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ARID AND RANGE LANDS RESEARCH INSTITUTE (ARLRI)

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Photographs (clockwise): *Eragrostis superba* pasture, Improved Hay box, Hay Retail outlet in Narok, Goats and Cattle

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Abbreviations and Acronyms

AF	Agro Forestry
AI	Artificial Insemination
AIA	Appropriation in Aid
APVC	Agrivultural Product Value Chain
ARLRI	Arid and Range Lands Research Institute
ASAL	Arid and Semi Arid Lands
ASAL-APRP	Arid & Semi-Arid Lands Agricultural Productivity Research Program
ASDSP	Agricultural Sectoral Development Support Programme
CECI	Cenchrus ciliaris
CDW	Cold Dressed Weight
CGIAR	Consultative Group of International Agricultural Research
CHLORO	Chloris roxybhurghiana
EAAPP	East Africa Agricultural Productivity Program
ECF	East Coast Fever
ENMA	Enteropogon macrostachyus
ERASU	Eragrostis superba
ES	Estrous synchronization
EU	European Union
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistics
FGD	Focused Group Discussion
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
Ha	Hectare
HMF	Hydroxymethylfurfural
IFAD	International Fund for Agricultural Development
ICARDA	International Centre for Agricultural Research in Dry Areas
KAKISWA	KARI Kiboko Welfare Association
KALRO	Kenya Agricultural & Livestock Research Organization
KAPAP	Kenya Agricultural Productivity & Agri-Business Project
KARI	Kenya Agricultural Research Institute
KBWG	Kibwezi Beekeepers Women Group
KCC	Kenya Cooperative Creameries
KEBS	Kenya Beareau of Standards
KEFRI	Kenya Forestery Research Institute
KLMC	Kenya Livestock Marketing Council
KMC	Kenya Meat Commission
KNBS	Kenya National Beaureau of Statistics
NGO	Non Governmental Organization
MoA	Ministry of Agriculture
MOET	Multiple Ovulation and Embryo Transfer
PhD	Doctor of Phylosophy
PPR	Pestis Des Petits Ruminantial
RVF	Rift Valley Fever
SEAZ	Small East African Zebu
UAE	United Arab Emirates

Introduction

The Kenya Agricultural and Livestock Research Organisation, (KALRO) is a corporate body created under the Kenya Agricultural and Livestock Research Act of 2013 to establish suitable legal and institutional framework for coordination of agricultural research in Kenya.The national economic blue print Vision 2030 recognizes the role of research in technology generation and creation of new knowledge; all of which are vital in national development. Vision 2030 also places great importance on value addition in agriculture and livestock as a means of raising rural household incomes as captured by the sector's driving strategy, the Agricultural Sector Development Strategy 2010-2020 (ASDS). In implementing the second medium term plan, the Kenya Government reformed the National Agricultural Research Systems through creation of the Kenya Agricultural and Livestock Research Organization (KALRO). Its formation was aimed at restructuring agricultural and livestock research into a dynamic, innovative, responsive and well-coordinated system driven by a common vision and goal.
KALRO therefore has the following goals which it aims to fullfill in accomplishing vision 2030:

- Promote, streamline, co-ordinate and regulate research in crops, livestock, genetic resources and biotechnology in Kenya.

- Expedite equitable access to research information, resources and technology and promote the application of research findings and technology in the field of agriculture.

KALRO is a government parastatal charged with the national responsibility of undertaking research and providing solutions on constraints that affect agriculture. The Organization envisions to be a globally competitive agricultural and livestock research organization. The Organization services its parent Ministry of Agriculture, Livesdtock and Fisheries (MOALF) through generation and dissemination of agricultural and livestock knowledge, innovative technologies and services that respond to clientele demands, for sustainable livelihoods. This is done through research activities conducted at the Organization's various Institutes spread across the country, KALRO Kiboko being one of them.

