and light from reaching the small weeds which then become weak and die. In addition to minimizing weed infestation organic mulches (such as straws and dry grass) facilitate retention of soil moisture there by controlling temperature fluctuations, improves physical, chemical and biological properties of soil by adding nutrients to the soil which enhances the growth and yield of green gram. It also improves soil structure directly by preventing impact of raindrop

	(soil erosion) and indirectly by promoting biological activity. Although a common farmer may not afford, synthetic mulches are easy to obtain and apply, and are reusable.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Researchers, Extension Agents, Service providers
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Farmer field Business schools • On-farm demonstrations during farmer field days • Training in workshops
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release mulching technology in sorghum varieties • A platform for interaction of sorghum value chain stakeholders • Availability of plant or crop residues for organic mulches. • Size of the land. • Competing uses of crop residues. • Type and availability of the crop residues • Cost and availability of synthetic materials • Disposal of synthetic material after use.
Partners/stakeholders for scaling up and their roles	• KALRO to provide Research services • County governments and MoALF to provide extension services, farmer mobilization and policy formulation • NGOs to provide micro financing services
C: Current situation and future scaling up	
Counties where already promoted	Machakos, Kitui, Makueni
Current extent of reach	Available and practiced in different crop value chains
Counties where TIMP will be promoted	Where green gram is a priority value chain.
Challenges in dissemination	• Lack of green gram 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. Be aware of small tears and rips which will allow weeds to emergence through plastic mulches including around the holes. The nutsedges and oxalis may penetrate mulches as early as six days after mulching.
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Crop diversification to increase availability of organic mulches. • Establish and follow a good integrated weed management control program for the particular green gram 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	• 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/ 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 such as use of a black polythene in addition to organic materials like straws dry leaves, and dry grass. • Mulching in green gram is environmentally friendly
Social, environmental, policy and market conditions necessary	• Mulching practice is socially acceptable • Increased productivity will provide supply to the markets • Availability of supporting frameworks/ policies
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	• The work is mainly done by women who have any other roles creating more work for them • Women might not be aware that mulching is used as a weed control • Women have limited access to productive resources such as land so they might not have enough residues to do mulching • The practice uses remnants from previous crops/plants that may offer competition in terms of fuelwood and livestock thus bringing a conflict those performing the specific tasks, e.g. women in case of fuelwood and men for livestock feed. This will negatively affect the adoption and scaling up.
Gender related opportunities	• Women who mainly perform the weeding tasks will get a relief and spend their efforts elsewhere. • Similarly, the improved productivity will benefit both gender in terms of higher earnings.
VMG issues and concerns in development, dissemination, adoption and scaling up	• Though easy to use, it is labour intensive for VMGs, hence its adoption and scaling up is a challenge. • VMGs have limited access and control of productive resources such as land • The VMGs have no finances to pay hired labor due to limited access to credit facilities
VMG related opportunities	• Mulch is locally available on-farm, and thus has very low costs implying that all including • VMGs can take advantage of the practice • Improves food production and nutrition for VMGs.
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, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: Status of TIMP readiness (1=Ready for upscaling: 2=Requires validation; 3=Requires further research	Ready for upscaling.
Contacts	Centre Director KALRO Kabete, off Waiyaki way, P.O. Box 14733-00800, NAIROBI. Tel:+254-0721822312 E-mail: cd.narl@kalro.org
Lead organization and scientists	KALRO, Dr Hottensiah Mwangi, Dr Violet Momanyi
Partner organizations	County governments, Private Public Partnerships

2.8.3 TIMP Name	**Solarization bed for weed control in green gram**
Category (i.e. technology, innovation or management practice)	Innovation
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 germinate and compete with the crop for growth resources such as nutrients leading to yield losses.
What is it? (TIMP description)	Solarisation is a method where transparent/ clear polythene films/ plastic is used to heat the soil and kill weed seedlings and dormant seeds in the top six inches of the soil. This increases soil temperatures by about 10^0C or more than atmospheric. The basic phenomenon is building up of lethal high temperatures in the soil where most dormant and viable seeds are present.

	 Solarization of soil using transparent polythene film. Source: infonet-biovision.org The mechanism can increase soil temperature by 8-12 ºC over non mulched soil which kills seeds and rhizomes of annual and perennial weeds if not deeply buried. Effectiveness depends on specific species and also the length of period of heating.
Justification	Solarization for two consecutive years is successful in controlling perennial weeds. The Mechanism effectively breaks the dormancy of weed seeds, solar scotching of emerged weed seedlings and direct killing of weed seeds by heat. Solarization with 0.05mm T Polythene sheets for 40 days is effective in controlling weeds than use of 0.01mm polythene and takes shorter time duration. This is a good ecological and environmentally friendly method that is sustainable for small scale organic growers. If done properly, the use of post-emergent herbicides to control weeds is not necessary.
Region promoted	Non
Counties where TIMP will be upscaled	Solarization weed control can be upscaled in all the areas where green gram of high value is being grown especially for organic farmers.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers and extension agencies
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • On-farm experimentation and dissemination • Demonstrations on larger plots • Field days, shows, farmer to farmer communication, leaflets, training on how to use solarization.
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release solarisation bed technology weed control in green gram varieties • A platform for interaction of green gram value chain stakeholders • Development of the agronomic practice for green gram • Capacity building and training on use of polythene and solar power.

Partners/stakeholders for scaling up and their respective roles	• Public and private partners (MOALF&I) for extension. • 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	
Current extent of reach	Validation of solarization needs to be done before recommendations are given to the farmers.
Challenges in dissemination	• Lack of green gram 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	• Establish green gram 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	• Chances of successful scaling are higher when diverse value chain stakeholders collaborate in an innovation platform. • Awareness creation through demonstrations and farmer field days help in adoption of the technology of Solarisation bed for weed control • Availability of 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 increased area under green gram cultivation and increase productivity.

	• Solarization to control weeds is cheaper than manual weed control because it requires less labour and achieves timely weed management.
Social, environmental, policy and market conditions necessary	Sensitization of communities on alternative methods of weed control and appropriate use of transparent polythene is very necessary.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not determined
Estimated returns	Not determined
Gender issues and concerns in development and Gender issues and concerns in development, dissemination concerns in adoption and scaling up dissemination	• Women are left out when it comes to formation green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Women are not able to attend organized agricultural trainings and meetings due to their domestic roles and other activities which takes much of their time • Women have limited access to agricultural technologies and information due to their social status in the society • Limited knowledge and information and low literacy levels among the farmers. • Women have limited finances to purchase the required equipment for the TIMP • 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. Need to sensitize both men and women on value of crop losses caused by weed competition
VMG related opportunities	• Women and children are the main sources of labour in green gram production • Adoption of technology will reduce the labour burden for women and children. • There will be increased production of green grams hence increased food security and nutrition
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs are left out when it comes to formation green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • VMGs are not able to attend organized agricultural trainings and meetings due to financial constraints as they have limited access to credits Due to prejudice associated with their social status, VMGs are excluded from accessing benefits from improved technologies. Affirmative action is required to promote the solarization for the VMGs including value addition aspects.

VMG related opportunities	• Increased production will lead to increased consumption of green gram of high nutritive value hence improved health of VMGs; high value of crop will lead to economic empowerment of VMGs.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya 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 **)**	• Requires validation and further research
G: Contacts	
Contacts	KALRO Kabete P.O. Box 14733-00800, Nairobi Email: cdnarl@kalro.org
Lead organization and scientists	KALRO, Dr Violet Momanyi, Dr Hottensiah Mwangi
Partner organizations	MoALF in Counties, Chemical companies.
C: Current situation and future scaling up	

2.8.4 TIMP Name	**Stale seed bed for Weed Control in green gram**
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 germinate and compete with the crop for growth resources such as nutrients leading to yield losses.
What is it? (TIMP description)	A weed management practice in which weed seeds just below the soil surface are allowed/ stimulated to germinate after rainfall or wetting the soil and then killed prior to planting the green gram seeds while minimizing soil disturbances. Weeds are killed using post-emergent herbicides such as glyphosate, sulfosate and glufosinate, or ploughed into the soil. At this stage shallow or use of non-residue paraquat may be used to destroy dense flush young weed seedlings. This is followed by sowing the selected green gram. Several passes made in the soil with roto Spike tooth hallow is useful to destroy the emerging weeds during preparation of stale beds.

Justification	The technology effectively controls broad and narrow leaved weeds that germinate and emerge before the crop is planted. Competition from weeds deprive green of available resources leading to weak and stunted growth in the young crop depending on weed density and diversity, stage of weed growth and environment. Grass weeds such as crab sanguinalis (*Digitaria sanguinalis*), goose grass (*Eleusine indica*) and couch grass which is difficult to control are killed after they germinate. Likewise broadleaved weeds such as amaranths species (eg Red pigweed *(A. retroflexus*)), datura (*Datura stramonium*) and black jack (*Bidens pilosa*) are killed. Weeds whose control is difficult and challenging but can be validated by this technology include: the sedges, wandering jew (*Commelina* species), parthenium and stiga species.
Region promoted	-
Counties where TIMP will be upscaled	Stale weed bed control can be upscaled in all the areas where green gram is being grown.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers and extension agencies
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Training workshops, Seminars, Meetings • On-farm experimentation and dissemination, field days, shows • Farmer to farmer communication, leaflets, demonstrations on larger plot, training on how to use stale bed.
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release stale seed bed for weed control in sorghum varieties • A platform for interaction of sorghum value chain stakeholders • Capacity building and training on use of polythene and stale bed
Partners/stakeholders for scaling up and their respective roles	• Public and private partners –(MOALF&I) 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	
Current extent of reach	Validation of these stale beds needs to be done before recommendations are given to the farmers.
Challenges in dissemination	• Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low use of the technology • Labour intensity

	• Limited knowledge and information and low literacy levels among the farmers. • Capacity building is required to impart knowledge and skills in safe use and application of stale beds. • The farmers need to understand the proper use of stale weed beds
Recommendations for addressing the challenges	• Establish green gram innovation platforms • There is need to train the agricultural extension county officers as TOTs on appropriate use of stale beds. This help in reaching the farmers with the information. • Agricultural extension and environmental officers on the ground for farmer empowerment and guidance on use of stale bed.
Lessons learned	• 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- Stale seed bed • Availability of market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Consumers concerns of herbicide residues in the soil and subsequent crops needs attention • 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	Not determined
Estimated returns	Not determined
Gender issues and concerns in development and dissemination	Need to sensitize both men and women on value of crop losses caused by weed competition.
Gender issues and concerns in development, dissemination concerns in adoption and scaling up	• Women are left out when it comes to formation green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Women are not able to attend organized agricultural trainings and meetings due to their domestic roles and other activities which takes much of their time • Women have limited access to agricultural technologies and information due to their social status in the society • Limited knowledge and information and low literacy levels among the farmers. • Women have limited finances to purchase the required equipment for the TIMP

	• Capacity building is required to impart knowledge and skills in appropriate use and application of stale seed bed for weed control. • The farmers need to understand the proper use and application of stale seed bed for weed control in green gram farms • Need to sensitize both men and women on value of crop losses caused by weed competition
Gender related opportunities	• Women stand to benefit in increased production due to timely operations, increased yields and sales. • Adoption of technology will reduce the labour burden on women and children. The children can get time for school work, while the women can engage in other economic activities. • Adoption of technology will reduce the labour burden for women and children. • There will be increased production of green grams hence increased food security and nutrition
VMG issues and concerns in development, dissemination, in adoption and scaling up	• VMGs are left out when it comes to formation green gram innovation platforms to facilitate interaction with other farmers with relevant stakeholders • VMGs are not able to attend organized agricultural trainings and meetings due to financial constraints as they have limited access to credits • Due to prejudice associated with their social status, VMGs are excluded from accessing benefits from improved technologies. Affirmative action is required to promote the TIMP for the VMGs including value addition
VMG related opportunities	• Timely operations will lead to enhanced production by VMGs. • Increased production will lead to increased consumption of green gram of high nutritive value hence improved health of VMGs; high value of crop will lead to economic empowerment of VMGs.
E: Case studies/profiles of success stories	
Success stories	-
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram 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 Research **)**	Requires validation and further research
G: Contacts	
Contacts	KALRO Kabete P.O. Box 14733-00800, Nairobi

	Email: cdnarl@kalro.org
Lead organization and scientists	KALRO Dr Violet Momanyi, Dr Hottensiah Mwangi
Partner organizations	MoALF in Counties, Chemical companies.

2.8.5 TIMP Name	**Mechanical weed control in green gram production**
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Annual and perennial grass and broadleaved weed species infestation that compete with the crop for growth resources such as nutrients leading to low yields of poor quality.
What is it? (TIMP description)	Mechanical/ manual weed control is a technique that manages weed populations through physical methods that remove, injure, kill, or make the growing conditions unfavourable for growth using tools such as pangas, jembes and slashers. Some of the methods cause direct damage to the weeds through complete removal or causing a lethal injury. Other techniques may alter the growing environment by eliminating light, increasing the temperature of the soil, or depriving the plant of carbon dioxide or oxygen. Mechanical control can be either selective or non-selective. A selective method has very little impact on non-target plants where as a non-selective method affects the entire area that is 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 weeding 2 to 3 weeks later depending on the rate of regrowth.
	  *1.Sub-soiler for land tillage* *2. Clean seed bed prepared manually* *Source: Hottensiah Mwangi*
	Weeding delay that may result into weed take over with resulting in severe competition with the green gram is avoided. The right tools for weeding are used to avoid shock-stress on green gram due to disturbance and root damage because the young green gram plant is very sensitive.The intra row weeds can also be removed by hand pulling.

Justification	Manual hand weeding is labour intensive. It is commonly done late when weeds have competed and taken over the green gram crop. If mechanical control methods are applied at the optimal time and intensity, some weed species may be controlled or even eradicated from the fields. If not controlled weeds will take over, win the competition and cause yield losses. Deep tilling maximizes soil disturbance and brings dormant weed seeds to the surface for germination. Some species are known to be deeply buried and remain dormant in the soil for years before favorable conditions allow germination. By tilling the farmer increases the chances for weed seed germination. The fine soil allows weed seed to grow rapidly by allowing the seed to open and roots to spread easier than compact soils. These emerged weeds can then be destroyed by mechanical weeding to get a clean crop that will give good yields.
Region promoted	Makueni, Machakos, Kitui.
Counties where TIMP will be upscaled	All counties growing green gram.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers and Agricultural extension officers.
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release improved mechanical weeding in sorghum varieties • A platform for interaction of sorghum value chain stakeholders • Participatory Implementation, stakeholder sensitization.
Partners/stakeholders for scaling up and their respective roles	• Public and private partners –(MOALF&I) for extension, • 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 NGOs, CBOs, and FBOs- To provide specialist services like community mobilization, nutrition training etc. • KALRO for research
C: Current situation and future scaling up	
Current extent of reach	Limited research done on gender responsive weeding implements.
Challenges in dissemination	• Lack of green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Labour intensity • Low use of agronomic practices • Labour intensity • Appropriate implements such as sub-soilers are not readily available in the market.
Suggestions for addressing the challenges	• Establish green gram innovation platforms • Work with Jua Kali industries for fabrication of appropriate implements such as sub-soilers.

Lessons learned	• 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 technologies • Availability of market is essential • Partnership is important in technology dissemination and adoptionand this can be facilitated through innovation platforms • Access and use of appropriate weeding tools (technology) will provide timely weed control with reduced drudgery to enhance crop production.
Social, environmental, policy and market conditions necessary	Sensitization of communities on the mechanical weed management practices for sensitive sorghum young plants.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not determined
Estimated returns	Not determined.
Gender issues and concerns in development, dissemination concerns in adoption and scaling up	• Mechanical weeding is gender unfriendly to operate especially for women it is labour intensive • The TIMP increases more work for women who are already burdened by their domestic roles • Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Women and youth have limited access to education, training and extension services than men • Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms • There is need to equip women, youth and stakeholders with information relating to the TIMP • Women and youth have limited access and control of production resources such as land, credit to purchase farm equipment
Gender related opportunities	• Women stand to benefit in increased production as this is a nutritious food crop which will improve the diets. • Sale of extra green gram improve the household income. • Also weeding labour will be reduced.
VMG issues and concerns in development, dissemination, adoption and scaling up	• Mechanical weeding is not friendly for VMGs to perform as it is labour intensive • VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • VMGs have limited access to education, training and extension services than men • Due to prejudice associated with their social status, VMGs are excluded from access to and benefits from improved technologies. • Thus, affirmative action is required to promote the crop for the VMGs including value addition aspects.
VMG related opportunities	• Increased production will improve food and nutrition security and economic empowerment of VMGs • Increased employment for women and youth

E: Case studies/profiles of success stories	
Success stories	Mechanical weed control has successful controlled weeds across the country
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya
F: **Status of TIMP Readiness (**1. Ready for up-scaling; 2. Validation 3. Requires further research**)**	1. Ready for up-scaling
G: Contacts	
Contacts	KALRO Kabete P.O. Box 14733-00800, Nairobi Email: cdnarl@kalro.org
Lead organization and scientists	KALRO, Dr Hottensiah Mwangi, Dr Violet Momanyi.
Partner organizations	MoALF in Counties

2.8.6 TIMP Name	**Chemical weed control in green gram production**
TIMP Name	Herbicide (Chemical) Weed Control
Category (i.e. technology, innovation or management practice)	Management Practice
A: Description of the technology, innovation or management practice	
Problem to be addressed	Diversity of annual and perennial narrow and broadleaved weed species that compete with green gram for nutrients leading yield losses to low and poor quality yields.
What is it? (TIMP description)	Chemical weed control is a technology used to control the germination and growth of the weed species through application of chemicals/ herbicides to weeds or the soil. The technology requires intensive knowledge on the mode of action of the herbicides, the selective ones for sorghum, conditions necessary for application to be effective, type of soil, when to apply and how application is done. Use only recommended herbicides listed by Pesticide Control Board.

