Kenya Agricultural and Livestock Research Organization

Agricultural Mechanization Research Institute

2015-2016 Annual highlights

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Enhancing crop and livestock production through development of appropriate mechanization options and breeding and husbandry intervention strategies in Kenya.

More information can be obtained from

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1 Agricultural Mechanization Research Programme

1.1 Programme mandate

The institute has the national mandate of generating and disseminating agricultural mechanization technologies and innovations on crops and livestock value chains in Kenya to increase agricultural productivity, improve post-harvest value of crops and livestock products and conserve the environment.

The Agricultural Mechanization Research Institute was established in November 2015 with its headquarters located at Katumani in Machakos County (1° 35'S and 37° 14'E) at an altitude of about 1600 m above sea level, about 80 km southeast of Nairobi, and about 9 km South of Machakos town, along the Machakos–Wote Road. The institute has Katumani Research Centre and four sub-centres which are Kiboko, Masongaleni, Ithookwe (Makueni County) and Voo and Kampi ya Mawe (Kitui County).

The objectives of AMRI include:

- Development and promotion of appropriate machinery and equipment for different agricultural operations
- Acquiring, testing and adapting different machinery and equipment for different agricultural operations and production value chains
- Establishing linkages with private sector for fabrication and supply of appropriate agricultural machinery and equipment
- Development of appropriate machinery for transporting farm produce within the farm and to markets/buying centres
- Development and promotion of appropriate post-harvest technologies, renewable energy and farm structures
- Development and promotion of appropriate soil and water management technologies
- Social and economic impact assessment of agricultural mechanization technologies

1.2 Highlights of Achievements

The achievements of the programme for the calendar year 2015-2016 include the following;

- A report on the baseline survey on the status of agricultural mechanization in Kenya
- A report on challenges and solutions for agricultural mechanization to small holder farmers; the case of Africa, Presented to an International Symposium of Agricultural Commodity Trade, RDA, Jeonju, South Korea.
- Technology dissemination through field days in Kitui, Taita Taveta and Uasin Gishu counties and ASK shows
- Capacity building of stakeholders (engineers, technicians, artisans, processors and scientists) on diversification of maize products through Nixtamilization process (cooking maize in lime).
- A draft report on Agricultural Mechanization Research Institute strategic implementation plan, 2016-2020
- Evaluated agricultural mechanization technologies (harvesting methods for cassava and deficit irrigation for grain amaranth).

Participation in Agricultural shows in Eldoret (Uasin Gishu County), Machakos and Kitui Counties and International Trade Fair in Nairobi

Partnerships on agricultural mechanization with stakeholders (MoA-agricultural engineering services (AES) and Agricultural Technology Development Centre (ATDC), The Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI), National Irrigation Board, Farm Concern

1.3 Status of Agricultural Mechanization in Kenya

1.3.1. Introduction

Agricultural productivity is low in Kenya due to low levels of mechanization, amongst other factors. A baseline survey on agricultural mechanization (AM) was undertaken in Kenya through funding from The Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI).The study focused on agricultural value chains of highest economic importance in Kenya and mainly food crops, industrial crops, horticultural crops and livestock. The objectives were appraising the status of information on AM in Kenya, establishing the levels of AM among selected agricultural value chains, identifying constraints and proposing interventions for the adoption of the improved AM technologies and innovations, recommend strategies, set research agenda, make technical and policy recommendations to enhance AM in the respective value chains in Kenya.

1.3.2. Methodology

Secondary and primary data sources provided key information on selected agricultural value chains. The secondary information and desktop reviews were undertaken through key informants' interviews via taking notes, use of checklists and discussions with key AM stakeholders. The survey was done using a semi-structured questionnaire through a multistage sampling design which involved selecting the nine agricultural value chains, target counties, sub counties and wards and finally random sampling of respondents using transects depending on the nature of the value chain. The study considered the value chains in terms of the enterprise sizes, viz small, medium and large scale. Five hundred fifty five (555) respondents were interviewed for various value chains in the following counties; Trans Nzoia (Maize), Bungoma (Rainfed rice) and Kirinyaga (Irrigated rice), Nakuru (Wheat), Kericho (Tea), Kisumu (Sugarcane), Muranga (Coffee), Kirinyaga (Tomatoes), Makueni (Mangoes) and same counties selected for livestock based interviews.

1.3.1 Results

1.3.2 The survey findings are reported according to target value chain and key in and out of field Operations

Food and industrial crops value chain

Land preparation is done by oxen and four wheeled tractors and harrowing by disc harrow. In maize and rice production systems mechanization ranged from 67-100 % whereas in tea and sugarcane the machine usage ranged from 0-100% with nil in coffee. Horticultural crop mechanization levels ranged from 81-96% of the sample farmers. Under irrigated rice production, rotavation by motorized rotavator for rice seedlings averaged 81 % of sampled farmers.

Mechanized planting is common in maize (56%) and wheat (95%) and absent in rice, industrial and horticultural crops.

Mechanized weeding in maize was highest (46%) followed by tea (14.1%). The rest of the value chains had less than 5% machinery usage in weed management.

Mechanical harvesting for industrial and horticultural crops was insignificant. Rice and wheat harvesting had significant mechanization levels, with wheat at 98%, irrigated and upland rice at 55 and 11%, respectively. Mechanized harvesting was not reported for maize, tea, sugarcane and tomatoes whereas it was less than 5% for coffee and mangoes. However, mechanized transport for food crops stood at 100 % except for rice at 4.