Following the reorganization of former KARI into KALRO with amalgamation with Coffee, Tea and Sugar research foundations through an act of parliament meant to streamline agricultural and livestock research, the Kiboko Centre was upgraded into the headquarter of Arid and Range Lands Research Institute (ARLRI). Kiboko Research Centre, also referred to as simply KALRO Kiboko, was established in 1969 with the mandate to carry out research for sustainable management, utilization and improvement of rangelands for increased range productivity for improved livelihoods. This is now operating within the KALRO goal of integrating livestock value chains fostering commercialization of agricultural enterprises. The focus of the Centre is mainly on the arid and semi-arid rangelands but the Centre also backstops research in other ecozones.

Centre Vision

The vision is to be a globally competitive Centre in developing and transferring arid and range lands technologies that contribute to an improved quality of life for the people of arid and semi – Arid areas,

Centre Mission

The Centre mission is to develop, adapt, disseminate and catalyse adoption of appropriate arid and range lands technologies in collaboration with various stakeholders while conserving the natural resource base.

The arid and semi arid areas constitute over 84% of the Country's land mass and are home to about 10 million or nearly 25% of the total human population.

The vital county statistics and salient features of the areas the Centre research concentrated on prior to the on-going changes are summarized in Table 1 below.

Table 1: Previous Kiboko Research Centre Mandate Counties Land Statistics

County	District	Total land area (ha)	Agric. land (ha)	ASAL (ha)	Farm households	Total population
Taita-Taveta	Taita	1,777,128	582,400	467,164	57,635	246,671
	Taveta	4205.6	33550	838775	17185	67,665
Kajiado	Kajiado	2,190,100	345,000	253,181	96,621	687,312
Makueni	Makueni	800,880	585,200	288,983	144,320	884, 527
Narok	Narok	1793300	994,800	866,250	68,805	850,920
	Total	6,272,940	2,507,400	1,875,578	367,381	1,852.568

The livestock carrying capacity in the dry lowlands (Ecological Zone IV to V) is usually 4 - 12 ha per Tropical Livestock Unit (cow and a calf or its equivalent weighing 250 kg Liveweight). Therefore, even where land appears expansive, there is overstocking especially in the agro-pastoral settings since the average herd size is 7 heads per household against 8 ha of land owned. Further, priority is given to crop production in the agro-pastoral production system. The threat of land degradation and conflict over resources is, therefore, real. The need for interventions to ensure sustainability is high.

Beef is the main agricultural enterprise in the arid and semi arid areas though crops such as barley and wheat are increasingly being cultivated especially in Narok. In Taita-Taveta, beef does not rank among the top five enterprises which are led by dairy. In Makueni, maize production is the main agricultural enterprise despite low yields, low prices and perennial crop failures.

HUMAN INTEREST STORIES

Beekeepers in Kibwezi sub county benefit from KALRO's training on proper honey harvesting and post-harvest handling

Beekeeping has been widely promoted in many countries as a major contributor to rural development. Honey production is of growing socio economic significance in the world.

The story of honey begins with a single honeybee, buzzing around in instinctual search for a sweet, nectar-rich blossoming flower ready for pollination. It ends, most often, with a delicious heap of pure honey, resting on the tip of your spoon or finger, ready to nourish your body. Honey is a natural food produced by bees from nectar or secretion of flowers. Honey has a content of 80-85% carbohydrates, 15-17 % water, 0.3 % proteins, 0.2 % minerals notably calcium, iron, zinc, potassium and phosphorous. It also contains vitamins as well as antioxidants in low levels of concentration.

The quality of honey is a major factor both for local and international markets to enable attainment of competitive prices and ensure safety of human health. Proper understanding and standardization of honey components and attributes during handling and processing cannot be overemphasised. The major causes of honey deterioration includes; heating at high temperatures, high moisture content and adulteration. These quality hazards appear to be common along the pathway from producers, retailers and consumers. According to prescribed standards, a good quality honey should have a water content of 18% or less. Higher levels of water can cause fermentation of honey. Honey that is not adulterated or blended, is considered to be a good quality honey.