		
	Application of a pre-emergent herbicide on the soil Source: Hottensiah Mwangi	*Applllying pre-emergent herbicide to kill weeds after manual tillage* Source: Violet Momanyi
Justification	Appropriate use of herbicides (applications done at the right time and rate indicated on the label) kills weeds there by reducing drudgery and allows timely weed control. Several pre-emergent and post-emergent selective herbicides are registered for control of annual and perennial broad leaved weeds in millet. **Pre-emergent** herbicides applied on the soil same or following day after planting include Lasso and Linuron prevent the germination of both narrow and broad leaved weeds. Lasso is applied at a rate of 150 - 170mls and Linuron at 60 - 80g in 20 litres of water. **Post emergent herbicides** are applied to kill germinated broad leaved weeds in the middle rows of green gram using a hood to avoid injury to the crop. The herbicide 2,4-D 600 SL applied at a a rate of 100 - 200 mls (1.6 - 2.3/ ha) in the middle of the rows 2-3 weeks after crop germination effectively kills broad leaved weeds while glyphosate applied at a rate of 200-600mls in 20 litres of water (2-3 litres/ ha) effectively kills germinated weeds. Planting should then be done 2-3 weeks after application. Always use the rate indicated on the label to effectively control weeds. Constant walking speed, proper calibration of the sprayer, maintenance of correct sprayer pressure and flow rate from each nozzle is required to ensure effective control.	
Region promoted	-	
Counties where TIMP will be upscaled	Regions where green gram is grown	
B: Assessment of dissemination and scaling up/out approaches		
Users of TIMP	Farmers, Axtension agents, Researchers	
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations, training on safe use of herbicides.	

Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release herbicide weed control in green gram varieties • A platform for interaction of green gram value chain stakeholders • Capacity building and training on safe use of herbicide for all users
Partners/stakeholders for scaling up and their respective roles	• Public and private partners –(MOALF&I) 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	
Current extent of reach	Validation of these herbicides needs to be done under different agro-ecological zones and soils before recommendations are given to the farmers.
Challenges in dissemination	• Lack of green gram 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. The farmers need to understand the proper use and application of herbicides to avoid buying inappropriate herbicides and minimize health, environmental and social hazards.
Recommendations for addressing the challenges	• Establish green gram innovation platforms • There is need to train the agricultural extension county officers as TOTs on appropriate use of herbicides. This help in reaching the farmers with the information. • 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 on the ground for farmer empowerment and guidance on safe use of herbicides.
Lessons learned	• 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 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 weed control methods will reduce labour 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 herbicides is vital.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not determined
Estimated returns	Not determined
Gender issues and concerns in development and dissemination	Need to sensitize both men and women on value of crop losses caused by weed competition
Gender issues and concerns in development, dissemination concerns in adoption and scaling up	• Women and children are the main sources of labour for this crop. • Adoption of technology will reduce the labour burden on women and children. The children can get time for school work, while the women can engage in other economic activities. • Women and youth have limited access to productive resources such as credit to buy weed control chemicals • Women and youth have limited access to education, training and extension services and on new technologies such as weed control chemicals • Women have less access to agricultural information, technology and knowledge • Men dominant most decisions at the household and community levels on types of chemicals to use at the farm level • Women have limited access to information, technology and knowledge on stalk disposal as compared to men • Women have got limited access to funding as compared to men to purchase the weed chemicals • There is slow information and awareness flow to female farmers due to their low academic levels
Gender related opportunities	• The technology would create employment for the youth and women • Youth could form groups and engage in spraying weed using weed control chemicals • The adoption of the TIMP will lead to reduced work for women as it will attract men into engaging into weeding • There will be increased yields and sales leading to improved food and nutrition security
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited access to productive resources such as land, credit to access fertilizers and farmyard manures. • VMGs have limited access to training and extension services such as chemicals used in weed control • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to their status to purchase weed control chemicals

VMG related opportunities	Use of herbicides will improve weed management leading to increased productivity, increase availability of green gram for consumption which will improve food security hence improved health of VMGs; high value of crop will lead to economic empowerment of VMGs.
E: Case studies/profiles of success stories	
Success stories	Not known
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestock Research Organization, Nairobi, Kenya Information and instructions displayed on the herbicide labels attached to container on how to use.
F: Status of TIMP Readiness (1. Ready for up-scaling; 2.) Requires validation; 3. Requires Research)	Requires validation and further research
G: Contacts	
Contacts	KALRO Kabete P.O. Box 14733-00800, Nairobi Email: cdnarl@kalro.org
Lead organization and scientists	KALRO, Dr Violet Momanyi, Dr Hottensiah Mwangi
Partner organizations	MoALF in Counties, Chemical companies.

2.8.7 TIMP Name	**Safe Use of herbicides in green gram production**
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 to crops and the soil, use of herbicides for spraying crops without wearing the right protective clothing, storage of herbicides in non-designated stores, wrong application techniques, spraying at the wrong times and against the wind direction, and use without following the guidelines provided on the labels (eg rate and Pre-Harvest Interval), disposal of expired herbicides and empty containers. Inadequate enforcement of global and national policies and regulation on use of pesticides.
What is it? (TIMP description)	The technology includes methodologies for proper herbicide handling, application, and disposal of left overs and containers in order to minimize pollution of the environment and contamination of the produce. Capacity building of farmers, crop protection spray teams on safe handling and use of herbicides right from transportation from the agro-dealers to storage in their houses, mixing procedures and their application in the field in order to ensure safety of the crop, the person handling them and the environment at large.

Justification	Although cases of improper and misuse use of pesticides are very common in most of the areas where maize is grown, they are not documented. There have been 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. Most of these irregularities can easily be corrected through sensitization and capacity building forums for end users to be made aware of the best practices that should be used when handling herbicides. There has been reports of increase of chronic diseases in human beings resulting from pesticide exposure.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, green gram producers
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Farmer trainings, farmer participatory demonstrations/ farmer field schools, shows, trade fairs, Plant clinics, Pesticides spray Demonstrations.
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and employ safe use herbicide application in maize varieties • A platform for interaction of maize value chain stakeholders • Development of agronomic practices for green gram • Collaboration between all partners, willingness of farmers to adhere to proper guidelines. • Adequate facilitation: funds, logistics (transport)
Partners/stakeholders for scaling up and their roles	• Ministry of Agriculture-Extension Service to conduct extension services and farmer trainings, Individual Farmers, farmer groups/CBOs to participate in the implementation of the various technologies for maize production • KALRO and Universities to develop the technologies and conduct ToTs. AAK, PCPB, KEPHIS.
C: Current situation and future scaling up	
Counties where technology is already being promoted if any	To be selected
Counties where TIMPS will be up scaled	To be selected
Challenges in dissemination	• Lack of sorghum innovation platforms to facilitate interaction of farmers with relevant stakeholders • Low use of technology • Labour intensity and requires skilled man power • Change of mindset in favour of current practices maybe difficult to achieve. • Illiteracy and inadequate capacity to use herbicides correctly. Most farmers cannot read and interpret the labels properly resulting to overuse or underuse of herbicides. • Use of banned pesticides from neighboring countries • Inadequate capacity by farmers and agrochemical companies to dispose herbicides (pesticides) properly

Suggestions for addressing the challenges	• Establish sorghum innovation platforms • Capacity building and sensitization forums for both farmers and agro dealers using participatory approach. • Formation of youth spray teams. • Establishment of aggregation centres for pesticide containers • Establishment of training of Extension staff and lead farmers as TOT. • Increase surveillance along the border points and enforce the laws.
Lessons learned in upscaling if any	• 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 technologies • Availability of market is essential • Partnership is important in technology dissemination and adoption and this can be facilitated through innovation platforms • Consumers concerns of herbicide residues in the soil and subseguent crops needs attention • Upscaling of this technology needs young men and youth due to its hazardous nature. Some of the aspects of this technology need a lot of capital to actualize. For instance, the collection and incineration of pesticide containers needs a lot of money that may not be accessible by most men or youth groups. • The illiteracy levels of some farmers may hinder the use of correct information/knowledge in the use of herbicides in some areas.
Social, environmental, policy and market conditions necessary	Organized collective marketing channels critical for benefits to be derived from practice
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not determined
Estimated returns	Not determined
Gender issues and concerns in development, dissemination, adoption and scaling up	• Technology is not safe for use by expectant women and the physically challenged individuals because of it hazardous/dangerous nature. • Herbicides and protective gear are expensive and most women may not afford them. • Lack of knowledge by men and women on the dangers of herbicides especially on storage and disposal. • Low levels of illiteracy and inability to read and interpret the content of the herbicide labels especially on re-entry period after spraying and PHI. This can cause herbicides poisoning to get into contact. • Women spray herbicides but it's not recommended
Gender related opportunities	• Formation of spray teams by men creating employment • Reduces workload for women • Improves food security and nutrition
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited access to training and extension services where they can get information on herbicides • VMGs have limited access to markets as they sometimes cannot travel to far regional markets due to their status to purchase herbicides for weed control

	• These are dangerous products that may not be handled by vulnerable groups. • Herbicides are expensive for most youths and physically challenged groups that may not utilize them.
VMG related opportunities	• Safe use of herbicides practice can easily be undertaken by the youth as an enterprise by forming Spray teams in the wards in each county. • Youths to offer spray calibration services to farmers as an enterprise. • Youths to help in the collection of pesticide containers and assist in the incineration processes by AAK. • Youth to own and operate agro chemicals that stock right pesticides and offer advisory services to farmers at the agrovet shops • Improved food security and nutrition for VMGs
E: Case studies/profiles of success stories	
Success stories	• The AAK has trained youth spraying teams that have helped in the spraying of the farms in a few counties thus reducing cases of people being exposed to herbicides. • Some counties who have aggregation centres by AAK for collection of pesticide containers. This has led to reduction of these containers on farms. • Safe use of Pesticide campaigns by AAK, PCPB, KALRO and MOLF.
Application guidelines for users	Esilaba, A.O.et al. (2021). KCEP-CRAL Green Gram Extension Manual. Kenya Agricultural and Livestoc ResearchOrganization, Nairobi, Kenya Manuals, brochures developed by KALRO and CABI as reference material
Status of TIMP readiness (1. Ready for upscaling; 2. Requires validation; 3. requires further research)	Ready for upscaling
F: Contacts	
Contacts	KALRO Kabete P.O. Box 14733-00800, Nairobi Email: cdnarl@kalro.org
Lead organization and scientists	KALRO, Dr Violet Momanyi, Dr Hottensiah Mwangi
Partner organizations	MoALF&I, CABI, PCPB, AAK, KEPHIS, County Governments, Universities

2.9 Green Gram Post Harvest Management

2.9.1 TIMP Name	**Harvesting**
Category (i.e. technology, innovation or management practice)	Management Practice

A: Description of the technology, innovation or management practice	
Problem to be addressed	Losses due to incorrect timing of harvest and inappropriate harvesting methods.
What is it? (TIMP description)	This is a management practice involving careful maturity indices, pre-harvest operations and actual harvesting procedure. **Maturity indices and correct time for harvesting** Green grams should be harvested at the physiological maturity, i.e. when 95% of the pods have fully matured, and turned black and dry. During this time, pods are thin and brittle and hence shattering is not a problem during harvesting. This also ensures optimum grain quality and consumer acceptance.  Green gram crop with pods turning black, ready for harvesting **Harvesting** Harvesting of green grams is done either manually or by machines (combine harvester). Manual harvesting: When harvesting is done manually, green gram stalks may be cut with a hand saw, or sickle; or uprooted. Alternatively, mature pods may simply be handpicked. The harvested bundles should be kept in one direction to facilitate efficient threshing. They should be stacked in a dry, clean place to facilitate circulation of air around.  Manual harvesting of green grams in Kitui (Source: Philip Muasya, *Standard*) **Mechanical harvesting:** For mechanical harvesting, the plants should defoliate (using defoliants / or desiccants) and dry before harvesting. Seed splitting and damage during harvesting can be minimized by harvesting the crop at the optimum moisture content (14 to 16%), avoid harvesting during the noon when temperatures are too high, and by proper harvest settings.
Justification	Incorrect timing of harvesting and inappropriate harvesting methods leads to losses of green grams. Harvesting before the maturity of the crop results in lower yields, higher proportion of

	immature seeds, poor grain quality and more chances of pest infestation during storage. Delayed harvesting results in shattering of pods and losses caused by birds, rats and insects. Correct timing of harvest reduces these losses.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders and extension agents
Approaches used in dissemination	On-farm experimentation and demonstration, Farmer Field and Business Schools, Farmer Innovation Platforms (FIPs), field days, leaflets
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality green grams, availability of quality standards
Partners/stakeholders for scaling up and their respective roles	• 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 correct maturity indices and appropriate harvesting procedures. They will also offer advice and collect information on the uptake and practice on the technology • KALRO – will train trainers and provide technical backstopping on dissemination of maturity indices and appropriate harvesting procedure.
C: Current situation and future scaling up	
Counties where already promoted, if any	Kitui, Machakos, Baringo
Counties where TIMPs will be upscaled	Machackos
Challenges in development and dissemination	• Lack of knowledge on maturity and appropriate harvesting technology • Negative attitude by farmers towards adoption of new agricultural TIMPs
Suggestions for addressing the challenges	• Awareness creation about the TIMP to farmers • Capacity building of farmers on the TIMP • Availing data on economics and the gains to be made through adoption of the TIMP
Lessons learned in up scaling, if any	• Involvement of stakeholders such as CBOs and NGOs enhances adoption • Continuous capacity building is key to attitude change. • Consistent trainings, demonstrations and sensitisations would motivate farmers to adopt the TIMP
Social, environmental, policy and market conditions necessary for development and up-scaling	• Farmers are willing to adopt the technology • There is favourable policy for adoption of the technology • conditions: The market absorb saved grain from reduced harvesting losses
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Labour for harvesting
Estimated returns	Not yet estimated

Gender issues and concerns in development, dissemination, adoption and scaling up	• Women have limited access to productive resources such as land, credit facilities and equipment • In the target counties, green gram cultivation is mainly done by women increasing their work burden • Women loss their crops due to late harvesting as a result of being overworked • Women have no finances to pay for hired labor due to limited access to credits • Women are exploited by middle men and brokers due to limited market information and extension • The TIMP is easily adoptable after training and many farmers can use the technology since it reduces losses incurred during and after harvesting.
Gender related opportunities	• The TIMP increases farm income through reduction of postharvest losses. • There is increased employment for women and youth • There is increased food security and nutrition for households
VMG issues and concerns in development and dissemination, adoption and scaling up	• It is labor intensive for some VMGs especially the PLWD and the sick. • VMGs lack access to information on new technologies and information • VMGs have no finances due to limited access to credit facilities • Mechanical harvesting can be encouraged to all gender, including the VMGs.
VMG related opportunities	• Adoption of the TIMP means reduced postharvest losses, • This will enable VMGs to have enough green gram to consume, hence get macro- and micronutrients (especially minerals) • More income for the farmers (VMGs)
E: Case studies/profiles of success stories	
Success stories	Farmers in Kitui and Machakos have adopted the technology
Application guidelines for users	Green gram harvesting leaflets, factsheets and manuals
F: Status of TIMP Readiness (1. Ready for up scaling; 2. Requires validation; 3. Requires further research)	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, Victor Wasike, Lusike Wasilwa
Partner organizations	MoA (County Governments), Farmer Groups, Service provider agencies e.g. financial institutions, traders and private sector processors

GAPS

- Quantification of the losses due to incorrect timing of the right maturity for harvesting different green gram varieties
- Quantification of losses of manual vs. mechanical green gram harvesting, including the cost-benefit analyses of each method

2.9.2. TIMP name	**Tarpaulins for drying of green gram pods before threshing**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Yield loss due to fungal infestation and inefficient threshing from inefficiently dried grain
What is it? (TIMP description)	The management practices involves drying of the pods on a tarpaulin (mats) until they are ready for threshing. This avoids contamination of the grain during drying, hence minimizing mycotoxin contamination of the grain.  Drying of green gram pods on a tarpaulin (Source: F. Wayua)  Dry pods ready for threshing (Source: F. Wayua)
Justification	Well dried pods enhance threshing efficiency and food safety of the grain
B: Assessment of dissemination and scaling up/out approaches	

Users of TIMP	Farmers and extension agents
Approaches to be used in dissemination	Farmer training and demonstrations, farmer field days, extension publications, agricultural shows and exhibitions, extension publications
Critical/essential factors for successful promotion	• Existence of effective extension services to demonstrate the technology • Accessibility and cost of the tarpaulins by farmers • Funding to promote the tarpaulins
Partners/stakeholders for scaling up and their roles	• Extension service providers to help in the dissemination • NGOs (e.g. One-Acre Fund) to help in technology dissemination through on-farm demonstrations; capacity building of farmers, availability of tarpaulins • Private sector e.g. agro-dealers to avail tarpaulins close to farmers • County governments – to help in the dissemination of the technology
C: Current situation and future scaling up	
Counties where already promoted, if any	Machakos, Kitu, Kakamega, Bungoma
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Lack of local availability of tarpaulins close to farmers • Lack of funds to procure the tarpaulins
Suggestions for addressing the challenges	• Adopting public-private-partnerships, so that the private sector (e.g. NGOs, agro-vets, etc.) can stock the tarpaulins closer to farmers • Availing appropriate credit facilities to farmers to enable acquisition of tarpaulins
Lessons learned in up scaling, if any	Up-scaling is enhanced through partnership technology dissemination, extension training and regular monitoring, and availing the tarpaulins within easy reach of farmers
Social, environmental, policy and market conditions necessary for development and up scaling	• Farmers are willing to adopt the technology • Policies to encourage supply of tarpaulins within easy reach to farmers are implemented • Market is able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 5,000/- per tarpaulin
Estimated returns	Reduced postharvest losses
Gender issues and concerns in development, dissemination adoption and scaling up	• Women have limited access to productive resources such as land, credit facilities and equipment • In the target counties, green gram cultivation is mainly done by women increasing their work burden • Women loss their crops due to inefficient drying methods due to lack of tarpaulins • Women have no finances to pay for tarpaulins due to limited access to credits • The TIMP is easily adoptable after training, providing appropriate credit facilities and availing the tarpaulins to local

	agro-dealers; many farmers can use the technology since it reduces losses incurred during drying
Gender related opportunities	• Opportunities for youth, women and VMGs in marketing tarpaulins • The TIMP increases farm income through reduction of postharvest losses, hence increased food security and nutrition for households. • The TIMP also enhances food safety by preventing contamination of the harvested produce during drying
VMG issues and concerns in development, dissemination adoption and scaling up	• It is labor intensive for some VMGs especially the PLWD and the sick. • VMGs lacks access to information on new technologies and information • VMGs have no finances due to limited access to credit facilities • Tarpaulins can be encouraged to all gender, including the VMGs.
VMG related opportunities	• Adoption of the TIMP means reduced postharvest losses and enhanced food safety • The technology can improve food and nutrition security and a window for increased income. • Opportunity for VMGs to engage in marketing of tarpaulins
E: Case studies/profiles of success stories	
Success stories	Farmers in Kitui, Machakos and Tana River have adopted tarpaulins
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Tarpaulins for drying of green gram pods before threshing. KALRO/KCSAP Programme Factsheet No. #, July 2020
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 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., Victor Wasike, Francis Wayua
Partner organizations	Extension service providers, CGIAR's, NGOs, County governments