There was immense mechanization in the crop value chain (maize) using hammer mill, shredders, tractor drawn chaff cutter, baler and wet mill. There was virtually no value addition except for grading and sorting for the tea and coffee. For the horticultural crops there was no significant value addition.

Livestock value chain

Livestock considered were cattle, poultry, sheep and goats, while the operations surveyed were; feeding and watering, animal protection, milking, slaughtering and animal waste management. The food crops/livestock system had the highest mechanization level at 40.9% and mainly crop residue processing, followed by industrial crops/livestock system (37.5%) and horticultural crop/livestock system had the lowest (16.7%). Other activities with notable levels of mechanization were hay making and milking. Milking operation was done manually by all the respondents within this system. There was no mechanization in poultry management operations. There was no mechanization reported for poultry management (feeding, watering and handling of livestock products)

2 Crop Health

2.1 Programme mandate

The programme undertakes development of technologies on crop health which are readily applicable to specific farming systems; biological, cultural, physical, chemical and integration of options. The programme has two laboratories serving the units of Pathology and Entomology Sections.

2.2 Achievements

2.2.1 Pathology

The following activities were carried out to achieve specific milestones towards specific areas:

- Two permits to carry out efficacy trials on two *Striga mycoherbicide* products granted by PCPB. The products are Kichawi Kill1 and Kichawi Kill2
- AMRI-Katumani plant pathology laboratory was granted a premises license for manufacture of *Striga mycoherbicide* for year 2017.

2.2.2 Entomology

Two technologies were developed on cassava and tea production systems;

- Cassava Production: ways of crop production towards mitigation of severe damage from cassava green mite.
- Tea Production: enhanced conservative production systems towards mitigation of damage by thrips and the red spider mite, *Oligonychus coffeae*.

Fig.2. High yielding cassava variety released by KALRO; Kitui show in May 2016 (left), and Prof El Sayed M. El Banhawy (University of Nairobi) and Dr. Evelyn Cheramgoi of KALRO Kericho in Nyeri tea production farms in 2015 (right) (Photos by Dr. D.L. Mutisya, KALRO-Katumani)

3 Sorghum agronomy

3.1 Programme mandate

The objective of the programme is to assemble and evaluate sorghum and millet germplasm, and develop varieties that are resistant to abiotic (drought, heat, and edaphic factors) and abiotic (stem borers, kernel covered smuts, aphids, charcoal rot, head smuts, foliar diseases, etc.) stresses of the ASAL areas. The programme also develops sustainable sorghum and millet husbandry technologies that maximize yields at low input levels.

3.2 Achievements

3.2.1 Evaluation of appropriate sorghum legume rotations for increased sorghum productivity in semi-arid Eastern Kenya

In semi-arid Eastern Kenya, soil fertility is largely maintained by use of low quality manure, inconsistent crop rotations/intercrops involving cereals and legumes, and grass leys which are inherently inadequate. Sorghum is not even a priority crop when it comes to use of limited local materials/approaches for soil fertility maintenance. Therefore, most farmers only harvest up to 300 kg ha^{-1} of sorghum even for good high yielding varieties (Kari Mtama 1 and Gadam) with yield potential of 1.7-4.5 t ha^{-1}. Most farmers are aware of inorganic fertilizers and their yield boosting potential in crops but affordability and limited knowledge on appropriate application techniques limit usage. A study was conducted to quantify the yield benefits of legumes to sorghum grown in rotation, identify the legume contributing the highest yield benefits to subsequent sorghum crop and assess the yield advantages of ratooned sorghum relative to fresh sown crop during unreliable long rain season. The legume test crops included green gram (*var*. N-26), cowpeas (*var*. Kvu 27-1) and black dolichos (*var*. DL 1002) whereas Sila and Gadam sorghum were the cereal crops. Nitrogen and phosphorous fertilizer in form of di-ammonium phosphate (DAP-18:46:0) was applied at rate of 23 and 25 kg N and P ha^{-1}, respectively at planting for an expected break-even grain yield of 1.8 t ha^{-1}. Generally, Gadam sorghum reflected a higher degree of agro-ecological adaptation compared to Sila by having a 26 % higher grain yield than the latter. Compared to sorghum monoculture, dolichos, cowpeas or green gram grown rotation with sorghum increased sorghum grain yield by 80 to 453 kg ha^{-1} in two test locations in Kibwezi and Kitui Counties. Green gram was the "best bet" legume for rotation with sorghum while ratoon sorghum showed greater yield stability as reflected in higher number of tillers (8 vs 1/ m^2) and productive heads (73 vs 10 %) compared to fresh sown sorghum.


Demonstration of appropriate fertilizer application method at Nguutani (left) and Training host farmers on stem borer control in Thange (Makueni)

3.2.2 Boosting sorghum fertility in Eastern Kenya

Sorghum productivity in semi-arid lands of eastern Kenya has remained low at 0.5-0.9t/ha despite being elite lines with yield potential of 2-5 t/ha. The soils are inherently of low N, available P, organic C and micronutrient especially Zinc (Zn) which could lead to low sorghum productivity as Zn is not incorporated in planting fertilizers used in the region. The focus of this activity was to evaluate use of growth enhancer (hormone) and or zinc trace element fertilizer (a constituent of Kelpak) in lower midlands zones (LM4 and LM5) for increased food and income security.

Growth hormone should be applied as topdress at 25-50 ppm/ha + 2% zinc /ha to enhance sorghum productivity in semi-arid lands. Micronutrient Zinc is better formulated in fertilizers to increase sorghum productivity in the region (Figs. 1 and 2).