Kibwezi beekeepers with active membership of about 500 in Kibwezi sub County of Makueni County for a long time have faced a challenge of producing poor quality honey which has affected their marketing. For this reason Kenya Agricultural and Livestock Research Organization (KALRO) Kiboko through *Kenya* Agricultural Productivity and Agribusiness Project *(KAPAP)* programme supported in training 37 beekeepers as community facilitators. These were representatives of 18 beekeeping groups in the Sub County. They were trained on hive management, appropriate harvesting, post-harvest handling, processing using improved methods and proper storage/packaging.

Beekeepers training sessions

A follow up was made after the training to ascertain the improvement of the quality of honey produced by the various beekeepers in Kibwezi Sub County. This entailed collection of 18 honey samples from the trained individuals for analysis. It was quite amazing that most (95%) of the samples met the minimum quality threshold standards set by Kenya Bureau of Standards (KEBS) in compliance with International Regulatory Standards. This was a clear indication that there was a huge improvement in the quality of honey produced by beekeepers. For this enterprise therefore, farmers will have an opportunity of getting better prices for their honey and thus improve their livelihood.

Kibwezi women group refinery;
Foreground: The chairlady with a guest

Group's packaged honey

The improvement in honey quality has boosted the honey sales from the group members. The refinery (Kibwezi refinery) currently buys honey from beekeepers at Ksh 220/kg as compared to earlier price of Ksh 150/kg. The volumes supplied to the refinery have since increased gradually, save for 2014 when the sub county received inadequate rains. Thus annual volumes supplied were; in the year 2013 (1,083kgs), 2014 (433kgs) and 641kgs had been supplied by June 2015 unlike the previous years when between 400kgs to 550 kgs of honey were being supplied annually to the refinery. Honey has multiple market opportunities. If an export market collapses, beekeepers still have the opportunity to sell or use the product within towns and villages at home,

or create secondary products. This is unlike other commodities. Also the startup investment is low with minimal risks compared to other rural income-generating activities like purchasing cows, goats, sheep etc. Besides honey, other products can be derived as well such as beeswax, propolis venom, royal jelly and pollen which can as well be exploited commercially. Beekeeping activity can be undertaken by the young and old, men and women: it is a gender inclusive activity.

Indeed beekeeping activity is an important sustainable and alternative source of income in rural areas, benefiting communities in enhancing their livelihoods.

For more information contact the Centre Director, KALRO Kiboko

Putting Smiles on Faces of Women in South Eastern Kenya Region through Pasture Seed and Hay Production

Kidake B., Kubasu, D., Ogillo, B., Kirwa E.C., Kimitei K.R. and Mnene W.N

Livestock production in the arid and semi-arid rangelands is majorly constrained by feed availability in terms of quality and quantity. These regions are about 50% degraded and experience erratic rainfall seasons making primary production fluctuate seasonally.
KALRO Kiboko has been involved in research and initiatives of improving the pasture, fodder base and rehabilitation of degraded areas in the arid and semi-arid areas of Kenya. Through the community based forage seed system, the centre has focussed on training farmers on pasture improvement for seed and hay production. Initially, KALRO Kiboko purposed to set up demonstration sites in Makueni County to be used for training on natural pasture improvement. A total of 9 Common interest groups, spread across the county were engaged.

One of the groups, Utheu wa Aka, with a group membership of 30, introduced to the Centre by the State Department of Agriculture at Kibwezi has been involved in various enterprises including livestock production. Due to scanty information and knowledge, the group did not have capacity on how to improve their pastures to feed their growing numbers of livestock. The group was involved in an upgrading program where the members used Togenburg bucks to improve the local goat breeds in a merry-go-round system in which improved kids were distributed to members.
KALRO Kiboko set in to train and demonstrate to the members how to improve their own pastures.


A training of the group at Kibwezi by KALRO officers on pasture improvement

Previously, none of the group members had improved their pastures, with their livestock mainly feeding opportunistically on annuals and crop residues. These feed resources were sourced from their degraded farms and a commercial private farm, 4 km away where the women worked and were paid by a 'feed for work' system. It was therefore necessary for the group members to be introduced to the concept of having own feed for their livestock. The group set aside a one-acre piece of land in the farm of one of the members and KALRO Kiboko researchers demonstrated by planting range grasses so as to be able to get pasture seeds as well as feed for livestock. Initially the land was planted with *Eragrostis superba* (Masaai love grass) species with the farmers later on being provided with *Cenchrus ciliaris* (foxtail grass), *Enteropogon macrostachyus* (bush rye grass) and *Chloris roxburghiana* (horsetail grass).