2.9.3 .TIMP name	Threshing of green gram pods (Multipurpose Legume Thresher)
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Postharvest losses due to inefficient threshing, breakages during manual threshing, and resulting pest infestation of broken grain
What is it? (TIMP description)	This is a motorised multipurpose thresher for threshing green grams, common dry beans and pigeon peas.  **Multipurpose legume thresher (Source: Wayua)**
Justification	The multipurpose legume thresher is fast and efficient, does not contaminate the threshed grain with soil, and has minimal breakages, hence better quality
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders and extension agents
Approaches to be used in dissemination	On-farm demonstrations, Farmer Field and Business Schools, farmer field days, exhibitions, and agricultural shows, farmer training, extension publications
Critical/essential factors for successful promotion	• County and Central Government support • Funding to promote the threshers • Existence of effective extension services to demonstrate the technology • Strong partnership linkages
Partners/stakeholders for scaling up and their roles	• Extension service providers to help in the dissemination • NGOs e.g. Agricultural Technology Development Centre (ATDC) - Katumani, and Bukura) to fabricate the threshers, and disseminate to farmers through on-farm demonstrations; capacity building of farmers, • KIRDI - to fabricate the threshers, and disseminate to farmers through on-farm demonstrations; capacity building of farmers • County governments to help in the dissemination of the technology
C: Current situation and future scaling up	

Counties where already promoted, if any	Kitui
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Lack of local availability of threshers • Lack of knowledge on the technology
Suggestions for addressing the challenges	• Adopting public-private-partnerships, so that the private sector (e.g. NGOs) can fabricate the threshers closer to farmers • Capacity building of farmers on the technology
Lessons learned in up scaling, if any	• Partnership is important in technology dissemination • Extension training and regular monitoring are essential in up-scaling
Social, environmental, policy and market conditions necessary for development and up scaling	• Farmers will be willing to adopt the technology • Policies to encourage local fabrication of threshers are implemented • The market is able to absorb increased supply of grain
• D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	• KES 120,000/-
Estimated returns	• Breaks labour bottlenecks • Slight reduction compared to traditional techniques • It also causes less splitting of seeds, low number of seeds left in pods,
Gender issues and concerns in development, dissemination adoption and scaling up	• Access of funds by women is limited • Thresher is expensive for women to afford • Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Women have limited access to education, training and extension services than men relating to farm mechanization • Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms • Threshers should be designed for easy start and operation. • Up-scaling should target all the gender and they should be affordable to all gender
Gender related opportunities	• Opportunities for youth in fabrication and repair of threshers, and providing threshing services • The motorised thresher is less laborious particularly for women who are mainly the ones doing manual threshing. Time saved can be used in other productive agricultural activities
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities

	• Operating a threshing machine is complicated for some VMGs especially those who are abled differently to operate • VMGs need to be equipped with information relating to the TIMP • Linking the VMG to financial institutions would enable them to buy since it is affordable and easy to maintain machines • Farm machines need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable
VMG related opportunities	• Improved nutrition for VMGs - the technology reduce postharvest losses, hence more green grams to be consumed and sold • Opportunity for VMGs to engage in fabrication and repair of threshers
E: Case studies/profiles of success stories	
Success stories	Farmers in Kitui and Machakos have adopted the threshers
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Green gram thresher. KALRO/KCSAP Programme Factsheet No. #. July 2022
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 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, Victor Wasike, Lusike Wasilwa
Partner organizations	Extension service providers, ATDC, KIRDI, NGOs

2.9.4 TIMP name	**Winnowing**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Poor quality grains
What is it? (TIMP description)	Dry green gram grains are winnowed to remove chaff, dust, foreign matter such as stones, broken grains, shrivelled, mouldy, insect damaged, rotten discoloured or faded, and any remaining plant parts grains. Winnowing is then done using a winnowing tray (*'uteo'*) to separate the dry grain from the soil matter before sorting. Sorting should be properly done as this attracts a better price than unsorted green gram grains.

	 Winnowing of threshed green gram grains (Source: Lusike Wasilwa)
Justification	Winnowing improves grain quality by removing chaff, dust, foreign matter such as stones, broken grains, shrivelled, mouldy, insect damaged, rotten discoloured or faded, and any remaining plant parts grains. High quality grain enhances fetches better prices.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, extension agents
Approaches to be used in dissemination	Extension publications, on-farm demonstrations, farmer training
Critical/essential factors for successful promotion	• Existence of effective extension services to demonstrate the technology • Strong partnership linkages
Partners/stakeholders for scaling up and their roles	• Extension service providers to help in the dissemination • NGOs to help in technology dissemination through on-farm demonstrations; and capacity building of farmers • County governments – to help in the dissemination of the technology
C: Current situation and future scaling up	
Counties where already promoted, if any	Kitui, Machakos
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	Lack of incentives for producing clean green gram grain
Suggestions for addressing the challenges	Proving incentives for farmers and traders who produce and sell clean green gram grains
Lessons learned in up scaling, if any	Extension training and regular monitoring are essential
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. KEBS ensure traders selling cleaner grain are certified and appreciated for their efforts • Favourable policy, encouraging better prices for clean grain • Existing and new markets are developed and maintained
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Labour for winnowing
Estimated returns	Higher income and better nutrition from clean grains

Gender issues and concerns in development, dissemination adoption and scaling up	• The TIMP improves grain quality, hence more income for women and youth • In the target counties, green gram winnowing is mainly done by women increasing their work burden • Women have no finances to pay for hired labor due to limited access to credits • The TIMP is easily adoptable after training and many farmers can use it since it improves grain quality
Gender related opportunities	• The TIMP increases farm income through enhancing grain quality • There is increased food security and nutrition for households • There is more employment for women and youth
VMG issues and concerns in development, dissemination adoption and scaling up	• Winnowing is labor intensive for some VMGs especially the PLWD and the sick. • VMGs lacks access to information on new technologies and information • VMGs have no finances due to limited access to credit facilities to hire labor
VMG related opportunities	• Adoption of the TIMP means clean grain which fetches better prices, hence improving food and nutrition security and income • This will enable VMGs to have enough green gram to consume, hence get macro- and micronutrients (especially minerals
E: Case studies/profiles of success stories	
Success stories	Farmers in major grain growing areas have adopted the winnowing technology
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Green gram winnowing. KALRO/KCSAP Programme Factsheet No. #. July 2022
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 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., Victor Wasike, Francis Wayua
Partner organizations	Extension service providers, CBOs, NGOs and County governments

2.9.5. TIMP name	Mechanized solar drying of threshed green gram grains
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Postharvest loss due to mycotoxin contamination of inefficiently dried grain
What is it? (TIMP description)	Drying of threshed grains can be done in open sunshine, or in mechanised solar dryers and electricity powered dryers, which are fast and efficient. Drying of threshed grain involves reducing the moisture content to 10%, which is important for safe storage  Diesel powered grain dryer in Kitale, Kenya (Source: Wayua)  Greenhouse solar dryer for agricultural produce (Source: Wayua) The grains should be dried to a moisture content of 10% which is important for safe storage. Use a moisture meter for accurate determination of moisture content.
Justification	Well dried grains eliminates mycotoxin contamination of the grain and is important for safe storage.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, processors, extension agents, research organizations and universities
Approaches to be used in dissemination	On-farm demonstrations, farmer training, extension publications, agricultural shows and exhibitions, farmer field days
Critical/essential factors for successful promotion	• Existence of effective extension services to demonstrate the technology

	• Strong partnership linkages • Funding to promote the driers
Partners/stakeholders for scaling up and their roles	• Extension service providers (Public and private) to help in the dissemination • CGIAR's • NGOs): technology dissemination through on-farm demonstrations; capacity building of farmers, availability of solar dryers • County governments –Help in the dissemination of the technology • Financial institutions – provide credit to farmers to enable acquisition of the drying machines
C: Current situation and future scaling up	
Counties where already promoted, if any	Busia, Trans Nzoia, Kisii
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	Lack of local availability of dryers
Suggestions for addressing the challenges	Adopting public-private-partnerships, so that the private sector can stock the dryers closer to farmers and charge a fee for their usage Farmer groups to be given affordable credit facilities to acquire the solar dryers
Lessons learned in up scaling, if any	The technology is more appropriate to large scale farmers. Small-scale farmers can pool their grain to use and benefit from the technology
Social, environmental, policy and market conditions necessary for development and up scaling	• Ability of farmers to pool their grain for drying in the driers • The market is able to absorb increased supply of grain • Favourable policy, encouraging better prices for properly-dried grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	This includes costs of hiring the drier, and fuel for drying
Estimated returns	Reduced losses as a result of properly dried grain
Gender issues and concerns in development, dissemination adoption and scaling up	• In the target counties, green gram winnowing is mainly done by women increasing their work burden • Women have no finances to pay for hired labor due to limited access to credits • The TIMP is easily adoptable after training and many farmers can use it since it improves grain quality • Access to funds by women is limited • Use of dryers will not overburden any gender in implementation and therefore have potential for adoption by both gender.
Gender related opportunities	• Offers employment for the youth in offering grain drying services • The dryers improves grain quality, hence more income for women and youth • It makes work easy for women and it enhances equitable distribution of labour

	• Improves food security and nutrition for households
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGS have no finances to pay for hired labor due to limited access to credits • VMGs have limited access to agricultural information on new technologies and innovations • VMGs due to their status are ignored when important decisions are being made relating to farming
VMG related opportunities	• The technology can improve food and nutrition security and a window for increased income for VMGs • The dryers improves grain quality, hence more income for women and youth • It makes work easy for VMGs • Improves food security and nutrition for households
E: Case studies/profiles of success stories	
Success stories	Farmers in Kitui and Machakos have adopted the dryers
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Drying of threshed green grams. KALRO/KCSAP Programme Factsheet No. #, July 2020
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 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., Victor Wasike, Francis Wayua
Partner organizations	Extension service providers, NGOs and County governments

2.9.6 TIMP name	**Moisture meter for green gram moisture determination**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	High postharvest losses and mycotoxin contamination due to inappropriately dried grains
What is it? (TIMP description)	This is a portable electronic machine for accurate measuring the moisture content of threshed green gram and other food grains. Threshed grain is placed inside the bowl of the moisture meter, and the reading taken after 1-2 minutes. The grains should be dried to a moisture content of 10% which is important for safe storage.

	 Moisture meter (Source: Mbeyagala *et al*., 2017)
Justification	Drying and storage challenges are the two main postharvest problems faced by green gram farmers in Kenya after harvesting their produce. Inappropriate drying leads to mycotoxin contamination of the grain in storage. Inappropriately dried grain will not mill correctly during processing and value addition. The moisture meters enable farmers to accurately know when their grain is dry enough to the recommended moisture content for storage (10%), hence preventing mycotoxin contamination and postharvest losses. Well dried grains eliminates mycotoxin contamination of the grain and is important for safe storage.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, extension agents, research organizations and universities, Government (e.g. National Cereals and Produce Board)
Approaches to be used in dissemination	Extension publications, on-farm demonstrations, agricultural shows and exhibitions, farmer field days and farmer training
Critical/essential factors for successful promotion	• Existence of effective extension services to demonstrate the technology • Accessibility and cost of the tarpaulins by farmers • Funding to promote the tarpaulins
Partners/stakeholders for scaling up and their roles	• Extension service providers to help in the dissemination • NGOs to help in technology dissemination through on-farm demonstrations; capacity building of farmers, availability of grain moisture meters • Private sector e.g. agro-dealers to avail grain moisture mters close to farmers • County governments – to help in the dissemination of the technology
C: Current situation and future scaling up	
Counties where already promoted, if any	Kakamega, Busia, Trans Nzoia, Kisii, Tharaka Nithi, Machakos, Embu, Kakamega
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Lack of local availability of grain moisture meters close to farmers • Lack of funds to procure the moisture meters

Suggestions for addressing the challenges	• Availing the devices locally through agro-dealers and other private sector entrepreneurs • Farmer groups to be given affordable credit facilities to acquire the grain moisture meters
Lessons learned in up scaling, if any	Up-scaling is enhanced through partnership technology dissemination, extension training and regular monitoring, and availing the moisture meters within easy reach of farmers
Social, environmental, policy and market conditions necessary for development and up scaling	- Farmers willingness to adopt the technology - Market able to absorb increased supply of grain - Policies to encourage supply of moisture meters within easy reach to farmers are implemented - Favourable policy, encouraging better prices for well-dried grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 50,000/ per piece
Estimated returns	Reduced losses, hence higher returns and enhanced nutrition
Gender issues and concerns in development, dissemination adoption and scaling up	• Women have limited access to productive resources such as land, credit facilities and equipment • In the target counties, green gram cultivation is mainly done by women increasing their work burden • Women loss their crops due to inefficient drying methods due to lack of reliable apparatus to test when their grain is dry enough for safe storage • Women have no finances to pay for moisture meters due to limited access to credits • The TIMP is easily adoptable after training, providing appropriate credit facilities and availing the moisture meters to local agro-dealers; many farmers can use the technology since it reduces losses incurred due to incorrect detection when drying is complete
Gender related opportunities	• Opportunities for youth, women and VMGs in selling moisture meters • The TIMP increases farm income through reduction of postharvest losses, hence increased food security and nutrition for households. • The TIMP also enhances food safety by preventing mycotoxin contamination from improperly dried grain due to poor detection methods of the correct drying parameter
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs lacks access to information on new technologies and information • VMGs have no finances due to limited access to credit facilities • VMGs have limited access to agricultural information on new technologies and innovations • VMGs due to their status are ignored when important decisions are being made relating to farming • Moisture meters can be encouraged to all gender, including the VMGs.
VMG related opportunities	• Adoption of the TIMP means reduced postharvest losses and enhanced food safety

	• The technology can improve food and nutrition security and a window for increased income. • Opportunity for VMGs to engage in marketing of moisture meters
E: Case studies/profiles of success stories	
Success stories	Farmers in Kakamega, Trans Nzoia, Bungoma, Tana River have adopted the technology
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Grain moisture meter. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up-scaling
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., Victor Wasike, Francis Wayua
Partner organizations	Extension service providers, NGOs, agro-dealers, County Governments

2.9.7. TIMP name	**De-stoning machine**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	Low quality and food safety risks due to presence of stones, glass, metal particles and other physical contaminants in green grams
What is it? (TIMP description)	This is a machine which removes stones, glass, metal particles and other physical contamination from green gram grains, using vibration and fluidized air.  Destoning machine

Justification	The machine removes stones from the green grams, hence guaranteeing safety and quality of the produce, hence better prices
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmer groups and cooperatives, traders, industrial processors
Approaches to be used in dissemination	Field days, exhibitions, agricultural shows, trainings and promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Ideal for commercial green gram production and marketing (large scale producers). For small-scale operations, the stones and physical contaminants can be removed during winnowing. • County and central government support • Funding to promote the varieties
Partners/stakeholders for scaling up and their roles	• NGOs / CBOs to help in the dissemination • Traders and industrial processors to adopt the technology • Financial institutions – provide credit to value chain actors to enable acquisition of the de-stoners
C: Current situation and future scaling up	
Counties where already promoted, if any	None
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Lack of information and skills on the technology • Lack of funds to acquire de-stoners
Suggestions for addressing the challenges	• Capacity building of farmers, traders and extension agents • Provide appropriate financial services and credit facilities to small-scale farmers and traders
Lessons learned in up scaling, if any	Up-scaling is enhanced through partnership, extension training and regular monitoring, and availing the machines within easy reach of farmers, traders and processors
Social, environmental, policy and market conditions necessary for development and up scaling	- Ideal for large scale green gram production and industrial - Value chain actors willingness to adopt the technology - Market able to absorb increased supply of grain - Policies to encourage supply of destoning machins within easy reach to farmers are implemented - Favourable policy, encouraging better prices for higher quality grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Better prices from higher quality grain
Gender issues and concerns in development, dissemination adoption and scaling up	Women have limited access to funds • Women have limited access to productive resources such as land, credit facilities and equipment • In the target counties, green gram work is mainly done by women increasing their work burden • Women loss their crops due to inefficient post-harvest methods due to lack of reliable apparatus to remove stones
Gender related opportunities	Opportunities for youth to engage in commercial production of green grams; and also in offering grain de-stoning services to value chain actors

	Improved quality of grains Improved incomes for youth and women
VMG issues and concerns in development, dissemination adoption and scaling up	Financial constraints to VMGs • VMGs lacks access to information on new technologies and information • VMGs have no finances due to limited access to credit facilities • VMGs have limited access to agricultural information on new technologies and innovations • VMGs due to their status are ignored when important decisions are being made relating to farming
VMG related opportunities	The technology can improve food and nutrition security and a window for increased income. Opportunities for youth to engage in commercial production of green grams; and also in offering grain de-stoning services to value chain actors Improved quality of grains Improved incomes for youth and women
E: Case studies/profiles of success stories	
Success stories	Large scale traders and industrial processors in major cities are using the technology
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). De-stoning machine. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up-scaling
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., Victor Wasike, Francis Wayua
Partner organizations	- Industry (processing factories, exporters, and other traders) - NGOs - County governments

2.9.8 TIMP name	**Purdue Improved Crop Storage (PICS) Hermetic Bags**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problem addressed	High postharvest losses of food grains
What is it? (TIMP description)	This is gunny bag with two inner polythene linings. Dry green gram (10% moisture content) to be stored is put inside the inner polythene bag which is then tied air-tight. The second polythene is also tied air-tight, followed by tying the outer gunny bag cover. This is a

	chemical-free storage of dry green gram and other food grains. The PICS bags is very effective in keeping off green gram storage pests, the main one being bean bruchid. Grain can keep over one year inside the hermetic bags, if kept in a cool dry place, and other destructive agents e.g. rodents are kept at bay.  Purdue Improved Crop Storage (PICS) Hermetic Bags (Source: Wayua)
Justification	Pests can cause crop loss of up to 100%. PICS bags prevents bruchid infestation during storage, and increase shelf life of green gram and food grains along the value chain through hermetic storage. This will increase income of farmers and traders. The PICS hermetic bags are chemical-free crop storage, hence safer to use.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, processors, Government agencies (e.g. National Cereals and Produce Boards)
Approaches to be used in dissemination	On-farm demonstration, field days, exhibitions, agricultural shows, trainings and promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Existence of effective extension services to demonstrate the technology • Accessibility and cost of the hermetic bags to farmers • Funding to promote the hermetic bags
Partners/stakeholders for scaling up and their roles	• Extension service providers to help in the dissemination • NGOs and agro-dealers to help in technology dissemination through on-farm demonstrations; capacity building of farmers, availability of hermetic bags • Private sector e.g. agro-dealers to avail tarpaulins close to farmers • County governments – to help in the dissemination of the technology • Financial institutions – provide credit to farmers to enable acquisition of the hermetic bags
C: Current situation and future scaling up	
Counties where already promoted, if any	Busia, Trans Nzoia, Kisii, Tharaka Nithi, Machakos, Embu, Kakamega
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Lack of local availability of hermetic bags close to farmers • Lack of funds to procure the hermetic bags
Suggestions for addressing the challenges	• Adopting public-private-partnerships, so that the private sector (e.g. NGOs, agro-vets, etc.) can stock the hermetic bags closer to farmers