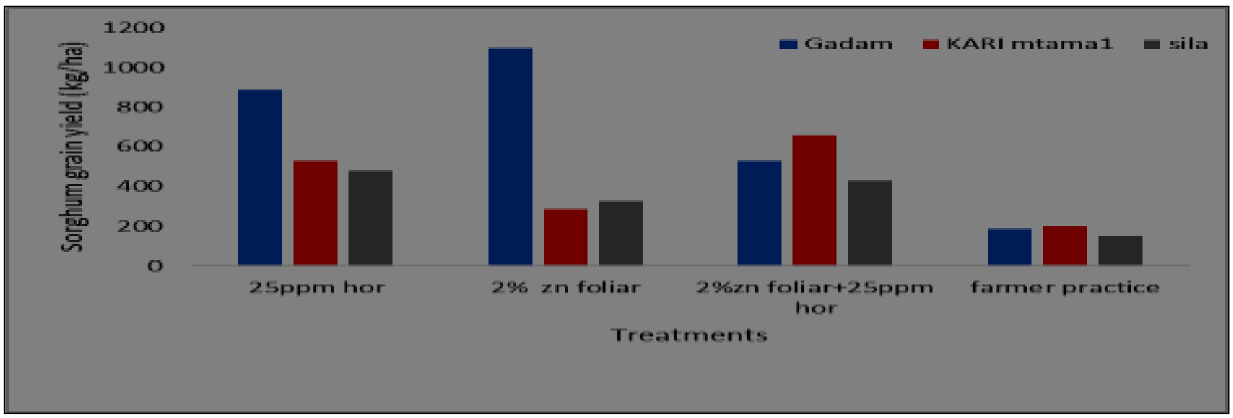


Fig. 1. Effect of growth hormone and micronutrient zinc application on three sorghum grain yield (kg/ha) at Nguutani, Mwingi.

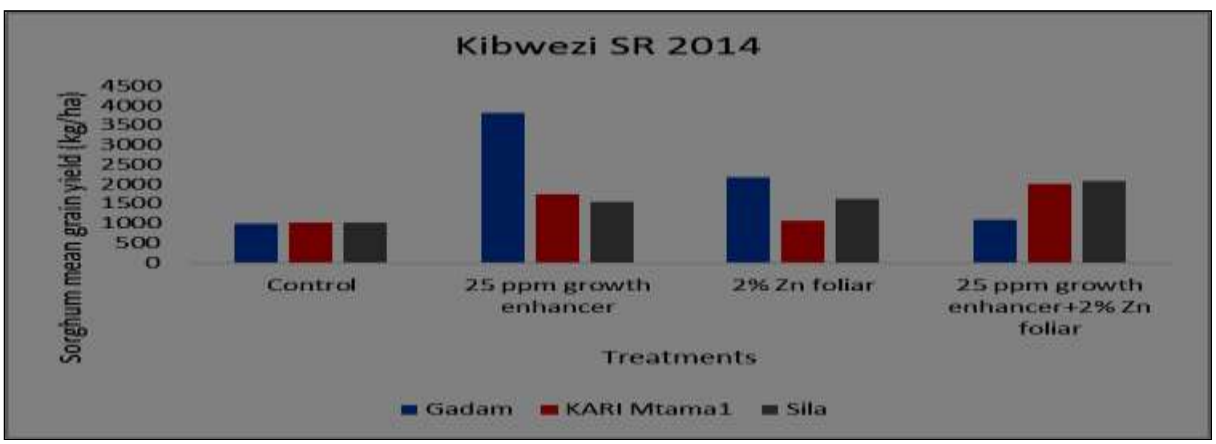


Fig. 2. Effect of growth hormone and micronutrient zinc application on three sorghum varieties grain yield (kg/ha) at Kibwezi Makueni in 2014

4 Horticulture

4.1 Programme mandate

Horticulture programme Katumani conducts research in fruit trees, both common and local vegetables, as well as alternative crops.

4.2 Achievements

4.2.1 Germplasm evaluation

Out of eight lines evaluated in 2015 and 2016, KAM 001, KAM 114 and KAM 201 were the best performers in all test locations. Further, KAM 001 and KAM 114 were forwarded to KEPHIS for distinctive, uniformity and stability (DUS) evaluation before release.

4.2.2 Plant population and soil fertility trials

Different fertility levels were evaluated at two different spacing on grain amaranth. There were 4 levels of fertility (0.5 t farm yard manure (FYM) ha^{-1}, 10 t FYM and 20 kg P_2O_5 ha^{-1}. Preliminary findings showed that using 20 kg P_2O_5 and 10 t of FYM gave higher yields compared to the control and 5 ha^{-1}.

4.2.3 Grain amaranth insect pest management

Control measure for pigweed weevil that tunnels the amaranth stem was identified and early application of systemic pesticides at two weeks after plant emergency was the best strategy.

4.2.4 Seed bulking

Farmers received 200 kg of grain amaranth seeds.

4.2.5 African leafy vegetable research

One promising line of vegetable amaranth (KAT vegetable 1) will be entered in NPT in the next ASAL APRP funding cycle. Ten promising lines of pumpkins are at various stages of evaluation.

About 20 kg of seed (assorted African Leafy Vegetables) were multiplied and availed to farmers.

5 Root and tuber crops

Programme mandate

The objective of this programme is to assemble and evaluate roots and tuber crops (sweet potatoes and cassava) germplasms, and develop varieties that are resistant to abiotic (drought, heat, and edaphic factors) and abiotic (sweet potato weevil, sweet potato mottle virus, cassava mealy bugs, green mites, aphid stem scales, cassava mosaic virus, etc.) stresses of the ASAL areas, and to develop sustainable roots and tuber crop husbandry technologies that maximise yields at low input levels.