Degraded area (left) where the pasture establishment was done and the same area (right) after introducing range pastures

Upon maturity over 50 kg of seed was harvested, bulked and then sold by the farmers. The total amount of money earned by the group from the sale of the seed during the second season amounted to Ksh. 30,000 (approximately 315 US dollars). According to the group, they used this money to purchase weaned goats for group members who had not benefited from the goat multiplication venture. Group members also got seeds from KALRO Kiboko to also improve their own pastures, with each member required by the group by-laws to have her own pasture plot as a pre-condition for continuing to be a member of the group. The size was dependant on the size of land one has. This enhanced the members' capacity to feed their livestock i.e. the goats as well as harvest seeds which were in turn sold and the proceeds used to uplift their living standards. The money generated is also used by the farmers most of whom have small scale businesses to expand their ventures. Part of the seed is also used to expand the area under pastures on their farms with some now planting the grasses on the bench terraces constructed on the farms to control soil erosion.

A fully established pastures demonstration plot for the group at the demo site in Kibwezi

Following the training, the patron of the group opted to plant bush rye grass in her already established *Melia volkensii* (*'mukau'*) plantation since the grass does well under shade. The bush rye grass seeds were provided by KALRO Kiboko Centre. Her well established plot is proof that limited land should not be an excuse for not growing grass pastures. This has enabled her get enough feed for her livestock especially during the dry season when feed availability is usually quite a big challenge in the region. Many farmers usually have to incur costs of purchasing feed for livestock to avoid losing them due to starvation and drought. In addition, the farmers were trained on aspects of feed conservation and preservation, enabling them to store the hay harvested from the plots for use during the dry season.


The patron of the group with KALRO officers at her farm in Kibwezi

This venture of pasture improvement through the community seed bulking initiative by KALRO Kiboko Research Centre has put smiles on many of the group members hence making them envy for many groups in the region

Happy Utheu wa Aka group members in a dance to celebrate their successes

For more information contact the Centre Director, KALRO Kiboko

1. RANGE RESOURCE MANAGEMENT & ECOLOGY SECTION

During the year under review, the activities in the Section were supported by funds from Arid and Semi Arid Lands Agricultural Productivity and Research Program (ASAL-APRP), and Kenya Agricultural Productivity and Agribusiness Program (KAPAP). One scientist was on training namely Mrs.Kirwa, E.C on a PhD scholarship by EAAPP at the University of Nairobi

Scientists in the section also participated in short duration trainings and attended workshops and seminars both within and away from the centre. Most of the courses were to strengthen the capacity of the scientists to perform their functions better. However, it needs to be noted that the support staff in the section and the centre need tailor-made courses especially for any emerging methods of plant identification and collecting data in the field and handling data with various computer packages.

1.1 ASAL-APRP Program

1.1.1 Greening arid and Semi-arid lands and improving livestock productivity through tree-grass integration

Kidake B, Kimitei R, Kubasu D, Ogillo B, Muthiani E N and Mnene W N

Introduction

More than 60% of the livestock and 70% of wildlife in Kenya is found in the arid and semi-arid areas. The productivity of livestock in these areas is low due to lack of feed in terms of quality and quantity. As fodder production is rain-fed, livestock growth is cyclic with animals gaining weight during the wet season when quality and quantity feed is available and lose it during the dry season. This feed scarcity is made worse by the degradation of the pastures through overgrazing and destruction of the environment.

Poverty is also high in these areas (64%) and is higher in female headed households. As there are few sources of livelihood in these areas, utilization of the natural resources especially the destruction of the environment through the burning of charcoal is common. These areas are therefore, exposed to more environmental degradation.