	• Availing appropriate credit facilities to farmers, traders and processors to enable acquisition of hermetic bags
Lessons learned in up scaling, if any	The major outcome of PICS bags was a change in marketing behavior: farmers sell later, at 5 months after harvest, increasing their income. Up-scaling is enhanced through partnership technology dissemination, extension training and regular monitoring, and availing the tarpaulins within easy reach of farmers.
Social, environmental, policy and market conditions necessary for development and up scaling	- Policies to encourage supply of hermetic bags within easy reach of farmers are implemented - Favourable policy, encouraging better prices for high quality grain - Market able to absorb increased supply of grain
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	- KES 300/- per PICS bag
Estimated returns	Reduces postharvest losses by 100%
Gender issues and concerns in development, dissemination adoption and scaling up	• Women have limited access to productive resources such as land, credit facilities and equipment • In the target counties, green gram cultivation is mainly done by women increasing their work burden • Women loss their crops due to inefficient storage methods due to lack of hermetic bags • Women have no finances to pay for hermetic bags due to limited access to credits • The TIMP is easily adoptable after training, providing appropriate credit facilities and availing the hermetic bags to local agro-dealers; many farmers can use the technology since it reduces losses incurred during storage
Gender related opportunities	• Opportunities for youth in selling PICS bags to farmers and traders • The TIMP increases farm income through reduction of postharvest losses and enhancing food safety, hence increased food security and nutrition for households.
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs lacks access to information on new technologies and information • VMGs have no finances due to limited access to credit facilities • VMGs due to their status are ignored when important decisions are being made relating to farming
VMG related opportunities	• Adoption of the TIMP means reduced postharvest losses and enhanced food safety • The technology can improve food and nutrition security and a window for increased income. • Opportunity for VMGs to engage in marketing of hermetic bags
E: Case studies/profiles of success stories	
Success stories	The technology is widely used in major grain growing areas of Kenya

Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Purdue Improved Crop Storage (PICS) Hermetic Bags. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up-scaling
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., Victor Wasike, Francis Wayua
Partner organizations	Extension service providers, NGOs, agro-dealers, County governments

2.9.9 TIMP name	**Green gram stores**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	High postharvest storage losses of food grains
What is it? (TIMP description)	The TIMP includes a storage structure for storage of the grains in hermetic bags. The storage structure ensures that the hermetic bags are not attacked by rodents, and maintains the quality of the grain. The store can adopt acoustic technology to monitor and control insect infestation of the store. Practice First In First Out (FIFO) principle in stock management. 
Justification	The TIMP reduces losses by maintaining the quality of stored grain and ensures a steady supply of grain. This enables farmers to bulk green grams during harvest season and sell the grains during the off seasons at higher prices.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, industrial and commercial processors
Approaches to be used in dissemination	On-farm demonstration, exposure visits, trainings and promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Existence of functional institutional arrangements and market linkages • Accessibility and cost of grain storage structures to farmers

	• Funding to promote the grain stores
Partners/stakeholders for scaling up and their roles	• Extension service providers (Public and private) to help in the dissemination • NGOs / CBOs • National and County governments (e.g. NCPB) to help in the dissemination • Financial institutions to provide credit for constructing grain stores
C: Current situation and future scaling up	
Counties where already promoted, if any	Major grain growing areas of Kenya
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Lack of information and skills to operate grain stores • Lack of credit to construct stores
Suggestions for addressing the challenges	• Capacity building of farmers, traders and extension agents • Provide appropriate financial services and credit facilities to small-scale farmers, traders and processors
Lessons learned in up scaling, if any	• Partnership is important in technology dissemination • Extension training and regular monitoring are essential
Social, environmental, policy and market conditions necessary for development and up scaling	- Existence of functional institutional arrangements - Market able to absorb increased supply of grain - Policies for grain stores are implemented
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Yet to be determined
Estimated returns	Reduced losses, increased shelf-life and hence more income from grain sales
Gender issues and concerns in development, dissemination adoption and scaling up	• Women have limited access to productive resources such as land, credit facilities and equipment • In the target counties, green gram cultivation is mainly done by women increasing their work burden • Women have limited access to agricultural information and extension • Women have been experiencing post-harvest losses due • men loss their crops due to inefficient storage methods • Women have no finances to construct and operate grain stores due to limited access to credits
Gender related opportunities	Opportunities for youth in setting and operating grain stores Improved quality of seeds Reduction of post- harvest losses due to poor storage
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs have limited access to productive resources such as land, credit facilities and equipment • VMGs have limited access to agricultural information and extension • VMGs have been experiencing post-harvest losses due due to inefficient storage methods

	• VMGs have no finances to construct and operate grain stores due to limited access to credits The management practices reduce postharvest losses, hence more green grams to be consumed and sold
VMG related opportunities	• The technology helps in conserving green grams, hence contributing to food security for VMGs; and enabling sales of green grams during off seasons when prices are higher
E: Case studies/profiles of success stories	
Success stories	Grain stores have been adopted by farmers, traders and processors in major green gram producing and processing areas of Kenya
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020).Green gram stores. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	1-Ready for up-scaling
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., Victor Wasike, Francis Wayua
Partner organizations	Traders, industrial processors and County Governments

2.10 Green gram Processing and Value Addition

2.10.1 TIMP name	**Green gram flour**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	Limited utilisation of green grams
What is it? (TIMP description)	Flour prepared from green grams  
Justification	The TIMP helps to reduce over-dependence of maize flour. Maize production has been negatively affected by climate change – e.g. Maize Lethal Necrosis Disease (MLND) and Fall Army Worm (FAW). Hence the need to diversify flour sources. Use of green

	gram flour is one such example. Diversification of green gram food products will enhance consumption of green grams, and demand thus spur increased production. Green grams can be processed to make flour, which can either be fortified or used to make nutritious porridge, or mixed with wheat flour (ration of 1:1) to make various bakery products (*chapati*, *mandazi*, bread and cakes).
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, small-scale processors / enterprenuers, industrial and commercial processors
Approaches to be used in dissemination	On-farm demonstration, field days, agricultural shows and exhibitions, promotional materials (posters/brochures/leaflets), exposure tours to processing groups
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality green grams, availability of quality standards
Partners/stakeholders for scaling up and their roles	• Farmer groups – provide land for establishment of small-scale green gram processing facility • Extension service providers to help in the dissemination • KALRO – will train trainers and provide technical backstopping on dissemination of green gram flour production technology • KEBS – Standards formulation for green gram flour, certification of private green gram flour processors • Private sector processors • Supermarkets and institutions (e.g. schools and hospitals) will provide markets for the green gram flour • National and County governments • Financial institutions to provide funds for processors
C: Current situation and future scaling up	
Counties where already promoted, if any	Baringo, Isiolo
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited awareness of the technology by farmers • Majority of the Kenyan population only recognizing maize as the staple food • Difficulty in acquiring certificates from regulatory authorities, lack of standards for the product, lack of credit facilities
Suggestions for addressing the challenges	• Awareness creation about the product to the government agencies, farmers, and traders • Capacity building of farmers on how to make and 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 green

	grams, focusing on the nutritional quality of green grams (rich in minerals). • Working with KEBS to develop standards for green gram flour
Lessons learned in up scaling, if any	• It would be good for farmer tours to processing groups to expose farmers to green gram flour production technology • Adequate capacity building is essential for technology adoption • Target women and youth as entrepreneurs in society who are the major adopters (manufacturers) and consumers, respectively.
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. KEBS ensure processors are certified; and develop standards for green gram flour • Changing consumer behaviour to incorporate green gram flour • Existing and new markets are developed and maintained • Policies on composite flours are developed and / or implemented
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Not yet determined
Gender issues and concerns in development, dissemination adoption and scaling up	• Women had limited markets to sell green gram products due to limited mobility and exposure • Processing is mainly done by women, who have limited access and control of resources such as finances to purchase products for blending • Women, men and the youth should participate in technology demonstrations • Processing is mainly done by women and it is involving the youth and men will reduce drudgery for women. • Women were not aware that *mandazi* and *chapatti* could be processed using gran grams • Target women and youth agro-processors / entrepreneurs; start by targeting informal roadside sellers of *mandazi* and *chapatti* in the study areas, who may find it easy to incorporate green gram flour into their product portfolios. • Some gender, e.g. men in certain communities, avoid eating green grams, but may be in a position to eat diversified green gram products prepared from green gram flour
Gender related opportunities	Women and youth stand to benefit in production, use and sale of green gram flour. There will be job creation for youth and women in selling *mandazi* and *chapatti* in the study areas There will be improvement in food security and nutrition for women and youth
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs lacks access to information on new technologies and information • VMGs have limited access to productive resources such as land, credit facilities and equipment

	• VMGs have limited access to agricultural information and extension • VMGs have no finances to purchase equipment for value addition of green grams due to limited access to credit facilities
VMG related opportunities	• There is employment for VMGs in processing and selling of the diversified products • The micro-nutrients in green gram flour are particularly healthy for persons with HIV/AIDS • Nutritious products can be made from green gram 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	Youth groups processing green gram flour in green gram growing areas
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Green gram flour. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100, Kakamega Email: Francis.Obuoro@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua., Victor Wasike, Francis Wayua
Partner organizations	Traders and processors / enterprenuers, extension service providers, KEBS, financial institutions

GAPS:

1. Optimizing blending *ratio* and processing *procedures* for green gram flour.
2. Characterising the various green gram varieties for their green gram flour yield production potential
3. Providing data on gross margins for green gram flour production

2.10.2 TIMP name	**Green gram balls**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	Limited green gram utilisation products
What is it? (TIMP description)	A food product prepared from deep frying green grams which have been boiled, mashed, mixed with wheat flour, and kneaded into balls

	   
Justification	Diversification of green gram food products will enhance consumption of green grams, enhance demand and thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, microenterprise processors, traders, industrial and commercial processors
Approaches to be used in dissemination	On-farm demonstration, field days, agricultural shows and exhibitions, exposure tours to processing facilities, promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality green grams, availability of quality standards
Partners/stakeholders for scaling up and their roles	• Farmer groups – provide land for establishment of small-scale green gram processing facility • Extension service providers to help in the dissemination • KALRO – will train trainers and provide technical backstopping on dissemination of green gram balls production technology • KEBS – Standards formulation for green gram balls, certification of private processors • Private sector processors / enterprenuers • Supermarkets and institutions (e.g. schools and hospitals) will provide markets for the green gram flour • National and County governments • Financial institutions to provide funds for processors
C: Current situation and future scaling up	
Counties where already promoted, if any	Baringo, Isiolo
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited awareness of the technology by farmers

	• Majority of the Kenyan population only recognizing maize as the staple food • Difficulty in acquiring certificates from regulatory authorities, lack of standards for the product, lack of credit facilities
Suggestions for addressing the challenges	• Awareness creation about the product to the government agencies, farmers, and traders • Capacity building of farmers on how to make and 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 green grams, focusing on the nutritional quality of green grams (rich in minerals). • Working with KEBS to develop standards for green gram balls
Lessons learned in up scaling, if any	• It would be good for farmer tours to processing groups to expose farmers to green gram ball production technology • Adequate capacity building is essential for technology adoption • Target women and youth as entrepreneurs in society who are the major adopters (manufacturers) and consumers, respectively.
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. KEBS ensure processors are certified; and develop standards for green gram balls • Changing consumer behaviour to incorporate green gram products • Existing and new markets are developed and maintained
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Not yet determined
Gender issues and concerns in development, dissemination adoption and scaling up	• Women had limited markets to sell green gram products due to limited mobility and exposure • Processing is mainly done by women, who have limited access and control of resources such as finances to purchase products for blending • Women, men and the youth should participate in technology demonstrations • Processing is mainly done by women and it is involving the youth and men will reduce drudgery for women. • Women were not aware of some products such as green gram balls could be processed using gran grams • Women also had limited skills relating to making green gram balls
Gender related opportunities	There will be employment creating for women and youth There will be income for women and youth Increased food security for women and entire household
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs lacks access to information on new technologies and information • The VMGs might not be aware of the green gram balls • Some of the VMGs might not be able to make green gram balls due to their physical conditions

VMG related opportunities	• Opportunity to produce, trade in, and consume locally produced green gram balls • Women can diversify family diet and generate income at village level by making the products for sale • Nutritious products can be made from green gram flour contributing to the nutrition of VMGs.
E: Case studies/profiles of success stories	
Success stories	Youth groups processing green gram balls
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020).Green gram balls. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100, Kakamega Email: Francis.Obuoro@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua., Victor Wasike, Francis Wayua
Partner organizations	Traders and processors / enterprenuers, extension service providers, KEBS, financial institutions

GAPS:

- Characterising the various green gram varieties for their green gram balls production potential (for example, which variety produces the best quality green gram balls?)
- Providing data on gross margins for green gram balls production

2.103.TIMP name	**Green gram crackies**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	Limited green gram utilisation products
What is it? (TIMP description)	A food product prepared from deep frying green grams which have been boiled, mashed, mixed with wheat flour, and extruded using a noodle machine. 

	
Justification	Diversification of green gram food products will enhance consumption of green grams, enhance demand and thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, traders, extension agents, restaurants, small-scale processors, industrial and commercial processors
Approaches to be used in dissemination	On-farm demonstration, field days, agricultural shows and exhibitions, exposure tours to processing facilities, promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality green grams, availability of quality standards
Partners/stakeholders for scaling up and their roles	• Farmer groups – provide land for establishment of small-scale green gram processing facility • Extension service providers to help in the dissemination • KALRO – will train trainers and provide technical backstopping on dissemination of green gram balls production technology • KEBS – Standards formulation for green gram balls, certification of private processors • Private sector processors / entrepreneurs • Supermarkets and institutions (e.g. schools and hospitals) will provide markets for the green gram flour • National and County governments • Financial institutions to provide funds for processors
C: Current situation and future scaling up	
Counties where already promoted, if any	Baringo, Isiolo
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited awareness of the technology by farmers • Majority of the Kenyan population only recognizing maize as the staple food • Difficulty in acquiring certificates from regulatory authorities, lack of standards for the product, lack of credit facilities
Suggestions for addressing the challenges	• Awareness creation about the product to the government agencies, farmers, and traders • Capacity building of farmers on how to make and 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 green grams, focusing on the nutritional quality of green grams (rich in minerals). • Working with KEBS to develop standards for green gram crackies
Lessons learned in up scaling, if any	- It would be good for farmer tours to processing groups expose farmers to green gram crackies production technology - Adequate capacity building is essential for technology adoption
Social, environmental, policy and market conditions necessary for development and up scaling	Target women and youth as entrepreneurs in society who are the major adopters (manufacturers) and consumers, respectively.
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Not yet determined
Gender issues and concerns in development, dissemination adoption and scaling up	• Women also had limited skills relating to making green gram crackies Women have limited processing skills due to limited mobility and exposure due to their busy schedule and domestic roles • Processing is mainly done by women, who have limited access and control of resources such as finances to purchase products for blending • Women, men and the youth should participate in technology demonstrations • Processing is mainly done by women and it is involving adding more work burden to women • Women were not aware of some products such as green gram crackies that they could be processed using green grams • Some gender, e.g. men in certain communities, avoid eating green grams, but may be in a position to eat diversified green gram products
Gender related opportunities	Improves marketability of green grams due to diversified products There is increased food security and nutrition .
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs lacks access to information on new technologies and information • VMGs also have limited skills relating to making green gram crackies • VMGs have limited processing skills due to limited mobility and exposure due to their busy schedule and domestic roles

	• Processing work is labor intensive for some VMGs especially the abled differently • VMGs might not be aware of some products such as green gram crackies that they could be processed using green • VMGs have limited knowledge on new technologies and information due to their status in the society
VMG related opportunities	• VMGs have diversified diet and generate income at village level by making the products for sale • Nutritious products can be made from green gram flour contributing to the nutrition of VMGs. • There is potential for employment for VMGs
E: Case studies/profiles of success stories	
Success stories	Youth groups processing green gram balls
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020).Green gram crackies. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100, Kakamega Email: Francis.Obuoro@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua., Victor Wasike, Francis Wayua
Partner organizations	Traders and processors / enterprenuers, extension service providers, KEBS, financial institutions

GAPS:

- Characterising the various green gram varieties for their crackies production potential (for example, which variety produces the best quality crackies?)
- Providing data on gross margins for crackies production

2.10.4 TIMP name	**Green gram cakes**
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problem addressed	Limited green gram utilisation products
What is it? (TIMP description)	Cake prepared from a mixture of mashed green gram and wheat flour

	
Justification	Diversification of green gram food products will enhance consumption of green grams, enhance demand and thus spur increased production.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, microenterprise processors, restaurants, traders, industrial and commercial processors
Approaches to be used in dissemination	On-farm demonstration, field days, agricultural shows and exhibitions, exposure tours to processing facilities, promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building and networks, promotions involving Public Private Partnerships (PPP); increased production of high-quality green grams, availability of quality standards
Partners/stakeholders for scaling up and their roles	• Farmer groups – provide land for establishment of small-scale green gram processing facility • Extension service providers to help in the dissemination • KALRO – will train trainers and provide technical backstopping on dissemination of green gram balls production technology • KEBS – Standards formulation for green gram balls, certification of private processors • Private sector processors / enterprenuers • Supermarkets and institutions (e.g. schools and hospitals) will provide markets for the green gram flour • National and County governments • Financial institutions to provide funds for processors
C: Current situation and future scaling up	
Counties where already promoted, if any	Baringo, Isiolo
Counties where TIMPs will be upscaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Limited awareness of the technology by farmers • Majority of the Kenyan population only recognizing maize as the staple food • Difficulty in acquiring certificates from regulatory authorities, lack of standards for the product, lack of credit facilities

Suggestions for addressing the challenges	• Awareness creation about the product to the government agencies, farmers, and traders • Capacity building of farmers on how to make and 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 green grams, focusing on the nutritional quality of green grams (rich in minerals). • Working with KEBS to develop standards for green gram cake
Lessons learned in up scaling, if any	• It would be good for farmer tours to processing groups to expose farmers to green gram ball production technology • Adequate capacity building is essential for technology adoption • Target women and youth as entrepreneurs in society who are the major adopters (manufacturers) and consumers, respectively.
Social, environmental, policy and market conditions necessary for development and up scaling	• Regulatory bodies e.g. KEBS ensure processors are certified; and develop standards for green gram cake • Changing consumer behaviour to incorporate green gram products • Existing and new markets are developed and maintained
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Not yet determined
Estimated returns	Not yet determined
Gender issues and concerns in development, dissemination adoption and scaling up	• Women were not aware of various products that can be made from cassava • Women had limited markets to sell cassava products due to communities' perception towards the product • Women had limited processing skills at the household level
Gender related opportunities	• Increased market value and income for women and the youth • Diversified uses of green grams • Acceptability of green grams products leading to increased incomes • Improved food security and nutrition for women and youth
VMG issues and concerns in development, dissemination adoption and scaling up	• VMGs lacks access to information on new technologies and information • Due to prejudice associated with their social status, VMGs are excluded from access to and benefits from improved technologies. • VMG have limited processing skills at the household level

VMG related opportunities	• Opportunity to produce, trade in, and consume locally produced green gram cakes • Women can diversify family diet and generate income at village level by making the products for sale • Nutritious products can be made from green gram flour contributing to the nutrition of VMGs. • The micro-nutrients in green gram are particularly healthy for persons with HIV/AIDS
E: Case studies/profiles of success stories	
Success stories	Women groups processing green gram cake
Application guidelines for users	Wayua, F., Wasike, V. and Wasilwa, L. (2020). Green gram cake. KALRO/KCSAP Programme Factsheet No. #, July 2020
F: Status of TIMP readiness (1-Ready for upscaling, 2-requires validation, 3-requires further research)	Requires validation
G: Contacts	
Contacts	Centre Director, KALRO Kakamega P.O. Box 169-50100, Kakamega Email: Francis.Obuoro@kalro.org Tel. 05620-30031/30039
Lead organization and scientists	KALRO: Francis Wayua., Victor Wasike, Francis Wayua
Partner organizations	Traders and processors / enterprenuers, extension service providers, KEBS, financial institutions

GAPS:

- Characterizing the various green gram varieties for their cake production potential (for example, which variety produces the best quality cakes?)