5.1 Achievements

5.1.1 Sweet potato on-farm demonstrations

- Fertilizer use - 5 g per hill (NPK 18:18:0) vs. no fertilizer application.
- Plant density - 60×30 and 90×30 cm and high density increased sweet potato root yield.
- Weed control - Poly ethane cover for reduced soil moisture weevil infestation.
- Virus free seed production - Use of net tunnels for keeping planting materials clean

Breeding for high yield and virus resistance - Potential varieties are at screened in National Performance Trials for future release.

5.1.2 Cassava

Cassava is one of the crop that is gaining popularity due to its adaptability, ease of cultivation, productivity, utilization and income generation potential. Most of the farmers have been growing earlier developed varieties that are late maturing (18-36 months) and are susceptible to pests and diseases such as cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). Efforts are now directed towards control of emerging challenge of CBSD in all the cassava growing regions of the country.

Advanced yield trial for cassava. Special attributes of the varieties that performed well out of the fifteen tested

- Clones TC2, 990005, TC4, TC14 AND 92/00061 showed resistance to CMD.
- Clones TC4, 92/00061, TME419 and TC14 did not show symptoms of CBSD

6 Maize

6.1 Programme mandate

The Programme seeks to assemble and evaluate maize germplasm, and develop varieties that are resistant to abiotic (drought, heat, and edaphic factors) and biotic factors (stem borers, weevils, LGB, aphids, maize streak, head smuts, etc.) stresses of the ASAL areas. The programme also develops sustainable maize husbandry (agronomic) technologies that maximise yields at both low and optimal input levels.

6.2 Achievements

6.2.1 Released hybrids in 2015

The Programme released 5 Katumani Kit, 3 Transitional Kit and 5 Medium Kit hybrids in 2015. Three hundred and fifty-five kilograms of CKDHL 0089, CKDHL 0323, CKDHL 0364, CKDHL 0374, CKDHL0470, CML 312 and CML 442 varieties were produced for seed companies. Out of what was produced, 312 kilograms were issued out to seed companies.

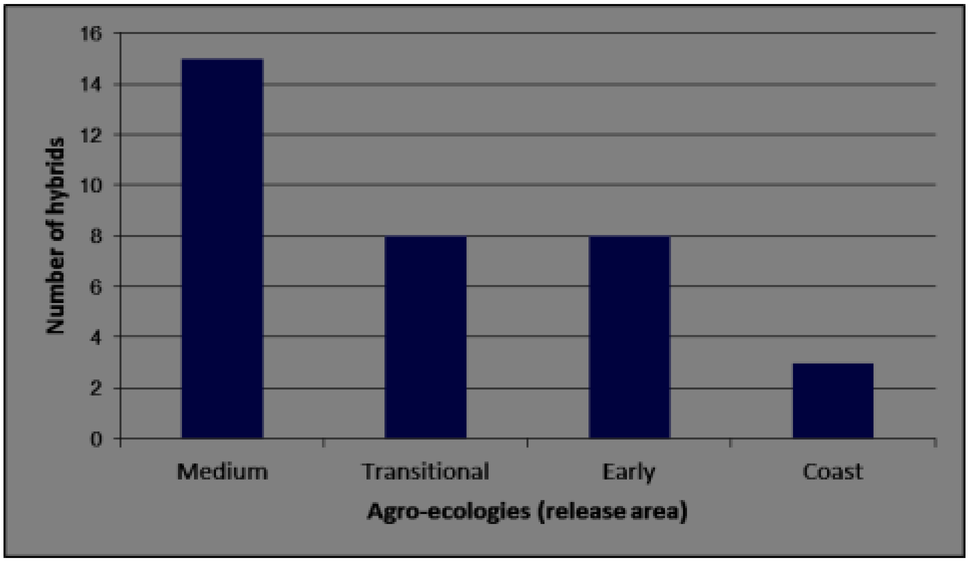


Fig. 1. Hybrids released in Kenya since WEMA's inception

6.2.2 Regulatory Team engagement with policymakers

In an attempt to seek support of targeted county leaders in lifting of the ban, the RT team participated in various fora with policymakers. WEMA–K RT members collaborated with OFAB PC to organize such training/visit sessions (Figure 7).

6.2.3 Screening for Maize Lethal Necrosis (MLN) disease in Naivasha

Twenty-first generation MLN tolerant maize inbred lines obtained from CIMMYT were used in making 50 crosses in 2016 of KALRO X CIMMYT. These materials were then submitted to Naivasha for artificial screening under MLN. Only 5 Hybrids qualified with a score of 2-2.5 on a scale of 1-5, where 1 is resistant/tolerant and 5 is susceptible.

6.2.4 Released and/or recommended hybrids in 2016

Fifty-two hybrids have already been released in Kenya (Fig. 7).