In the southern rangelands, there exists a large pool of desirable less understood grasses, shrubs and trees that may used to improve feed production in ASAL. A trial was therefore set to test a system of integrating trees into improved pastures in the semi-arid areas of Southern Eastern Kenya. The trees selected are to be able to supply quality wood products and livestock feed during the dry season. These include *Melia volkensii* and *Faidherbia albida.*

Methodology

Experimental lay out and Land Preparation

The design of the experiment on-station is as indicated in Table 1. Four treatments were laid out as shown with two of the treatments incorporating trees and grasses while the other two were only planted with grass species and unimproved pastures, respectively. Land preparation involved clearing the first three blocks of all the trees and bushes that were growing naturally in the farm. The land had not been used for any other purpose other than grazing and browsing by livestock.

Selective clearing was only carried out in Block 4, where unimproved pastures, comprising of native grass species are found. Ploughing was then carried out using a tractor and 2-by-2 feet holes manually dug for planting the trees. The spacing was as indicated in Table 2.

Table 2: Experimental Design for the Tree-grass Intercropping Trials

Block 1		**Block 2**				**Block 3**				**Block 4**
***Cenchrus ciliaris* alone**		***Cenchrus ciliaris* + *Melia vokensii***				***Cenchrus ciliaris* + *Faidherbia albida***				**Unimproved pastures**
G1		G1T1S1	G1T1S2	G1T1S3		G1T2S3	G1T2S2	G1T2S1		T3
G1		G1T1S1	G1T1S2	G1T1S3		G1T2S3	G1T2S2	G1T2S1		T3
G1		G1T1S1	G1T1S2	G1T1S3		G1T2S3	G1T2S2	G1T2S1		T3
G1		G1T1S1	G1T1S2	G1T1S3		G1T2S3	G1T2S2	G1T2S1		T3

Key

T1 = *Melia vokensii* T2 = *Faidherbia albida* T3 = Unimproved pastures
S1 = Spacing 1 = 5m x 5m S2 = Spacing 2= 7.5m x 7.5m S3 = Spacing 3= 10m x 10m
G1 = *Cenchrus ciliaris*

Preparation of Seedlings

Faidherbia albida seedlings pretreatment and establishment

Seedlings grown from seeds sourced from Kenya Forestry Research Institute (KEFRI) Muguga. Prior to planting in polythene pots, the seedlings were tested for viability and germinability under different treatments to identify the best method of treatment. The treatments included hot water immersion until it cools, soaking in cold water, immersing in concentrated sulphuric acid and scarifying using grade 1 sand paper. Out of these methods, the scarified seeds germinated first with a 90 % germination success. It was thus selected as the pretreatment method to apply to all the seeds for plating in the pots. The soil used for germination was mixed with goat manure and sand in the ratio 3:1:1 and the seed pushed up to a depth of 5 cm. The seeds were watered frequently until they germinated as shown in Plate 1

Planting of *F. albida* Seeds in the Nursery

Plate 1: Germinated seedlings of F. albida tree species at KALRO Kiboko

Seedlings of *Melia volkensii* were sourced from KEFRI Centre in Kibwezi. These had been germinated in a nursery using standard procedures and were ready for transplanting at a height of 30 cm. All the seedlings (*M. volkensii and F. albida*) were transplanted in the holes at KALRO Kiboko (plate 2). Before transplanting, the holes were filled halfway with top-soil mixed with cattle manure. Samples of the soil from the farm were taken for nutrient analysis and manure was

added to the soil during planting based on the analysis and recommendations from the sample analysis.

Plate 2: Planting of M. volkensii seedlings at KALRO kiboko field plot

Management of Seedlings at KALRO Kiboko

Management of the field plots and the seedlings at the station was mainly through watering whenever the trees showed signs of water stress.

Data Collection from the Field Plots

Data collection was done quarterly from the site and this includes seedling development in terms of plant survival, total plant height, number of branches and crown heights post-establishment. As of the grasses, biomass production was also quarterly estimated before mowing and baling A summary of tree data collected 2 months post-planting is presented in the Table 3 below.