2.11 Mechanization of Green Gram Production Activities

2.11.1 TIMP Name	**Power Tiller**
Category (i.e. technology, innovation or management practice)	**Technology**

	
A: Description of the technology, innovation or management practice	
Problem to be addressed	• Difficult to prepare a uniform fine tilth seedbed manually • Slow and tedious processes of seedbed preparation in a commercialized Green gram commodity • Drudgery leads to low acreage • Delayed operation lead to late planting • High cost of manual Labour
What is it? (TIMP description)	A Power tiller is a low powered two-wheeled agricultural implement also referred to as a walking tractor 8-16hp that can be fitted with implements such as a rotary tiller, disk harrow, mouldboard plough, trailer, chisel or water pump at alternate times for easing farm operations. It can complete one hectare in two hours per operator. This will vary depending on the climatic conditions, soil types, soil moisture content, operator stamina and experience. Fuel consumption is about 15 liters per ha. Though these results may vary with the technical ability or aptitude of the operator.
Justification	It has multiple uses and other advantages. A Power Tiller can be used in seedbed preparation, sowing seed, planting seed, spraying of fertilizer or herbicide and even irrigation. In addition, can also be used for threshing and transporting produce. A power tiller is ideal where the land size is small. Farm sizes less than one hectare may limit maneuverability of conventional tractors and manual Labour is costly to maintain apart from being slow.
B: Assessment of dissemination and scaling up/out approaches	

Users of the TIMP	Green gram farmers and researchers
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Field Demonstrations and training, • Agricultural shows (ASK) and other exhibitions
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction of Green gram value chain stakeholders • Multiple usage, timeliness, efficiency and low cost
Partners/stakeholders for scaling up and their roles	KALRO, Universities (for information) Machinery fabricators NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where the TIMP is already promoted if any	Meru, Machakos, Embu, Kitui
Counties where TIMP will be up scaled	Makueni, West Pokot
Challenges in dissemination	• Lack of Green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Lack of machines • Lack of facilitation to demonstration site • High initial cost for small-scale machines
Suggestions for addressing the challenges	• Establish Green gram innovation platforms • Acquisition of the machines • Lack of facilitation to demonstration site • Build capacity through efficient agricultural production to afford the cost
Lessons learned in up scaling if any	• 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 • Mechanization in agriculture increases production • Mechanization releases labour to alternative requirement areas • Provides low cost farm operations
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on mechanization importance in agricultural production

	• Include all gender groups in research, and validation. • Appropriate policy formulation of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 280,000
Estimated returns	KES 180,000/ month gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	• Power tiller is not gender friendly especially for women • Power tiller would make work easier for women but women will not be able to purchase the equipment due to lack of finances due to limited access to credit facilities • Tilling equipments should be designed for easy start and operation by all gender. • Up-scaling should target all the gender and it should be affordable to all gender • Women have limited access and control of productive resources such as land , information, farm equipment and credits
Gender related opportunities	• Creates employment especially for youth • Reduces drudgery for women farmers as well as men • Power tiller increases participation of household members in tilling finger millet farm that is women, men and youth
VMG issues and concerns in development, dissemination, adoption and scaling up	• Operating Tine hallow **is** complex for some VMGs especially those who are abled differently • VMGs have less access to agricultural information, technology and knowledge so they might have information of the equipment • VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • VMGs need to be equipped with information relating to the TIMP • Power tillers need to be designed in such a way which would enable people abled differently to operate it

	• In addition they need to be affordable and easy to maintain by all types of farmers
VMG related opportunities	• Creates employment for VMGs • Reduces drudgery for VMGs • Increases food production and nutrition for VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as maize, wheat, Green gram and rice
Application guidelines for users	• Demonstrations and training • User manuals
F: Status of TIMP readiness (1-ready for up scaling;, 2-requires validation; 3-requires further research**)**	Ready for up scaling
G: Contacts	
Contacts	The 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, Pole F.N.
Partner organizations	Local Fabricators

2.11.2 TIMP Name	**4 Wheeled Tractor 50Hp**
Category (i.e. technology, innovation or management practice)	 Technology
A: Description of the technology, innovation or management practice	
Problem to be addressed	• Difficult to prepare a uniform fine tilth seedbed manually • Delayed operation lead to late planting

	• Slow and tedious processes of seedbed preparation, in a commercialized Green gram commodity • High cost of manual labour
What is it? (TIMP description)	A small sized, 4-wheeled tractor is a low powered agricultural implement of 40-55hp that can be fitted with a rotary tiller, disk harrow, moldboard plough, trailer, chisel or water pump at alternate times for easing farm operations. It can do 4 hectares per day by one operator but can have two operators to run another 8 hours of 4 hectares coming to 8ha per day. This will vary depending on the climatic conditions, soil types, soil moisture content and operator experience. Fuel consumption is about 15 liters per ha. Though these results may vary with the technical ability of the operator.
Justification	It has multiple uses and other advantages. A Power Tiller can be used in seedbed preparation sowing seed, planting seed, spraying fertilizer, herbicide and even irrigation. In addition, can also be used for threshing through a power take off device and transporting produce. Farm sizes less than one hectare may limit maneuverability of conventional tractors yet manual Labour is costly and slow.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Green gram farmers and researchers
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Field Demonstrations and training, Agricultural shows (ASK) and other exhibitions
Critical/essential factors for successful promotion	• Applied and adaptive Research to evaluate and recommend the tractor for small scale farmers. • A platform for interaction of Green gram value chain stakeholders • Multiple usage, timeliness, efficiency and low cost
Partners/stakeholders for scaling up and their roles	KALRO, Universities (for information) Machinery dealers NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Non
Counties where TIMP will be up scaled	Machakos
Challenges in dissemination	• Lack of Green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders

	• Lack of tractors • Lack of facilitation to demonstration site • High initial cost for small-scale machines
Suggestions for addressing the challenges	• Establish a 4-wheeled innovation platform • Acquisition of the machines • Lack of facilitation to demonstration site • Build financial capacity through efficient agricultural production to afford the cost
Lessons learned in up scaling if any	• Chances of successful up-scaling are higher when diverse value chain stakeholders collaborate in an innovation platform • Partnership is important in technology dissemination and adoption • Mechanization in agriculture increases production • Mechanization releases labour to alternative requirement areas • Provides low cost farm operations
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on mechanization importance in agricultural production • Include all gender groups in research, and validation. • Appropriate policy formulation of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 1,780,000,00
Estimated returns	KES 450,000/ month gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	• The 4 wheeled tractor 50Hp **is** gender unfriendly hence it cannot be operated by women • Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities such as 4wheeled tractor 50Hp • Men dominate most decisions at the household and community levels hence they make decisions relating to land preparation for green grams planting • Farming machines should be designed for easy start and operation for all gender • Up-scaling should target all the gender • The is need to equip women, youth and stakeholders with information relating to the TIMP
Gender related opportunities	• Creates employment especially for youth

	• Reduces drudgery for women farmers as well as men • Promotes inclusivity of all genders
VMG issues and concerns in development, dissemination, adoption and scaling up	• Operating wheeled tractor 50Hp is complex for some VMGs especially those who are abled differently • VMGs have less access to agricultural information, technology and knowledge hence they might not know where to get such tractors • VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • VMGs need to be equipped with information relating to the TIMP • Linking the VMG to financial institutions would enable them to purchase the tractor since it is affordable and easy to maintain machines
VMG related opportunities	• Creates employment at production, transportation, processing and distribution for VMGs • Reduces drudgery for VMG farmers
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as maize, wheat, Green gram and rice
Application guidelines for users	• Demonstrations and training • User manuals
F: Status of TIMP readiness (1-ready for up scaling;, 2-requires validation; 3-requires further research**)**	Ready for up scaling Ready for out scaling
G: Contacts	
Contacts	The 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, Pole F.N.
Partner organizations	Local Fabricators

2.11. 3 TIMP Name	Moldboard Plough
Category (i.e. technology, innovation or management practice)	***Technology*** 
A: Description of the technology, innovation or management practice	
Problem to be addressed	• Slow and tedious processes of seedbed preparation, in a commercialized Green gram commodity • Difficult to prepare a uniform fine tilth seedbed manually • Delayed operation lead to late planting • High cost of manual Labour
What is it? (TIMP description)	Moldboard plough is an agricultural implement and is generally considered to be an important tillage implement. Moldboard ploughs are available for power tiller and tractor operation. a moldboard plough does four jobs namely 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.
Justification	Has High Efficiency and when well-adjusted, the plough automatically seeks the desired depth. It is Versatile. The various models have different features that enable high efficiency in preparation of the land. Enables weed Control, Pest Control and Improved Soil Health.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Potato farmers and researchers
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Field Demonstrations and training, Agricultural shows (ASK) and other exhibitions
Critical/essential factors for successful promotion	• Applied and adaptive Research to test, validate and release improved cabbage varieties • A platform for interaction of Green gram value chain stakeholders

	• Multiple usage, timeliness, efficiency and low cost
Partners/stakeholders for scaling up and their roles	• KALRO, Universities (for information) • Machinery fabricators • NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Non
Counties where TIMP will be up scaled	Machakos
Challenges in dissemination	• **Lack of Green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders** • Lack of machines • Lack of facilitation to demonstration site • High initial cost for small-scale machines
Suggestions for addressing the challenges	• **Establish Green gram innovation platforms** • Acquisition of the machines • Lack of facilitation to demonstration site • Build capacity through efficient agricultural production to afford the cost
Lessons learned in up scaling if any	• **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** • Mechanization in agriculture increases production • Mechanization releases labour to alternative requirement areas • Provides low cost farm operations
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on mechanization importance in agricultural production • Include all gender groups in research, and validation. • Appropriate policy formulation of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 550,000
Estimated returns	KES 180,000/ month gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	• Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities

	• Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in their farms Moldboard plough **is g**ender unfriendly to operate especially women and also expensive to purchase • Farming machines should be designed for easy start and operation by all gender . • Up-scaling should target all the gender • There is need to equip women, youth and stakeholders with information relating to the TIMP Linking the women and youth to financial institutions would enable them to buy since it is affordable and easy to maintain machines
Gender related opportunities	• Creates employment especially for youth • Reduces drudgery for women farmers as well as men
VMG issues and concerns in development, dissemination, adoption and scaling up	• Operating moldboard plough is complex for some VMGs especially those who are abled differently • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Linking the VMG to financial institutions would enable them to buy since it is affordable and easy to maintain machines
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 maize, wheat, Green gram and rice
Application guidelines for users	• Demonstrations and training • User manuals
F: Status of TIMP readiness (1-ready for up scaling;, 2-requires validation; 3-requires further research**)**	Ready for up scaling
G: Contacts	
Contacts	The Institute Director, KALRO AMRI -Katumani; P.O. Box 340. Machakos Email: cd.katumani@kalro.org Phone: 0711369535

Lead organization and scientists	Nasirembe W, KALRO, Egerton University, Pole F.N.

2.11.4 TIMP Name	**Disk Harrow**
Category (i.e. technology, innovation or management practice)	Technology 
A: Description of the technology, innovation or management practice	
Problem to be addressed	• Slow and tedious processes of seedbed preparation, in a commercialized Green gram 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)	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 soil structure, called tilth, that is suitable for planting seeds. Coarser harrowing may also be used to remove weeds and to cover seed after sowing.
Justification	• Creating of a crumbly layer for planting manually is tedious. • It is not possible to manually protect the soil surface from rapid drying. • Improving both the air and water penetrability into soil can be too expensive if manually undertaken. • Manual operation will reduce microbiological processes in the soil

	• Manual land harrowing Improves nutrient availability to plants.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Green gram farmers and researchers
Approaches used in dissemination	• **Farmer field and business Schools(FFBS)** • **Agricultural Innovation Platforms (AIP)** • Field Demonstrations and training, Agricultural shows (ASK) and other exhibitions
Critical/essential factors for successful promotion	• **Applied and adaptive Research to test, validate and release improved cabbage varieties** • **A platform for interaction of Green gram value chain stakeholders** • Multiple usage, timeliness, efficiency and low cost
Partners/stakeholders for scaling up and their roles	KALRO, Universities (for information) Machinery fabricators NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Non
Counties where TIMP will be up scaled	Makueni
Challenges in dissemination	• **Lack of Green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders** • Lack of machines • Lack of facilitation to demonstration site • High initial cost for small-scale machines
Suggestions for addressing the challenges	• **Establish Green gram innovation platforms** • Acquisition of the machines • Lack of facilitation to demonstration site • Build capacity through efficient agricultural production to afford the cost
Lessons learned in up scaling if any	• **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** • Mechanization in agriculture increases production • Mechanization releases labour to alternative requirement areas • Provides low cost farm operations

Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on mechanization importance in agricultural production • Include all gender groups in research, and validation. • Appropriate policy formulation of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 280,000
Estimated returns	KES 180,000/ month gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	• Disk Harrow **is g**ender unfriendly hence it can not be operated by women • The machine is expensive for green grams stakeholders to purchase especially women • Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Women and youth have limited access to education, training and extension services than men • Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms • Disk harrow should be designed for easy start and operation. • Up-scaling should target all the gender • The is need to equip women, youth and stakeholders with information relating to the TIMP
Gender related opportunities	• Creates employment especially for youth • Reduces drudgery for women farmers as well as men Facilitation to access information
VMG issues and concerns in development, dissemination, adoption and scaling up	• Operating a disk harrow is complex for some VMGs especially those who are abled differently • VMGs have less access to agricultural information, technology and knowledge hence they might not be aware of the existence of a disk harrow and how it is operated • VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • VMGs need to be equipped with information relating to the TIMP • Farm machines need to be designed in such a way which would enable people able differently to operate

	• In addition they need to be affordability and easy to maintain machines for all types of farmers
VMG related opportunities	• Creates employment especially for youth • Reduces drudgery for VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as maize, wheat, Green gram and rice
Application guidelines for users	• Demonstrations and training • User manuals
F: Status of TIMP readiness (1-ready for up scaling;, 2-requires validation; 3-requires further research**)**	Ready for up scaling
G: Contacts	
Contacts	The 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,
Partner organizations	Local Fabricators
Partner organizations	Local Fabricators

2.11.5 TIMP Name	**Tine Harrow**
A: Description of the technology, innovation or management practice	
Problems to be addressed	• Drudgery • Inefficient clod breaking • Delayed task accomplishment
What is it? (TIMP description) 	It is a harrow with peg shaped teeth of diamond cross section to a rectangular frame. It is used to • break clod • stir soil • uproot weeds • level ground • break soil • cover seeds.
Justification	The cost of labour, inefficiencies breaking clods, ability of stirring soil, uprooting weeds, ease of leveling ground, breaking soil and covering seeds

Counties where variety was tested and promoted	Non
Counties where the TIMP will be promoted	Machakos
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, seed producers, contractors, machine operators.
Approaches used in development and dissemination	On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building, stakeholder networks and effective extension services.
Partners/stakeholders for scaling up and their respective roles.	Public and private Partners (MoALF&I) ICRISAT, FIPs (Farmer Input Promotion), , Farmer Groups, Service provider agencies e.g. micro-finance agencies, banks, agro-vets, processors and manufacturers, aggregators e.g. CARD (Community Action for Rural Development)] and others e.g. NGOs, CBOs, and FBOs
C: Current situation and future scaling up	
Current extent of reach	Nil
Challenges in development and dissemination	• Machine availability • Land size • Trained plant operators
Suggestions for addressing the challenges	• Contracting approach/sharing • Use of smaller equipment • Train plant operators
Lessons learned in up scaling, if any	Nil
Social, environmental, policy and market conditions necessary	Gender inclusiveness in crop research and development; Capacity building of stakeholders; understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Per acre production cost KES 1,700/=
Estimated returns	Not yet tried
Gender issues and concerns in development, dissemination, adoption and scaling up	• Tine harrow **is g**ender friendly to operate especially for women and it affordable to purchase

	• Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Women and youth have limited access to education, training and extension services than men • Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms • Farming machines should be designed for easy start and operation. • Up-scaling should target all the gender • There is need to equip women, youth and stakeholders with information relating to the TIMP
Gender related opportunities	• High productivity • Creates employment especially for youth • Reduces drudgery for women farmers as well as men • With mechanization men gets attracted to planting seeds which was perceived as women activity –Increasing equality in gender division of labour
VMG issues and concerns in development, dissemination, adoption and scaling up	• Operating Tine hallow **is** complex for some VMGs especially those who are abled differently • VMGs have less access to agricultural information, technology and knowledge • VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • VMGs need to be equipped with information relating to the TIMP • Farm machines need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable and easy to maintain by all types of farmers
VMG related opportunities	• Creates employment especially for youth • Reduces drudgery for VMGs • Increases food production and nutrition for VMGs
E: Case studies/profiles of success stories	
Success stories	N/A
Application guidelines for users	Green gram mechanization production leaflets
F: **Status of TIMP Readiness**	Ready for scaling

1. Ready for upscaling; 2. Requires validation; 3. Requires further research	
G: Contacts	
Contacts	Eng. Nasirembe W. Wanjala
Lead organization and scientists	KALRO, AMRI Katumani Director.amri@kalro.org
Partner organizations	Egerton University

2.11.6 TIMP Name	**Seed Drill**
Category (technology, innovation or management practice)	Technology 
A: Description of the technology, innovation or management practice	
Problem to be addressed	• Slow and tedious processes of planting, in a commercialized Green gram commodity • Difficult to deliver small grains in a row at specified seed rate 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)	It is an implement consisting of a heavy frame set with separated hopper for fertilizer and seed. It is wheel driven to rotate the seed and fertilizer dispenser sprockets. Calibration of seed and fertilizer is done separately by interchanging pairs of gears to match the required gear ratio. It has coulters to open a furrow for delivery of seed and fertilizer while another is cover the planted furrow. The planter is dragged harrowed land to plant.