Fig. 2. Dr. Francis Nang'ayo of AATF and Dr. Murenga Mwimali of KALRO during an interview on K24 TV station on WEMA maize

Fig. 3. Dr. Jackim Ouda, with the WE1101 hybrid at an agricultural trade fair in Mombasa

Fig. 4. Members of Parliament and partners visit to the CFT Kiboko

Fig. 5. Participants in Training on NPT/DUS guidelines on GMO's, held at Lukenya Getaway

Fig. 6. Maize Lethal Necrosis (MLN) disease (above and below)

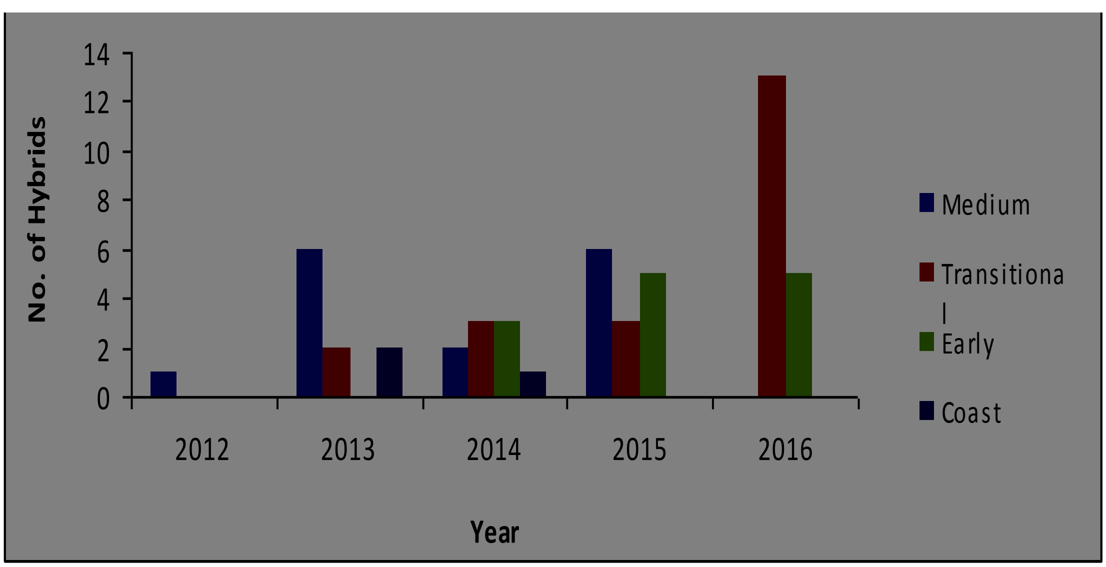


Fig. 7. WEMA Kenya release as per December, 2016

7 Grain legumes

7.1 Programme mandate

The grain legume Programme seeks to assemble and evaluate grain legume (beans, cowpea, pigeon pea, green grams) germplasm, and develop varieties that are resistant to abiotic (drought, heat, and edaphic factors) and abiotic (pod borers, pod suckers, bean maggots, aphids, fusarium wilt, charcoal rot, anthracnose, bacterial blight, BCMV, etc.) stresses of the ASAL areas. The programme also develops sustainable grains legume husbandry technologies that maximize yields at low input levels.

7.2 Achievements

7.2.1 Bean breeding

Three bush bean trials comprising 20 micronutrient lines, 12 drought-tolerant lines and 20 heat- and drought-tolerant lines were evaluated in Katumani, Kiboko, Kitui, and Maragua and in Laikipia.

Four lines passed NPT and were submitted to KEPHIS for DUS tests. Sixty-four beans lines were also evaluated for nutritive analysis, pending release.

Part of the bean trial fields set up at Katumani, Kiboko, Kitui, Maragua and in Laikipia

7.2.2 Climbing beans

Sixteen micronutrient rich climbing beans and 12 disease-tolerant varieties were evaluated at Katumani with 3 checks of released varieties. Four varieties are promising for advanced multi-location trials.

Part of the climbing bean trial fields set up at Katumani for 16 micronutrient rich climbing beans and 12 disease-tolerant varieties

7.2.3 Product formulation and technology dissemination

Twelve released and promising bean lines were evaluated for characteristics relating to cooking time, water absorption capacity, nutritive characteristics and ability to make pre-cooked bean products. The lines that passed the test are KAT B1, KAT B9, Wairimu and Rosecoco.

Two hundred farmers in Machakos and Makueni, 240 in Narok and Bomet and 700 in Homabay counties were trained on production and marketing of beans that can make pre-cooked beans. Eight hundred kilogrammes of KAT B1 and KAT B9 seed were supplied to the farmers to start production of grain for the processing industry.

Twenty-four women in Ntulele Narok and 36 farmers in Mulot while 22 in Machakos were trained in nutrition training using bean based products. The purpose being to improve their nutritive especially for the vulnerable groups (children under 5 years, the elderly and the sick). Farmers were trained on importance of nutrition, food safety and practical lessons on how to process bean flour. Using the flour they learned how to make bean based porridge, chapatti and Ugali.

A section of the women farmers being trained in nutrition using bean-based products in Ntulele (Narok), Mulot and in Machakos

8 Pasture and animal production

8.1 Programme mandate

The Programme was established to help solve the problem for poor animal health, which together with poor nutrition and inappropriate breeding practices lower the productivity of the livestock species in the arid and semi-arid areas (ASALs) of Kenya. The Programme works in collaboration with KALRO institutes with mandate on animal production to achieve its objective of enhancing productivity of cattle, goats, sheep and poultry, hence improving their productivity. To achieve this stated objective, the Programme evaluates, validates, and modifies (if need be) the generated technologies relevant for the ASALs before recommending their use by farmers.

8.2 Achievements

8.2.1 Evaluation for dry matter yield

Eight Brachiaria grass cultivars were evaluated for dry matter (DM) yield relative to commonly cultivated forages; Napier grass cv. Kakamega 1 and Rhodes grass at Mtwapa, Katumani, and Ol Joro Orok. The DM yields were lowest at Katumani, intermediate at Ol Joro Orok and highest at Mtwapa. The cultivars Basilisk, MG4 and Piata had the highest DM yield across the three sites (Fig. 1).