Table 3: Growth Characteristics of Melia volkensii and Feidherbia albida at KALRO Kiboko

Species	Total Mean height (cm)	Mean Crown height (cm)	Mean Number of branches	Plant survival (%)
Melia volkensii	62.3	48.16	17	93
Feidherbia albida	42.0	30.14	6	60

Progress

The activity is ongoing with the trees and grasses on station growing and performing well as a result of the good rains received after establishment.

1.1.2. Characterizing Tree-Grass Combinations in Kibwezi and Kathonzweni, Makueni County

Kimitei R, Kidake B,Ogillo B, Manyeki J , Kubasu D, Mnene WN

Introduction

Farmers in drylands have for centuries utilized a wide range of agroforestry practices, largely by preserving and managing a few scattered mature trees. Recent attempts to promote agroforestry through further tree planting in such environments have been made unfortunately without much success. There are quite a number of limitations, for example, alley cropping in the semiarid tropics, where below-ground competition for water between trees and crops frequently outweighed the benefits of soil enrichment and microclimate improvements.

Methods

Focused group discussions (FGD) were held in the respective sites with farmers who have tree plantations on their farms. The objective of this FGD was to understand farmer perspective and agroforestry practices in Kathonzweni and Kibwezi sub counties and also to identify the test farmers.

Group composition of the FGDs and modalities

Three focus group sessions, one at Kathonzweni and two at Kibwezi were conducted. All participants comprised of different gender and age, which were selected based on their involvement in agroforestry and also willingness to participate in the focus group discussions.
Before the discussion began, the moderators gave an introduction about the purpose of the meeting, and the expectations about individual participation. They stated that everyone's opinions and experience were important and assured participants regarding the confidentiality of their statements.
The moderators used a discussion guide (check list). In each group the same guide was used to ensure a fair comparison of findings among the three groups. The discussions covered the following broad areas: 1) The current agro forestry practices by farmers and their objectives 2) The trends over time in terms of acreage increasing/decreasing, 3) The current players 4) challenges 5) Possibility of tree-grass intercrop

Results

Changes in agroforestry (AF) practices at local level

Farmers have been managing trees traditionally in their pieces of land for quite some time in one form or the other, meet fodder and fuel wood requirements, as well as to maintain land productivity. Natural vegetation climaxes have disappeared in most semi-arid areas and remain only in a few isolated pockets. Farmers reported that in recent years, these practices have become commercial with the introduction of high value trees/improved fodder trees and grasses. Motivations for, and types of tree planting vary from household to household depending on the biophysical characteristics of the area, gender, wealth and the perceived contributions to farm income, which are mainly through sales of fruits, timber, poles, fuelwood and charcoal. The trees are also used as shade and sources of human and livestock medicine.

Some of the tree species planted includes, *Melia volkensii, Eucalyptus camadulensis, Kigelia pinnata* (sausage tree), *Leucaena leucocephala* (Lusina). Fruit tress include; Mango, citrus and

pawpaw. It was observed that the natural agro-forestry species e.g acacia species were naturally growing on the edges and farm boundaries along with main crops,

Agroforestry promotion projects and players

Different players have promoted agroforestry activities projects at community level. These players includes; KEFRI Kibwezi, Government of Kenya through forest department, ARIDSAK project and Japan International Co-operation. The players trained farmers involved in community forestry activities, provided seedlings and set up of community demonstration plots.

Farm size appears to be related to both number of trees and species diversity. During the interviews, a majority of farmers did not see the possibility for planting more trees on their farms, other than intercropping what they have already established, as most of their parcels are already very small and decrease with every generation.

Tree-grass planting possibilities

The majority of participants agreed that it is possible to intercrop trees and pastures in the same piece of land. In the past, the practice has been intercropping trees with food crops, e.g *Melia spp* with green grams and Mangoes with maize. It was quite interesting that some farmers are already intercropping *Melia spp* trees with pastures. The experience of the practicing farmers is that most tree species are not affected adversely by the under sown pastures, infact one farmer offered four and half acres of established *Melia spp* for pasture establishment.