Justification	• Making rows and planting small seed at a specified rate as it is covered is not possible manually. • It is not possible to manually protect the soil surface from rapid drying. • It is even more difficult to plant small seed at a predetermine depth uniformly. • Manual operation will reduce microbiological processes in the soil • Mechanical Green gram seed planting increases germination uniformity
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Green gram farmers and researchers
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Field Demonstrations and training, Agricultural shows (ASK) and other exhibitions
Critical/essential factors for successful promotion	• Applied and adaptive research to evaluate and recommend • A platform for interaction of Green gram value chain stakeholders • Multiple usage, timeliness, efficiency and low cost
Partners/stakeholders for scaling up and their roles	KALRO, Universities (for information) Machinery fabricators NGO supporting farmers for dissemination
C: Current situation and future scaling up	
Counties where already promoted if any	Non
Counties where TIMP will be up scaled	Machakos
Challenges in dissemination	• Lack of Green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Lack knowledge for appropriate machines • High initial cost for small-scale machines
Suggestions for addressing the challenges	• Establish Green gram innovation platforms • Acquisition of the machines • Lack of facilitation to demonstration site • Build capacity through efficient agricultural production to afford the cost
Lessons learned in up scaling if any	• 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 • Mechanization in agriculture increases production • Mechanization releases labour to alternative requirement areas • Provides low cost farm operations
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on mechanization importance in agricultural production • Include all gender groups in research, and validation. • Appropriate policy formulation of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	KES 40,000 (power auger digger), KES 80,000 (Tractor mounted hole digger)
Estimated returns	KES 20,000/ month gross income
Gender issues and concerns in development, dissemination, adoption and scaling up	• Seed driller is gender unfriendly so it is not easily operated by women • Seed driller is an expensive machines for women to purchase • Green gram machines should be designed for easy start and operation. • Up-scaling should target all the gender • Affordability to all gender
Gender related opportunities	• Creates employment especially for youth • Reduces drudgery for women farmers as well as men • It attract participation of all genders
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase the seed driller since they do not have to limited access to credit facilities • Operating a seed driller is complex for some VMGs especially those who are abled differently • VMGs need to be equipped with information relating to the TIMP • Seed drillers need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable and easy to maintain machines for all types of farmers farm equipment due to limited access to credit facilities

VMG related opportunities	• Can create employment for VMG at local level • It makes work easier for the VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as maize, wheat, Green gram and rice
Application guidelines for users	• User manuals and leaflets
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Ready for upscaling
G: Contacts	
Contacts	The 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,
Partner organizations and contacts	Local Fabricators
2.11.7 TIMP Name	**Seed planter**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problems to be addressed	• Drudgery • Efficient seed and fertilizer placement • Delayed task accomplishment
What is it? (TIMP description) 	It is a seed dispenser on the farm that places seed and fertilizer at predetermined quantities. It is commonly used in small grains. It is propelled by a tractor. It is an attachment of a tractor of size 45-65hp than can economically tow the implement on a well prepared seedbed using a plough, disk harrow and tine harrow
Justification	The cost of labour, inefficiencies in seed placement, releases labour for other activities and tremendously reduces time taken on a unit area being planted resulting into increased productivity.
Counties where variety was tested and promoted	Non
Counties where the TIMP will be promoted	Machakos Tharaka Nithi, Kitui, Makueni
B: Assessment of dissemination and scaling up/out approaches	

Users of TIMP	Farmers, Universities, researchers, extension agencies, seed producers, contractors, machine operators.
Approaches used in development and dissemination	On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building, functioning, stakeholder networks and effective extension services.
Partners/stakeholders for scaling up and their respective roles.	Public and private Partners (MoALF&I), ICRISAT, FIPs (Farmer Input Promotion), , Farmer Groups, Service provider agencies e.g. micro-finance agencies, banks, agro-vets, processors and manufacturers, aggregators e.g. CARD (Community Action for Rural Development)] and others e.g. NGOs, CBOs, and FBOs
C: Current situation and future scaling up	
Current extent of reach	Nil
Challenges in development and dissemination	• Machine availability • Land size • Calibration of planter • Trained plant operators
Suggestions for addressing the challenges	• Contracting approach/sharing • Use of smaller equipment • Train on Calibration of drill • Train plant operators
Lessons learned in up scaling, if any	Nil
Social, environmental, policy and market conditions necessary	Gender inclusiveness in crop research and development; Capacity building of stakeholders; understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Per acre production cost KES 1,500/=
Estimated returns	Not yet tried
Gender issues and concerns in development and dissemination adoption and scaling up	• A Seed planter is not affordable to purchase especially by women • Women and youth have limited finances to pay services and to purchase a seed planter due to limited access to credit facilities

	• Women and youth have limited finances to pay for services and purchase a green gram seed planter due to limited access to credit facilities • Women have limited access to education, training and extension services than men relating to farm tools • Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms • There has been inaccurate seed and fertilizers placing by women and youth leading to losses during planting time • The is need to equip women, youth and stakeholders with information relating to the TIMP • Women have been having low output due to poor planting methods.
Gender related opportunities	• Reduced Labor intensity in planting • Accurate Seed and fertilizer placing • Increased productivity • Reduces drudgery for women farmers as well as men • Creates employment for the youth and women • Improved food security and nutrition • Attracts men in planting
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase seed planters due to limited access to credit facilities • Operating a planter machine is complex for some VMGs especially those who are abled differently • VMGs need to be equipped with information relating to the TIMP • Farm machines need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable and easy to maintain machines for all types of farmers
VMG related opportunities	• Can create employment for VMG at local level • Reduces drudgery for VMGs
E: Case studies/profiles of success stories	
Success stories	N/A
Application guidelines for users	Green gram peat mechanization production leaflets
F: Status of TIMP Readiness **1.** Ready for upscaling;	Require validation

2. Requires validation; 3. Requires further research	
G: Contacts	
Contacts	Eng. Nasirembe W. Wanajala
Lead organization and scientists	KALRO, AMRI Katumani Director.amri@kalro.org
Partner organizations	Egerton University

2.11.8 TIMP Name	**Multi-crop cultivator**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problems to be addressed	• Drudgery • Efficient seed and fertilizer placement • Delayed task accomplishment
What is it? (TIMP description)  	Five teeth furrow openers are capable to withstand tough working conditions at heavy soils. With deep positive penetrations can break up hard soil clods and uproot stubbles to leave the ground perfectly worked. With the spacing adjustments or removable of tine on the main frame can be used for multiple number of applications suitable for green gram cultivation. It is propelled by a small sized tractor 45-55hp.
Justification	Increased labour cost, releases labour for other farm activities, reduced time spent per unit area, inefficiencies in inability of stirring soil, uprooting and covering weeds, difficulty of breaking up soil. Poor both air and water penetrability when done manually undertaken.

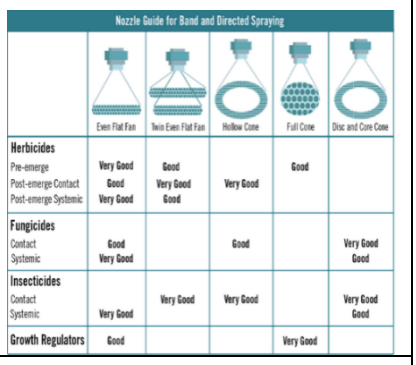
Counties where variety was tested and promoted	Non
Counties where the TIMP will be promoted	Machakos, Tharaka Nithi Kitui, Makueni
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Universities, researchers, extension agencies, seed producers, contractors, machine operators.
Approaches used in development and dissemination	On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building, stakeholder networks and effective extension services.
Partners/stakeholders for scaling up and their respective roles.	Public and private Partners (MoALF&I) ICRISAT, FIPs (Farmer Input Promotion), , Farmer Groups, Service provider agencies e.g. micro-finance agencies, banks, agro-vets, processors and manufacturers, aggregators e.g. CARD (Community Action for Rural Development)] and others e.g. NGOs, CBOs, and FBOs
C: Current situation and future scaling up	
Current extent of reach	Nil
Challenges in development and dissemination	• Machine availability • Land size • Calibration of planter • Trained plant operators
Suggestions for addressing the challenges	• Contracting approach/sharing • Use of smaller equipment • Train plant operators
Lessons learned in up scaling, if any	Nil
Social, environmental, policy and market conditions necessary	
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Per acre production cost KES 1200/=
Estimated returns	Not yet tried
Gender issues and concerns in development and dissemination adoption and scaling up	• Multi-crop cultivator is not gender friendly to operate especially by women • Multi-crop cultivator is expensive for green gram stakeholders to purchase especially women • Women and youth have limited finances to pay services and to purchase Multi-crop cultivator due to limited access to credit facilities

	• Women have limited access to education, training and extension services than men relating to farm mechanization • Men dominate most decisions at the household and community levels hence determines the type of machines to be used in farms • The is need to equip women, youth and stakeholders with information relating to the multi-crop green gram cultivator
Gender related opportunities	• Reduced Labour intensity for women • Increased productivity • Reduces drudgery for women farmers as well as men • Creates employment for the youth and women • Improved food security and nutrition
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase Multi-crop cultivator due to limited access to credit facilities • Operating Multi-crop cultivator is complex for some VMGs especially those who are abled differently • VMGs need to be equipped with information relating to the Multi-crop cultivator TIMP • Green gram cultivators need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable and easy to maintain for all types of farmers
VMG related opportunities	• Can create employment for VMG at local level • Reduces drudgery for VMGs
E: Case studies/profiles of success stories	
Success stories	N/A
Application guidelines for users	Green gram peat mechanization production leaflets
F: **Status of TIMP Readiness** **1.** Ready for upscaling; 2. Requires validation; 3. Requires further research	Require validation
G: Contacts	
Contacts	Eng Nasirembe W. Wanjala
Lead organization and scientists	KALRO, AMRI Katumani Director.amri@kalro.org
Partner organizations	Egerton University

2.11.9 TIMP Name	Multi-crop cultivator
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	
Problems to be addressed	• Drudgery • Efficient seed and fertilizer placement • Delayed task accomplishment
What is it? (TIMP description) 	Five teeth furrow opener are capable to withstand tough working conditions at heavy soils. With deep positive penetrations can break up hard soil clods and uproot stubbles to leave the ground perfectly worked. With the spacing adjustments or removable of tine on the main frame can be used for multiple number of applications suitable for green gram cultivation. It is propelled by a small sized tractor 45-55hp.
Justification	Increased labour cost, releases labour for other farm activities, reduced time spent per unit area, inefficiencies in inability of stirring soil, uprooting and covering weeds, difficulty of breaking up soil. Poor both air and water penetrability when done manually undertaken.
Counties where variety was tested and promoted	
Counties where the TIMP will be promoted	Machakos, Tharaka Nithi Kitui Makueni
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Universities, researchers, extension agencies, seed producers, contractors, machine operators.
Approaches used in development and dissemination	On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building, stakeholder networks and effective extension services.
Partners/stakeholders for scaling up and their respective roles.	Public and private Partners (MoALF&I) ICRISAT, FIPs (Farmer Input Promotion), , Farmer Groups, Service provider agencies e.g. micro-finance agencies,

	banks, agro-vets, processors and manufacturers, aggregators e.g. CARD (Community Action for Rural Development)] and others e.g. NGOs, CBOs, and FBOs
C: Current situation and future scaling up	
Current extent of reach	Nil
Challenges in development and dissemination	• Machine availability • Weeder setting • Trained plant operators • Weeder maintenance artisans
Suggestions for addressing the challenges	• Contracting approach/sharing • Train plant operators
Lessons learned in up scaling, if any	Nil
Social, environmental, policy and market conditions necessary	Gender inclusiveness in crop research and development; Capacity building of stakeholders; understanding the physical and biotic environment in target ecologies; understanding community culture, preferences, and practices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Per acre production cost KES 1,200/=
Estimated returns	Not yet tried
Gender issues and concerns in development and dissemination adoption and scaling up	• Multi-crop cultivator is not gender friendly to operate especially by women • Multi-crop cultivator is expensive for green gram stakeholders to purchase especially women • Women and youth have limited finances to pay services and to purchase Multi-crop cultivator due to limited access to credit facilities • Women have limited access to education, training and extension services than men relating to farm mechanization • Men dominate most decisions at the household and community levels hence determines the type of machines to be used in farms The is need to equip women, youth and stakeholders with information relating to the multi-crop green gram cultivator
Gender related opportunities	• Reduced Labour intensity for women • Increased productivity • Reduces drudgery for women farmers as well as men • Creates employment for the youth and women • Improved food security and nutrition

VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase Multi-crop cultivator due to limited access to credit facilities • Operating Multi-crop cultivator is complex for some VMGs especially those who are abled differently • VMGs need to be equipped with information relating to the Multi-crop cultivator TIMP • Green gram cultivators need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable and easy to maintain for all types of farmers
VMG related opportunities	• Reduces drudgery for VMGs • Creates employment for the VMGs
E: Case studies/profiles of success stories	
Success stories	N/A
Application guidelines for users	Green gram peat mechanization production leaflets
F: **Status of TIMP Readiness** **1.** Ready for upscaling; 2. Requires validation; 3. Requires further research	Require validation
G: Contacts	
Contacts	Eng. Nasirembe
Lead organization and scientists	KALRO, AMRI Katumani Director.amri@kalro.org
Partner organizations	Egerton University

2.11.10 TIMP Name	**Motorized Sprayer**
Category (technology, innovation or management practice)	Technology  
A: Description of the technology, innovation or management practice	

Problem to be addressed	It is a slow and tedious processes of manual spraying Green gram; Green gram has a high number of pests that invade leaf, stem tuber,
What is it? (TIMP description)	A motorized **sprayer** is a device used to spray a liquid, where sprayers are commonly used for projection of the chemical, weed killers, crop performance materials, pest maintenance chemicals, as well as manufacturing and production line ingredients. In agriculture, a sprayer is a piece of equipment that is used to apply herbicides, pesticides and fertilizers on agricultural crops. Sprayers are man-portable units typically backpacks with spray guns. They are used to control; weeds that can harbour insects by use of herbicides, insect pests that can cause diseases by the use of insecticides as well as pesticides. Control of fungal diseases by the use of fungicides. Application of micronutrients on the plants.
Justification	Pest reduce yields up to 98% and are a major menace in agricultural production. Before Green gram forms a canopy, broad leafed weeds compete with Green gram seedling for nutrients and light greatly reducing their yield. Manual sprayers are labour intensive while spraying labour is too expensive. It has lower pressure reducing its efficiency hence a motorized knapsack comes in handy. A modern motorized knapsack power that pumps four times faster and covers a wide area in a short time than the manual sprayer With the motorized sprayer, farmers can spray up to 2ha of land in one day as compared to the manual one which covers only one in a day.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Green gram Farmers and agribusiness entrepreneurs
Approaches used in dissemination	• Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP) • Field Demonstrations and training, Agricultural shows (ASK) and other exhibitions
Critical/essential factors for successful promotion	• Applied and adaptive research to test, validate and release improved cabbage varieties • A platform for interaction of Green gram value chain stakeholders • Use by Farmers

Partners/stakeholders for scaling up and their roles	Machinery fabricators NGO supporting farmers(AGGRA)
C: Current situation and future scaling up	
Counties where already promoted if any	W/Pokot, Bungoma, Busia, Kericho, Bomet
Counties where TIMP will be up scaled	Kericho
Challenges in dissemination	• Lack of Green gram innovation platforms to facilitate interaction of farmers with relevant stakeholders • Relatively high cost for individual small-scale farmer. • Limited awareness of the existence of machine among some farmers.
Suggestions for addressing the challenges	• Establish Green gram innovation platforms • Encourage group/cooperative ownership • Launch and awareness campaign through demonstrations and trainings
Lessons learned in up scaling if any	• 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 • Products from local/indigenous crops attract huge market, yet very little is being done to promote growth
Social, environmental, policy and market conditions necessary for development and up scaling	• Creation of awareness on mechanization importance in the community. Include all gender groups in research, and validation. • Good Policy on cost of agricultural mechanization
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Motorized sprayer 55,000 KES per unit
Estimated returns	KES 180,000.00/year
Gender issues and concerns in development dissemination, adoption and scaling up dissemination	Motorized sprayer designed for easy start and operation. Men have been drawn to spraying by the machine. This task was predominantly for women before the introduction of the machine.
Gender related opportunities	Creates employment at production, transportation, processing and distribution
Gender related opportunities	• Creates employment especially for youth • Reduces drudgery for women farmers as well as men