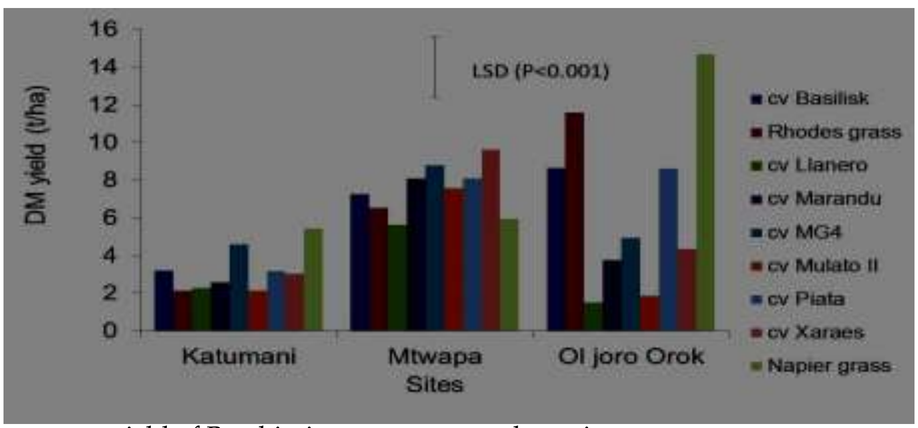


Fig. 1. Dry matter yield of Brachiaria grasses across three sites

8.2.2 Contribution of Brachiaria grasses to milk production

Twelve farmers in Machakos County participated in a feeding trial to evaluate the effects of feeding Brachiaria grasses to dairy cattle on milk production. From each farm one dairy cow was used resulting in 12 animals. The four best bet Brachiaria cultivars evaluated for milk yield (Piatá, Toledo, La Libertad and Basilisk) were compared with the local feeds which were varied mixtures of Napier grass, maize stover and natural pastures. The cows were in mid lactation (3 and 6 months into lactation). Two distinct groups of lactating dairy cows were observed, the relatively high (HY) and low (LY) yielding. On average, when fed on Brachiaria, milk production increased from 4-4.6 litres/cow per day for LY animals, representing a 15% increase and 9-12.6 litres/cow per day for the HY dairy cattle, representing a 40% increase compared with the local feeds (Fig. 2).

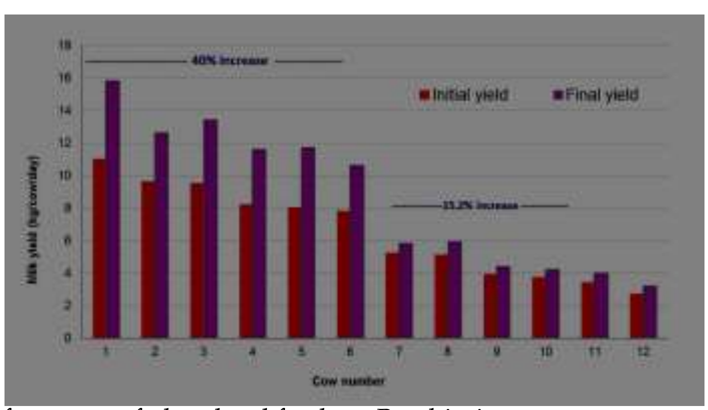


Fig. 2. Milk yield from cows fed on local feeds or Brachiaria

8.2.3 Selection Brachiaria grass cultivars by farmers

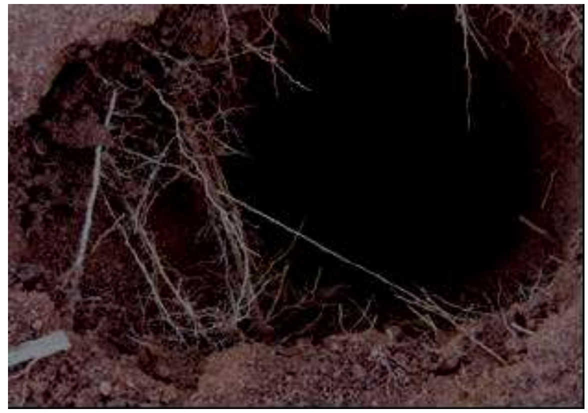
Low adoption of agricultural technologies has been attributed to insufficient attention to farmers' priorities and perceptions while developing and promoting technologies. A Participatory Variety Selection (PVS) involving 84-89 farmers was carried out at Katumani to evaluate and select adapted and productive Brachiaria grasses for the semi-arid environment. The brachiaria cultivars evaluated were; *Brachiaria brizantha* cvs. Marandu, Xaraes, Piatã, MG4, *Brachiaria decumbens* cv. Basilisk, *Brachiaria humidicola* cv. Llanero, *Brachiaria hybrid* cv Mulato II and Rhodes grass a control. The criteria used for selection were identified through focus group discussions by farmers from target Counties. Nine attributes; drought tolerance, soil erosion control, plant height at harvest, growth habit, colour of leaves, disease and pest tolerance, suitability for grazing and for cut-and-carry were used for selection criteria.. For each criterion, farmers' scores were recorded on a Likert scale of 1 to 4 with higher scores indicating high cultivar preference. Drought tolerance and colour had the highest mean score implying that they were important for consideration when selecting forages. Based on the overall criteria, MG4, Basilisk, Mulato II, and Xaraes were found to be most suitable and this concurred with results from agronomic evaluation where they produced the highest dry matter yield.