VMG issues and concerns in development, dissemination, adoption and scaling up	• Facilitation to access information • Affordability and easy to maintain machines
VMG related opportunities	
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as maize, wheat, Green gram and rice
Application guidelines for users	• User manuals and leaflets
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	• ready for upscaling;,
G: Contacts	
Contacts	The 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,
Partner organizations and contacts	Local Fabricators
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	
Estimated returns	KES 180,000.00/year
Gender issues and concerns in development ,dissemination, adoption and scaling up dissemination	• Motorized sprayer is designed for easy start and operation hence it is gender friendly and can be used by women also • Women and youth have limited finances to pay services and to purchase a motorized sprayer for use in the green gram farms due to limited access to credit facilities • Women have limited access to education, training and extension services than men relating to so they might not be aware of the of motorized sprayer • Men dominate most decisions at the household and community levels hence determines the type of farm equipment and machines to be used in green gram farms facilities to be used in farms • Men have been drawn to spraying by the machine. This task was predominantly for women before the introduction of the machine.
Gender related opportunities	• Creates employment especially for youth • Reduces drudgery for women farmers as well as men • It promote gender inclusivity reducing the work load for women

VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase motorized sprayer due to limited access to credit facilities • Operating a motorized sprayer is complex for some VMGs especially those who are abled differently • Green gram motorized sprayer need to be designed in such a way which would enable people able differently to operate
VMG related opportunities	• Can create employment for VMG at local level • Reduces drudgery for VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Mechanization has enabled increased production in other crops such as maize, wheat, Green gram and rice
Application guidelines for users	
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Ready for upscaling
G: Contacts	
Contacts	The 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,
Partner organizations and contacts	Local Fabricators

2.11.11 TIMP Name	**Seed drill planter**
Category (i.e. technology, innovation or management practice)	Technology
A: Description of the technology, innovation or management practice	

12.2.11 TIMP Name	Combine Harvester
Category (i.e. technology, innovation or management practice)	Technology

A: Description of the technology, innovation or management practice	
Problems to be addressed	• Drudgery • Efficiencies in grain detachment, winnowing, fuel, throughput and output. • Delayed task accomplishment
What is it? (TIMP description) 	• A combine harvester, is a versatile machine designed to efficiently harvest a variety of grain crops. The name derives from its combining three separate harvesting operations—reaping, threshing, and winnowing—into a single process. • The major components of the machine include threshing, separation and cleaning units. • After being beaten, the grains fall through a concave grid into the cleaning unit which consists of blower set to a speed that only blows out chaff and grain is collected on a receptor
Justification	The cost of labour, inefficiencies in grain detachment, winnowing, fuel, throughput and output makes it necessary for increased productivity.
Counties where Combine Harvester was tested and promoted	Meru, Machakos, Embu, Kitui
Counties where the TIMP will be promoted	Bomet, Kericho and West Pokot
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, seed producers, contractors, machine operators.
Approaches used in development and dissemination	On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building, functioning, stakeholder networks and effective extension services.
Partners/stakeholders for scaling up and their respective roles.	Public and private Partners (MoALF&I) ICRISAT, FIPs (Farmer Input Promotion), , Farmer Groups, Service provider agencies e.g. micro-finance agencies, banks, agro-vets, processors and manufacturers, aggregators e.g. CARD (Community Action for Rural Development)] and others e.g. NGOs, CBOs, and FBOs
C: Current situation and future scaling up	

Current extent of reach	Nil
Challenges in development and dissemination	• Protective clothing • Machine availability • Trained machine operators
Suggestions for addressing the challenges	• Contracting approach/sharing • Train on machine operation
Lessons learned in up scaling, if any	• Size, Portability, discharge height
Social, environmental, policy and market conditions necessary	Gender inclusiveness in Machine research and development; Capacity building of stakeholders; understanding community culture, preferences, and practices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Per acre production cost KES 2,500/=
Estimated returns	Not yet tried
Gender issues and concerns in development and dissemination	• Combine harvester is complicated for women to operate • Combine harvester is also expensive for women to afford • Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Women have limited access to education, training and extension services than men relating to farm mechanization • Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms • Combine harvesters should be designed for easy start and operation. • Up-scaling should target all the gender and they should be affordable to all gender
Gender related opportunities	• Reduced labour intensity in threshing • High productivity is increased food security and nutrition • Creates employment especially for youth • Reduces drudgery for women farmers as well as men
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Operating a combine harvester is complicated for some VMGs especially those who are abled differently to operate

	• VMGs need to be equipped with information relating to the TIMP • Linking the VMG to financial institutions would enable them to buy since it is affordable and easy to maintain machines • Farm machines need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable
VMG related opportunities	• Reduced labour intensity in threshing for VMGs • High productivity is increased food security and nutrition • Creates employment especially for VMGs • Reduces drudgery for VMGs
E: Case studies/profiles of success stories	
Success stories	Request from farmers for thresher
Application guidelines for users	Green gram mechanization production leaflets
F: **Status of TIMP Readiness** **1.** Ready for upscaling; 2. Requires validation; 3. Requires further research	Requires validation
G: Contacts	
Contacts	Eng. Nasirembe W. Wanjala
Lead organization and scientists	KALRO, AMRI Katumani Director.amri@kalro.org
Partner organizations	Egerton University
Missing	

2.11.12 TIMP Name	Thresher
Category (i.e. technology, innovation or management practice)	Innovation
A: Description of the technology, innovation or management practice	
Problems to be addressed	• Drudgery • Efficiencies in grain detachment, winnowing, fuel, throughput and output. • Delayed task accomplishment

What is it? (TIMP description) 	• A thresher was developed for threshing, separating, and cleaning millet seeds. • The major components of the machine include threshing, separation and cleaning units. • After being beaten, the grains fall through a concave grid into the cleaning unit which consists of blower set to a speed that only blows out chaff and grain is collected on a receptor
Justification	The cost of labour, inefficiencies in grain detachment, winnowing, fuel, throughput and output makes it necessary for increased productivity.
Counties where Motor sprayer was tested and promoted	Meru, Machakos, Embu, Kitui
Counties where the TIMP will be promoted	Makueni, West Pokot
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, extension agencies, seed producers, contractors, machine operators.
Approaches used in development and dissemination	On-farm experimentation and dissemination, field days, shows, farmer to farmer communication, leaflets, larger plot demonstrations.
Most effective approach	On-farm experimentation and larger plot effect demonstrations.
Critical/essential factors for successful promotion	Participatory implementation, stakeholder capacity building, functioning, stakeholder networks and effective extension services.
Partners/stakeholders for scaling up and their respective roles.	Public and private Partners (MoALF&I) ICRISAT, FIPs (Farmer Input Promotion), , Farmer Groups, Service provider agencies e.g. micro-finance agencies, banks, agro-vets, processors and manufacturers, aggregators e.g. CARD (Community Action for Rural Development)] and others e.g. NGOs, CBOs, and FBOs
C: Current situation and future scaling up	
Current extent of reach	Nil
Challenges in development and dissemination	• Protective clothing • Machine availability • Trained machine operators
Suggestions for addressing the challenges	• Contracting approach/sharing • Train on machine operation

Lessons learned in up scaling, if any	• Size, Portability, discharge height
Social, environmental, policy and market conditions necessary	Gender inclusiveness in Machine research and development; Capacity building of stakeholders; understanding community culture, preferences, and practices
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Per acre production cost KES 1,500/=
Estimated returns	Not yet tried
Gender issues and concerns in development, dissemination, adoption and scaling up	➢ Thresher is expensive for women to afford ➢ Women and youth have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities ➢ Women have limited access to education, training and extension services than men relating to farm mechanization ➢ Men dominate most decisions at the household and community levels hence determines the type of facilities to be used in farms ➢ Threshers should be designed for easy start and operation. ➢ Up-scaling should target all the gender and they should be affordable to all gender
Gender related opportunities	• High productivity increasing food security and nutrition for women and youth • Creates employment especially for youth • Reduces drudgery for women farmers in threshing
VMG issues and concerns in development, dissemination, adoption and scaling up	• VMGs have limited finances to pay services and to purchase farm equipment due to limited access to credit facilities • Operating a threshing machine is complicated for some VMGs especially those who are abled differently to operate • VMGs need to be equipped with information relating to the TIMP • Linking the VMG to financial institutions would enable them to buy since it is affordable and easy to maintain machines • Farm machines need to be designed in such a way which would enable people able differently to operate • In addition they need to be affordable

VMG related opportunities	• High productivity increasing food security and nutrition for VMGs • Creates employment especially for VMGs • Makes threshing easy to perform for VMGs
E: Case studies/profiles of success stories	
Success stories	Request from farmers for thresher
Application guidelines for users	Green gram mechanization production leaflets
F: **Status of TIMP Readiness** **1.** Ready for upscaling; 2. Requires validation; 3. Requires further research	Requires validation
G: Contacts	
Contacts	Eng. Nasirembe
Lead organization and scientists	KALRO, AMRI KatumaniDirector.amri@kalro.org
Partner organizations	Egerton University

2.12 Green Gram Farming Business and Marketing Practices

2.12.1 TIMP name	**Transformative Model of production of green grams**
Category (i.e. technology, innovation or management practice)	**Management practice**
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram 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 green gram 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 green gram 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	• Small scale farmers • Small-scale processors • Green gram exporters • Food processors • Local traders

	• Consumers • Input markets due to demand in improved markets
Approaches to be used in dissemination	• ToT • Field days • Exhibitions • Agricultural shows • Mobile phone text initiative • Farmer to farmer • Mass media • Trainings • Promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Availability of high yielding seeds • Availability of markets • Acceptability of green gram in the framing systems • Transformative ability of farmers • Favourable policy for trade in green gram
Partners/stakeholders for scaling up and their roles	• MoALFI: Mobilize, train and exhibit the products • NGOs / CBOs: -Mobilize, train and exhibit the products • Cooperatives: Register and train youth/women groups and give loans • KEBS: certification • Processors: To process high quality green gram products • Supermarkets to accept and stock product for sale • Consumers: Acceptability • Marketers: Moving green gram products from processors to consumers
C: Current situation and future scaling up	
Counties where already promoted, if any	Machakos, Kitui, Makueni, Tharaka-Nithi
Counties where TIMP will be Upscalled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in dissemination	• Awareness: Limited awareness of the economic potential by farmers and consumers • Stakeholder linkages: Stakeholders for enhancing transformation • High intensity of green gram management; both in the field and post-harvest
Suggestions for addressing the challenges	• Awareness creation about the potential of green gram production to farmers, consumers and other value chain actors • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product • Scaling up participation of end-user in technology development such as demonstrations and training activities • Promote green gram production all year round

Lessons learned in upscaling, if any	• Resistance of farmers in growing green gram • Subsistence levels of green gram production • Variability in green gram demand • Fluctuations in prices
Social, environmental, policy and market conditions necessary) for development and upscaling	• Farmers' perceptions • Increase in drought frequency • Supportive policy in place • Organized markets
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 12,790
Gender issues and concerns in development, dissemination and related opportunities	• Women's lives: Improved welfare of women through increased income • Employment opportunities: Increased employment opportunities for women in marketing green gram products • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a gender perspective • Capacity of rural women: Build capacity of rural women to identify and articulate their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
VMG issues and concerns in development, dissemination and opportunities	• VMGs' lives: Improved welfare of VMGs through identification of strengths, • Workloads: Lessening the VMGs' work loads • Employment opportunities: Increased employment opportunities for VMGs' • VMGs' authority: Enhancing green gram processing • Greater access to technologies: Enhancing accessibility to the technology by VMGs • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a VMG perspective

	• Extension message: Extension message must be made more relevant to their needs relevant to the growing of green gram • Capacity of rural VMGs: Build capacity to VMGs on identifying and articulating their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
E: Case studies/profiles of success stories	
Success stories from previous similar projects	• Green gram revolution in Kitui County
Application guidelines for users	• Factsheets • Green gram production guidelines
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Requires validation
G: Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

GAPS

Further research

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

2.12.2 TIMP name	**Building a Business Plan for Green gram production**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram productivity due to unplanned and traditional production, leading to lack of production targets, losses and market failure
What is it? (TIMP description)	A green gram business plan serves as an internal management and 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, green gram 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	• Small scale farmers • Small-scale processors • Food processors • Local grain traders • Grain exporters
Approaches to be used in dissemination	• ToT • Farmers' groups • Farmers' Trainings
Critical/essential factors for successful promotion	• Availability of green gram grains • Availability of farmers' groups • Accessed markets • Available technologies for increasing productivity
Partners/stakeholders for scaling up and their roles	• MoALFI: Mobilize, train and exhibit the products • NGOs / CBOs: -Mobilize, train and exhibit the products • Cooperatives: Register and train youth/women groups and give loans • KEBS: certification • Processors: To process high quality green gram products • Supermarkets to accept and stock product for sale • Consumers: Acceptability • Marketers: Moving green gram products from processors to consumers
C: Current situation and future scaling up	
Counties where already promoted, if any	None
Counties where TIMP will be Upscalled	Machakos, Tharaka-Nithi, Tana River, Isiolo, Baringo
Challenges in dissemination	• Literacy levels of farmers • Availability of farm records • Levels of skills in market information collection
Suggestions for addressing the challenges	• Capacity building in business plan development • Training of ToTs
Lessons learned in upscaling, if any	• None
Social, environmental, policy and market conditions necessary) for development and upscaling	• Existence of farmers' groups • Suitable environment for green gram production • Supportive policy in place • Improved access to markets
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 19,690
Gender issues and concerns in development, dissemination	• Women's lives: Improved welfare of women

and related opportunities	• Employment opportunities: Increased employment opportunities for women in marketing green gram products • Women's authority: Increasing the number of women in marketing green gram products • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a gender perspective • Capacity of rural women: Build capacity of rural women to identify and articulate their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
VMG issues and concerns in development, dissemination and opportunities	• VMGs' lives: Improved welfare of VMGs through identification of strengths, • Workloads: Lessening the VMGs' work loads • Employment opportunities: Increased employment opportunities for VMGs' • VMGs' authority: Enhancing green gram processing • Greater access to technologies: Enhancing accessibility to the technology by VMGs • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a VMG perspective • Extension message: Extension message must be made more relevant to their needs relevant to the growing of green gram • Capacity of rural VMGs: Build capacity to VMGs on identifying and articulating their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for users	• Factsheets

	• Business plan guidelines
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Requires validation
G: Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

2.12.3 TIMP name	**Contracted green gram production model**
Category (i.e. technology, innovation or management practice)	Requires validation
A: Description of the technology, innovation or management practice	
Problem addressed	Low productivity due to market failure in green gram 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	• Small scale farmers • Contractors
Approaches to be used in dissemination	• ToT • Field days • Exhibitions • Mobile phone text initiative

	• Farmer to farmer • Mass media • Trainings • Promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Availability of contractors • Willing producers • Availability of quality standards and assured markets • Favorable policy to promote contract farming
Partners/stakeholders for scaling up and their roles	• MoALFI: Mobilize, train and exhibit the products • NGOs / CBOs: -Mobilize, train and exhibit the products • Cooperatives: Register and train youth/women groups and give loans • KEBS: certification • Contractors
C: Current situation and future scaling up	
Counties where already promoted, if any	• Tharaka-Nithi, Machakos and Makueni
Counties where TIMP will be Upscalled	• Machakos, Tharaka-Nithi, Tana River, Isiolo and Baringo
Challenges in dissemination	• Contractors: Availability of contractors • Awareness: Limited awareness on contracted production by the smallholder farmers • Breaking the agreement
Suggestions for addressing the challenges	• Linking farmers to contractors • Awareness creation about the contracted production • Enforcement of agreement
Lessons learned in upscaling, if any	• Contracted farmers earn higher income • Contracted production arrangement enable farmers to access improved inputs • Contracted production has linked markets
Social, environmental, policy and market conditions necessary) for development and upscaling	• Acceptability by farmers on contracted production • Supportive policy in place • Ability to meet quality agreed
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Contracted production at kshs 100 per kilogram, Returns after deductions of the total variable costs per acre per season Kshs 23,500
Gender issues and concerns in development, dissemination and related opportunities	• Employment opportunities: Increased employment opportunities for women • Women's authority: Increasing the number of women in marketing green gram • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a gender

	perspective • Capacity of rural women: Build capacity of rural women to identify and articulate their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
VMG issues and concerns in development, dissemination and opportunities	• VMGs' lives: Improved welfare of VMGs through guaranteed green gram prices • Workloads: Lessening the VMGs' work loads • Employment opportunities: Increased employment opportunities for VMGs' • VMGs' authority: Enhancing green gram processing • Greater access to technologies: Enhancing accessibility to the technology by VMGs • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a VMG perspective • Extension message: Extension message must be made more relevant to their needs relevant to the growing of green gram • Capacity of rural VMGs: Build capacity to VMGs on identifying and articulating their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Contracted green gram production in Tharaka-Nithi
Application guidelines for users	• Contract farming factsheets • Agreement guidelines
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Requires validation
G: Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and	KALRO; Victor Wasike; John Wambua

scientists	
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

Gaps for further research

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

2.12.4 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 green gram 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 green gram, 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 green gram 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 green gram 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	• Small scale farmers • Green gram grain traders
Approaches to be used in dissemination	• ToT • Mobile phone text initiative • Farmer to farmer • Mass media • Trainings • Promotional materials (posters/brochures/leaflets)
Critical/essential factors for successful promotion	• Willing producers • Availability of quality standards and assured markets • Favorable policy to promote formation of collective marketing
Partners/stakeholders for scaling up and their roles	• MoALFI: Mobilization and training • NGOs / CBOs: -Mobilization and training • Cooperatives: Registration and training

C: Current situation and future scaling up	
Counties where already promoted, if any	• None
Counties where TIMP will be Upscalled	• Machakos, Tharaka-Nithi, Tana River, Baringo and Isiolo
Challenges in dissemination	• Formation of marketing groups • Awareness: Limited awareness on the collective marketing • Formation of the governing institutions • Distribution of incentives • High costs of group operations • Group dynamics
Suggestions for addressing the challenges	• Awareness on the importance of collective marketing • Training of group dynamics • Information dissemination – postharvest handling, value addition, and nutritional attributes of the product
Lessons learned in upscaling, if any	• Collective marketing increases income for the individual farmers • Collective marketing links farmers to buyers
Social, environmental, policy and market conditions necessary) for development and upscaling	• Farmers with common interests in green gram production and marketing • Suitable environment for the green gram production • Supportive policy in place • Ability to meet the required market quality standards
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 25,400
Gender issues and concerns in development, dissemination and related opportunities	• Employment opportunities: Increased employment opportunities for women • Women's authority: Increasing the number of women in marketing green gram production • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a gender perspective • Capacity of rural women: Build capacity of rural women to identify and articulate their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
VMG issues and concerns in development, dissemination and opportunities	• VMGs' lives: Improved welfare of VMGs through guaranteed green gram prices • Workloads: Lessening the VMGs' work loads • Employment opportunities: Increased employment opportunities for VMGs'