Fig. 1. Farmers selecting Brachiaria grass cultivars at Katumani

8.2.4 Brachiaria grasses improve soil health

Soils in the semi-arid regions of Kenya are often low in organic matter content (< 1%) and deficient in plant-available nutrients, especially nitrogen (N) and phosphorus (P). Any practice that increases the production of biomass carbon (C) via photosynthesis slows down the return of C to the atmosphere increases C reserves in the soils through Carbon sequestration process. This would improve the soil quality and productivity and make soils more resilient to climate change. One way to achieve this is to increase the amount of biomass C in soil where it is less susceptible to loss. This way the soil becomes a C 'sink' by absorbing atmospheric CO_2 from circulation and locking it in organic C form in the soil. Brachiaria grasses are endaphytic and have a great ability to sequester and accumulate large amounts of organic C due to their deep and abundant root system which also make them drought tolerant and enhance adaptation to poor fertility soils. A study was conducted to investigate the changes in microbial biomass carbon (C), nitrogen (N) and phosphorus (P) following cultivation of Brachiaria grasses in semi-arid region of Kenya. The Brachiaria grass cultivars included *Brachiaria decumbens* cv. Basilisk, *B. brizantha* cvs Marandu, MG4, Piatã and Xaraes, *B. humidicola* cv. Llanero and *B.* hybrid cv. Mulato II which were compared with two locally cultivated forage grasses (*Chloris gayana cv.* KAT R3 and *Pennisetum purpureum cv.* Kakamega 1) and a bare plot (negative check). The grass treatments were evaluated with fertilizers application (40 kg P applied at sowing and 50 kg N ha^{-1} in each wet season) and with no fertilizer applications. Generally, microbial biomass was higher in plots with grasses than in the bare plots. In addition a significant enrichment of organic matter was noted in the microbial biomass when

Brachiaria grasses were grown with N and P fertilizers. Among Brachiaria cultivars, the highest microbial biomass C was recorded in plots with cv. Mulato II and the lowest from the plots with cv. MG4. The cv. Marandu had the highest microbial biomass N (21.2 mg N kg^{-1}) in fertilizer treatments whereas cv. Mulato II hybrid had the highest microbial N (14.6 mg N kg^{-1}) in no fertilizer treatments.



Active growing Brachiaria grass (left) and soil enrichment with organic C (dense roots) (right)

9 Socioeconomics

9.1 Programme mandate

The Programme conducts research into social and economic aspects of design, development and dissemination of agricultural technologies. The studies aim at improving articulation of farmer priorities in research and technology development, promoting more efficient, sustainable and suitable agrarian industry in the semi-arid areas of Kenya while improving the welfare of farm families through application of agricultural science in dryland farming. Farming systems are characterized by ex-ante and ex-post assessments of research findings and done in the context of recommendations, technology adoption and institutional and policy environment.

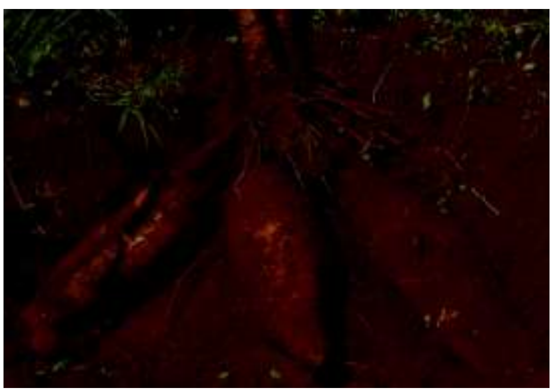
9.2 Achievements

9.2.1 Upgrading cassava value chain in eastern Kenya

The potential of cassava is limited by the low smallholder productivity, high labour demand during harvesting and the post-harvest physiological deterioration. A study was conducted to improve the smallholder productivity, evaluate the oxen drawn labour reduction technologies in harvesting, and the best storage methods for the fresh cassava roots.

9.2.2 Improved smallholder productivity

Cassava productivity was improved through the promotion of clean cassava planting materials. Three cassava varieties were multiplied at KALRO-Kiboko and disseminated to organized farmers. These varieties are Katune, Katsuhanzala and Kasukari.