	• VMGs' authority: Enhancing green gram processing • Greater access to technologies: Enhancing accessibility to the technology by VMGs • Roles in development and dissemination: Increasing acceptance, perceptions, capacity and reducing negative attitude • Impact assessment: Impact assessment from a VMG perspective • Extension message: Extension message must be made more relevant to their needs relevant to the growing of green gram • Capacity of rural VMGs: Build capacity to VMGs on identifying and articulating their information and services provided by government institutions • Self-confidence and empowering: Enhancing self-confidence and empowering them to engage with external agencies
E: Case studies/profiles of success stories	
Success stories from previous similar projects	None
Application guidelines for users	• Collective marketing manual • Agro-enterprise development guidelines
F: Status of TIMP readiness (1-ready for upscaling;, 2-requires validation; 3-requires further research**)**	Requires validation
G: Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

GAPS

Further research

- Profitable opportunities
- Performance of marketing as a group

2.12.5 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 green gram productivity 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 green gram 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 Green gram agro-enterprise
Justification	Profitability analysis reviews the management success and sustainability of the Green gram business. It indicates areas of adjustment
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	Farmers, Extension, NGOs, Researchers.
Approaches to be used in dissemination	• Trainings • Factsheets • Manuals • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Record keeping of costs and returns • Ability of farmers to keep records • Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• 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	Tharaka-Nithi
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination -	• Inability of farmers to keep records • Use of non-costed family labour in Green gram production
Suggestions for addressing the challenges	• Inability of farmers to keep records – capacity building • Use of non-costed family labour in Green gram production – capacity building on how to cost family labour
Lessons learned in up scaling if any	• Farmers will appreciate profitability analysis in the case of increased returns
Social, environmental, policy and market conditions necessary for development and up-scaling	• Social conditions – Awareness on record keeping • Environmental conditions – suitable for the increased production of Green gram • 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 variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 19,690
Gender issues and concerns in development and dissemination, adoption and	• Development and dissemination – low income to youth, women and men • Adoption and scaling – high costs applicable to the youth, women and men

scaling	
Gender related opportunities	• Increased income • Indicator of sustainable Green gram business
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – low income to VMGs • Adoption and scaling up – high costs to VMGs
VMG related opportunities	• Increased production and sales of Green grames by youth, females and males in the production of Green gram.
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 up scaling, 2, Requires validation, 3. Requires further research)	Ready for upscaling
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

GAPS

Further research

- Investigation on strategies to reduce costs of production of Green gram
- Investigation on price increasing strategies

2.12.6 TIMP Name	**Market research for Green gram farmers**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram productivity 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, leading to low market participation.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	• Farmers • Traders

	• Processors
Approaches to be used in dissemination	• Trainings • Factsheets • Manuals • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Can the farmers increase production within their group • How will the farmers increase their production and sales (more technology, more land, more members) • Can the farmers work with other existing groups (available/not available) • Do the farmers need to form new groups • Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• 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 up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination -	• Issues related to the literacy of the marketing groups • Issues related to the mobilization and creation of awareness • Levels of skills of the market research group • Existence of market information
Suggestions for addressing the challenges	• Issues related to increasing production from existing group – Capacity building of farmers • Issues related to mobilization and awareness creation – sensitization of farmers • Market research skills – Training • Market information – Record keeping
Lessons learned in up scaling if any	• None
Social, environmental, policy and market conditions necessary for development and up-scaling	• 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 variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 19,690
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – Participation by youth, women and men in the development of scaling up plan • Adoption and scaling – Participation by youth, women and men in the development of scaling up plan
Gender related opportunities	• Increase in production and sales by youth, females and males in the

	production of Green gram.
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – Participation by VMGs in the development of scaling up plan • Adoption and scaling up – Participation by VMGs in the development of scaling up plan
VMG related opportunities	• Increase in production and sales by VMGs of Green gram
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 up scaling, 2, Requires validation, 3. Requires further research)	quires validation
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

GAPS

Further research

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

2.12.7. 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	Farmers' failure to apply entrepreneurship while marketing green gram, leading 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 green gram, the market outlook will be narrow
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	• Farmers • Extension • NGOs • Researchers
Approaches to be used in dissemination	• Trainings • Factsheets

	• Manuals • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Organization of farmers • Availability of innovations • Achievement of profit • Access to finance • Availability of facilitators • Availability of many traders • Production volume and quality • Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• Farmers – Acceptability of innovations • 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 up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	• Small-scale farming • Availability of information • Profitability in Green gram farming • Levels of policy support
Suggestions for addressing the challenges	• Small-scale farming – capacity building to farmers • Availability of information on innovations • Profitable innovations • Strengthening county policy support
Lessons learned in up scaling if any	• Reduced cost of production, increased profit
Social, environmental, policy and market conditions necessary for development and up-scaling	• Social conditions – Conflicts with traditional methods • Environmental conditions – sustainability of innovations • Market conditions – Access to inputs such as fertilizer
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 19,690
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – Involvement of youth, men and females in the innovations adoption • Adoption and scaling – Differentiated innovations for instance spraying by females is difficult. Youth is normally engaged
Gender related opportunities	• Increased production and sales of Green gram by youth, females and males.
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – Involvement of VMGs in the innovations adoption • Adoption and scaling up – Capacity building
VMG related opportunities	• Increased production and sales of Green gram by VMGs leading to improved livelihood
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 up scaling, 2, Requires validation, 3. Requires further research)	ailable innovations are ready for up-scaling
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

Gaps for further research

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

2.12.8 . TIMP Name	**Internet/mobile marketing**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Limited use of technologies among the smallholder farmers while 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 of 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	• Farmers • Traders • Processors
Approaches to be used in dissemination	• Trainings • Factsheets • Manuals • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Education levels of the farmers and investors in Green gram production and profitability analysis

	• Levels of experiences in Green gram production • Availability of information on Green gram production and marketing • Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• Farmers – Sellers of Green gram production • County extension staff - Capacity building • NGOs – Capacity building • Private sector (local traders and exporters) – Buyers of Green gram • Research institutions – Capacity building
C: Current situation and future scaling up	
Counties where already promoted if any	Tharaka-Nithi and Makueni
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	• Low digital skills of farmers • Unconsolidated produce for the market • Small-scale farming • Inadequate information to stakeholders on the Green gram production and marketing and profitability • Internet connectivity • Levels of policy support on internet infrastructure
Suggestions for addressing the challenges	• Low digital skills of farmers – capacity building • Unconsolidated produce for the market – Delivery of produce to the designated centres • Small-scale farming – capacity building and sensitization to appreciate need for consolidation of produce • Inadequate information to stakeholders on the Green gram production and marketing and profitability - Developing information hubs • Internet connectivity – Information hubs • Level of policy support – Policy support in internet infrastructure and utilization
Lessons learned in up scaling if any	• 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 up-scaling	• 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 variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 19,690
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – Capacity building in digital skills for the youth, men and females • Adoption and scaling – Capacity building on benefits of digital marketing skills for the youth, men and females
Gender related opportunities	• Improved accessibility of information duel to availability of mobile phones by youth, males and females
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – Capacity building on digital skills • Adoption and scaling up – Capacity building on benefits of digital

	marketing skills for the VMGs
VMG related opportunities	• Improved accessibility of information duel to availability of mobile phones by VMGs
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 up scaling, 2, Requires validation, 3. Requires further research)	Requires validation
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

Gaps for further research

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

2.13 Agricultural Policy Options

2.13.1TIMP Name	**National Agricultural policy strategy framework**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram productivity due to lack of centralizing the smallholder farmers' agency and voices in terms of access to inputs and outputs markets. The instruments and the rules to achieve the policy productivity objectives are inappropriate for the smallholder farmers but instead favour the large scale farmers in Kenya.
What is it? (TIMP description)	The National Agricultural policy strategy framework provides instruments and rules for the Counties to develop agriculture in terms of productivity objectives which can assist the smallholder farmers of green gram.
Justification	Without the National Agricultural policy strategy framework, agriculture will remain not integrated with the National development objectives. There will be lack of instruments and the rules to achieve agricultural productivity objectives.
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	• Farmers • Policy makers • Traders • Processing industries • Extension • NGOs • Research institutions

Approaches to be used in dissemination	• Meetings • Radio • Television • Social media (WhatsApp, Facebook, twitter) • Internet • Farmers' groups • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Availability of stakeholders • Availability of specific Green gram-based policies • Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• Farmers – Demanding Green gram policies to support production and marketing • County extension staff - Sensitization of farmers • NGOs – Sensitization of farmers • Private sector (local traders and exporters) – Demanding Green gram 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	Kitui
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	• **Value Chain**: Green gram yields remain low and total domestic production is unable to satisfy demand by manufacturers leading to growing imports of raw materials. • **Aggregation**: Aggregation models including cooperatives—suffered after the downturn in Green gram production, wherein many farmers abandoned Green gram production. These weak organizations provide few services to farmers while providing limited bargaining power. • **Financial Incentives**: The government provides only limited support to Green gram 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, financing access to inputs, and importing their own hybrid seed. However, none of these efforts are explicitly tied to environmental or CSA standards.
Suggestions for addressing the challenges	**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 Green gram 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 Green gram 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 Green gram 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 up scaling if any	When policy instruments and rules are well implemented, there was an increase in productivity of green gram in Kitui County
Social, environmental, policy and market conditions necessary for development and up-scaling	• Social conditions – Acceptability of the policy instruments and rules by the smallholder farmers of green gram • Environmental conditions – sustainability in green gram production • Policy conditions – Lacking specific Green gram policy • Market conditions - Poor market infrastructure
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 25,400
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – Supporting youth, females and males in production and marketing Green gram • Adoption and scaling – Supporting youth, females and males in production and marketing Green gram
Gender related opportunities	• Providing incentives to youth, females and males in the production and marketing of Green gram. • Increased income by youth female and male • Increased employment by youth, females and males
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – Supporting VMGs in production and marketing Green gram • Adoption and scaling up - Supporting VMGs in production and marketing Green gram
VMG related opportunities	• Providing incentives to VMGs in the production and marketing of Green gram • Increased income by VMGs • Increased employment by VMGs
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 up scaling, 2, Requires validation, 3. Requires further research)	Ready for upscaling
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294

Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

Gaps for further research

1 Adoption of policies
2 Equity distribution among the stakeholders
3 Productivity levels among the smallholder farmers of Green gram
4 Farmer accessibility to production inputs
5 Impact on Green gram prices

2.13.2 TIMP Name	**County Integrated Development Planning**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram productivity due to lack of centralization of the smallholder agency and voices while planning agricultural development issues in Kenya
What is it? (TIMP description)	The County Integrated Development Planning is 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 Green gram production, marketing and processing are considered.
Justification	In the Counties where the green gram value chain creates wealth among the smallholder farmers, centralization of the farmers' agency and voices need to be considered during the County Integrated Development Planning. Failure to plan for the green gram production would to less optimization of opportunities
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	• Farmers • Traders • Processing industries • Extension • NGOs • Research institutions • Policy makers
Approaches to be used in dissemination	• Meetings • Radio • Television • Social media (WhatsApp, Facebook, twitter), internet • Farmers' groups • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Availability of stakeholders • Availability of agricultural policies and specific Green gram-based policies • Issues in Green gram business • Specific policy objective statement • Applied and adaptive Research to test, validate and release improved Green gram varieties

	• A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• Farmers – Demanding Green gram policies to support production and marketing • County extension staff - Sensitization of farmers • NGOs – Sensitization of farmers • Private sector (local traders and exporters) – Demanding Green gram policies to support production and marketing • Research institutions – Sensitization of stakeholders
C: Current situation and future scaling up	
Counties where already promoted if any	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	• Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on the agricultural policies whether National or County • Poorly established Green gram value chain • Green gram production are specific to agro-ecological zones and not all the Counties in Kenya grow Green gram
Suggestions for addressing the challenges	• 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 Green gram value chain – strengthening Green gram value chain • Green gram production are specific to agro-ecological zones and not all the Counties in Kenya grow Green gram – Diversification of Green gram
Lessons learned in up scaling if any	• There is increase in green gram productivity • There is green gram business in the Counties which recognize the potential of green gram during the County Integrated Development Planning
Social, environmental, policy and market conditions necessary for development and up-scaling	• Social conditions – Acceptability and contribution during the policy making process • Environmental conditions – lack of a comprehensive land use policy • Policy conditions – Lacking specific Green gram policy • Market conditions - Poor market infrastructure
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 25,400
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – Supporting youth, females and males in production and marketing Green gram • Adoption and scaling – Supporting youth, females and males in production and marketing Green gram
Gender related opportunities	• Supporting youth, females and males in the production and marketing of Green gram. • Increased income by youth female and male • Increased employment by youth, females and males

VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – in access to markets by VMGs • Adoption and scaling up - inaccess to markets by VMGs
VMG related opportunities	• Supporting VMGs the production and marketing of Green gram. • Increased income by VMGs • Increased employment by VMGs
E: Case studies/profiles of success stories	
Success stories from previous similar projects	• Promotion of green gram through County policies
Application guidelines for users	Training factsheets, manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for up scaling, 2, Requires validation, 3. Requires further research)	Ready for upscaling
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

GAPS

Further research

5 Adoption of policy options
6 Equity distribution among the stakeholders
7 Productivity levels among the smallholder farmers
8 Farmer accessibility to production inputs

2.13.3 TIMP Name	**Policy instruments related to Green gram**
Category (i.e. technology, innovation or management practice)	Management practice
A: Description of the technology, innovation or management practice	
Problem addressed	Low green gram productivity due to the existing policy instruments which do not centralize the smallholder farmers' issues in green gram production. 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 green gram production, some of the policy instruments include subsidy in the inputs and also minimum price for the green gram outputs.
Justification	Without policy instruments the green gram 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 green gram production
B: Assessment of dissemination and scaling up/out approaches	
Users of TIMP	• Farmers • Traders • Processing industries • Extension • NGOs • Research institutions • Policy makers
Approaches to be used in dissemination	• Meetings • Radio • Television • Social media (What's App, Facebook, twitter) • Internet • Farmers' groups • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Availability of policy objectives • Availability of policy instruments • Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• 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	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Counties where TIMPs will be up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination	• Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on the agricultural policies whether National or County • Poorly established Green gram value chain • Green gram production are specific to agro-ecological zones and not all the Counties in Kenya grow Green gram
Suggestions for addressing the challenges	• 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 Green gram value chain – strengthening Green gram value chain • Green gram production are specific to agro-ecological zones and not all the Counties in Kenya grow Green gram – Diversification of Green gram

Lessons learned in up scaling if any	• In the Counties where green gram production is supported through the policy, there is productivity increase
Social, environmental, policy and market conditions necessary for development and up-scaling	• Social conditions – Low understanding of policy instruments • Environmental conditions – lack of a comprehensive land use policy • Policy conditions – Lacking specific Green gram policy • Market conditions - Poor market infrastructure
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 25,400
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – Low Green gram production by youth, females and males • Adoption and scaling – Market in access by youth, females and males
Gender related opportunities	• Production-increasing by youth, females and males. • Increased resource use in agricultural production and processing by youth, women and men • Sustainability in Green gram farming by youth, women and men
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – Issues related to efficiency, factor markets, product markets by VMGs • Adoption and scaling up - Issues related to efficiency, factor markets, product markets by VMGs
VMG related opportunities	• Efficiency and access to factor and product markets by VMGs. • Increased income by VMGs • Increased employment by VMGs • Sustainability
E: Case studies/profiles of success stories	
Success stories from previous similar projects	Wealth creation in green gram production
Application guidelines for users	Training factsheets, manuals and power point slides are available
F: Status of TIMP Readiness (1. Ready for up scaling, 2, Requires validation, 3. Requires further research)	Ready for upscaling
G: Contacts	
Contacts	Centre Director, KALRO-Katumani P.O. Box 340-90100 Machakos cd.katumani@kalro.org Phone: 0736333294
Lead organization and scientists	KALRO; Victor Wasike; John Wambua
Partner organizations	Ministry of Agriculture, Livestock, Fisheries and Irrigation, Farmers

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Further research

9 Validation of policy instruments
10 Equity distribution among the stakeholders
11 Farmer accessibility to production inputs markets
12 Farmers accessibility to output markets

2.13.4 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 green gram productivity due to the development of agricultural policies not relevant to the problem emergency in green gram 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, (3) 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 green gram? 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	• Farmers • Traders • Processing industries • Extension • NGOs • Research institutions
Approaches to be used in dissemination	• Meetings • Radio • Television • Social media (What's App, Facebook, twitter) • Internet • Farmers' groups • Farmer field and business Schools(FFBS) • Agricultural Innovation Platforms (AIP)
Critical/essential factors for successful promotion	• Availability of stakeholders • The stages of problem emergence, formulation, implementation and evaluation

	• Applied and adaptive Research to test, validate and release improved Green gram varieties • A platform for interaction in Green gram value chain stakeholders
Partners/stakeholders for scaling up and their roles	• 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 up scaled	Isiolo, Machakos, Taita Taveta, Tharaka Nithi, West Pokot, Baringo, Tana River
Challenges in development and dissemination -	• Disorganization and scattered farmers • Small-scale farming • Inadequate information to stakeholders on issues • Poorly established Green gram value chain
Suggestions for addressing the challenges	• 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 Green gram value chain – strengthening Green gram value chain
Lessons learned in up scaling if any	• None
Social, environmental, policy and market conditions necessary for development and up-scaling	• Social conditions – Different issues among the Green gram producers • Environmental conditions – environmental issues concerning sustainability in green gram production • Policy conditions – Lacking specific Green gram policy • Market conditions – Market issues
D: Economic, gender, vulnerable and marginalized groups (VMGs) considerations	
Basic costs	Total variable costs per acre per season Kshs 19,710
Estimated returns	Returns after deductions of the total variable costs per acre per season Kshs 25,400
Gender issues and concerns in development and dissemination, adoption and scaling	• Development and dissemination – generation of issues and implementation by the youth, females and males in production and marketing of Green gram • Adoption and scaling – generation of issues and implementation by the youth, females and males in production and marketing of Green gram
Gender related opportunities	• Incorporation of issues generated by the youth, females and males. • Implementation of policy cycle
VMG issues and concerns in development and dissemination, adoption and scaling up	• Development and dissemination – Problems related to VMGs • Adoption and scaling up – implementation issues related to VMGs
VMG related opportunities	• Reduction of VMGs problems in the production and marketing of Green gram. • Involvement of VMGs in the implementation of policy
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 up scaling, 2, Requires validation, 3. Requires further research)	Requires validation
G: Contacts	
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Further research

1. Analysis of policy model
2. Impact on the new policy on Green gram production and marketing

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