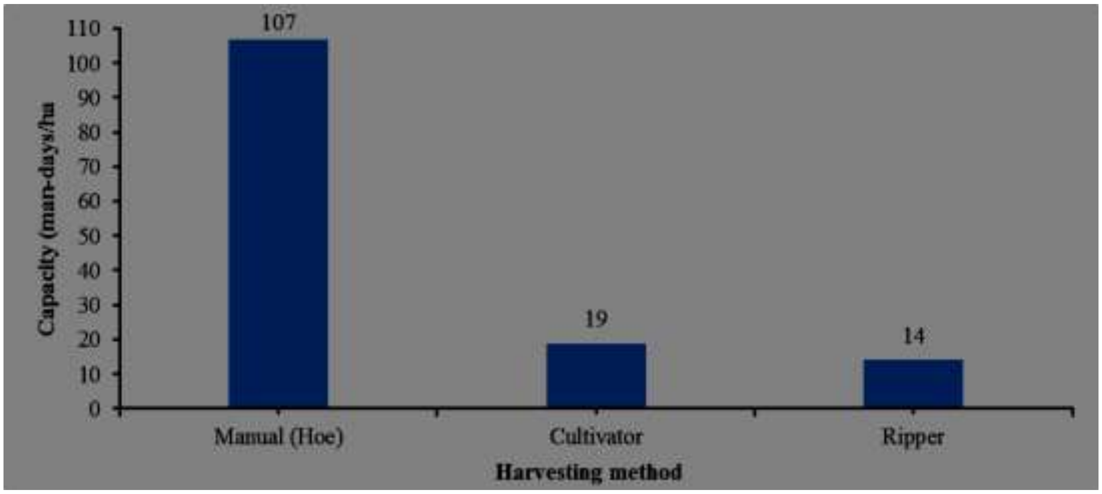
Katsuhanzala

Kasukari

Katune

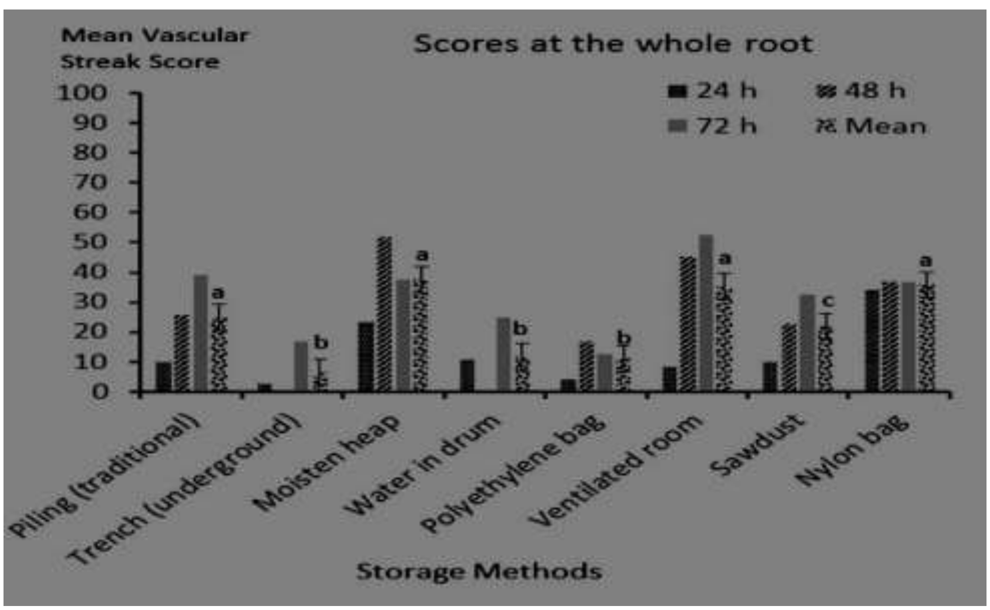
9.2.3 Oxen drawn labour reduction technologies in cassava harvesting

The labour in man-days used to harvest one hectare was manual (107), cultivator (19) and ripper (14) as shown in the Figure below:



9.2.4 Storage methods for the fresh cassava roots

The storage methods with the low mean vascular streak scores were the trench, use of water in drum and the polyethylene bag as shown in the Figure below.



10 KALRO Seed Unit

Programme mandate

The Unit maintains all KARLO pre-released and released varieties, populations and inbreds. This is besides multiplying the breeder, pre-basic, basic and certified seed of the required crop varieties. KSU also propagates seedlings of fruit trees and other vegetative propagated planting materials (stock). Seed produced in year 2016 in tons were beans 79.8, green gram 85.8, cowpeas 267.7, maize 53, sorghum 217, dolichos 49.9, finger millet 2 and pigeon peas 1.8 all totaling to 758 metric tons. The seedling produced were mangoes (12,768), citrus (2,112), avocados (1,056), sweet yellow passion (2,017) and pawpaws (8,100) all totaling to 29,165 pieces.

Healthy sorghum crop (left) and a bungalow built with proceeds from seed sales (right)

11 Human Resource Department

11.1 Performance through time management

Firms should have a well-defined mission, vision and strategies that all employees subscribe to. Organizational leadership is responsible for guiding workers towards maintaining an acceptable institutional culture. Employees should be cognizant of institutes' core values/business in all their undertakings. Where employees feel well-engaged they put their psychological contract into their jobs and have the energy and excitement to deliver the expected outputs. Engaged employees are committed and loyal to the organization.

The Director General introduced clock book as a time management strategy. As is the case with the normal hiccups whenever there is change, there were resistances from various employees. However, with strong support from the Institute Director, Centre Director, Deputy Centre Director and the Human Resource Department was able to roll out the exercise and it has gradually picked.

11.1.1 Staff changes

There were few staff changes during the period Noah Wawire (PhD) was appointed as the Ag. Institute Director for AMRI, with Peter Leley (PhD) being appointed as the Centre Director and Daniel Mutisya (PhD) being the Deputy Centre Director.

12 Publications

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Gichangi, E.M., Donald M.G. Njarui, Sita R. Ghimire, Mwangi Gatheru and Keziah W.N. Magiroi (2016). Effects of Brachiaria grasses on soil microbial biomass carbon, nitrogen and phosphorous in soils of semi-arid tropics of Kenya. *Tropical and Subtropical Agroecosystems*, 19:205-217.

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Nguku, S., Donald M. G. Njarui and Nashon K.R. Musimba (2016). Primary production variables of Brachiaria grass cultivars in Kenya dry lands. *Tropical and subtropical agroecosystems*, 19: 29-39.

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Njarui, D.M.G., Mwangi Gatheru, David M. Mwangi and George A. (2015). Keya. Persistence and productivity of selected guinea grass ecotypes in semi-arid tropical Kenya. *Grass Science*, 61: 142-152.

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Nzioki, H., D. M. Njarui, M. Ahonsi, J. Njuguna, L. Kago, C. Mutai, S. R. Ghimire (2016). Diseases of improved Brachiaira grass cultivars in Kenya. In Njarui, D.M.G, Gichangi, E.M, Sita, S.R and Muing R.W (Eds). In: Proceedings of 'Climate Smart Brachiaria for Improving Livestock Production in East Africa- Kenya Experience, Naivasha, Kenya 14-15 September, 2016 pp262-271.

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