If the choice is between trees and crops, one woman explained, she would choose crops because you cannot feed trees to a hungry child. In her opinion, trees on small holdings may lead to chronic malnutrition. Almost everyone present agreed that it is not possible to plant trees on a small farm, as trees are incompatible with crops and damage the soil.' In the farmers' experience, once trees are introduced, crop yields will visibly decrease.

Challenges faced by farmers in Agro forestry

The majority of those present at the interviews said that agroforestry was not practiced in the past because;

- Farmers had no interest in planting trees, as they could be found naturally in their land
- Farmers had no interest as trees and crops were established in pure stands
- Commercial and high value trees had not been identified and promoted

The current challenges facing farmers are the technical knowhow as the technology was introduced and farmers left on their own. Some of the exotic trees introduced e.g. *Eucalyptus camadulensis* require a lot of water which is not available in the ASALs thus compete for water and nutrients in the soil with food crops.

Conclusion

The interviewed farmers are eager to intercrop their *Melia volkensii* woodlots with pastures preferably *Enteropogon macrostachyus*, reason being that the grass species is shade tolerant and also does not compete with the *Melia* trees. All interviewed farmers have an established *Melia spp* woodlot ranging from 1-30 acres. The one with the highest acreage is a *Melia spp* champion farmer in Kibwezi Sub-County (plate 3). Data was also collected from the sampled *Melia spp* woodlot to capture canopy cover, density, girth ground cover, plant height and density.

Plate 3: Data collection in a farmer field in Kibwezi comprising of Melia volkensii plantation

1.1.3 Development of technologies for reseeding large expansive areas in the ASALs

Kidake B, Kirwa E, Kubasu D, Ogillo B, Mwangi S, Mosu A and Mnene W N

Introduction

Reseeding of expansive areas has been reported to be an expensive activity and which has failed to produce desirable results when undertaken using normal manual means in the rangelands of East Africa. There is need to test whether grazing animals can be used as seed dispersal agents in these areas.

The main objective of this activity was to develop technologies of reseeding expansive areas. The main activity that was to be undertaken for this activity was conducting an on-station reseeding experiment with grazing animals in the prepared sites. A preliminary study was undertaken with pen fed heifers at the centre. The objective was to provide baseline information for estimation of seeding rate for the on-station seeding experiment to be done in prepared sites within the KALRO Kiboko ranch

On-station Pen-feeding of zebu cattle on range grass seeds and recovery

The objectives of the experiment were three-fold, namely:-

(i) To test germination percentages of four range grass seeds;
(ii) To test the seed acceptability of the four rangeland grasses by the small East African zebu cattle; and
(iii) To determine the recovery and germinability of seeds after ingestion by the animals.

Methodology

Twelve (12) healthy zebu female animals aged between 2 and 3 years were selected from the Ranch herd and pen-fed on a basal diet of *Brachiaria Mullato* II hybrid for one week (7 days). They were then fed on grass seeds of *Cenchrus ciliaris* (CECI), *Chloris roxburghiana* (CHRO), *Enteropogon macrostachyus* (ENMA) and *Eragrostis superba* (ERSU) species. The CECI species seed had been harvested in 2013 while the later three species seeds had been harvested in 2014. All species were harvested from the KALRO Kiboko Centre plots.

There were three (3) replicates (animals) fed on the one species. The seeds were mixed with Molasses to improve their acceptability to the animals. This was done one-off in the morning at the start of the experiment. Water was provided *adlib* to the animals over the course of the

experiment. After feeding the seeds, animals were given a normal basal diet of *Brachiaria Mullato* II hybrid for a period of 6 days in the feeding pens (Plate 4).

Plate 4: Zebu animal feeding on ERSU seeds

Collection of feacal matter and laboratory handling

Faecal matter was collected separately and immediately from each of the pens holding the animals after start of experiment. This was carried out daily at intervals of 12 hours for a period of 96 hours. These were placed in well labelled buckets and taken in the laboratory for grass seed recovery and germination tests. In the laboratory, standard procedures involving washing of the faecal matter through appropriate sieves, was carried out (Plate 5). This involved hand mixing up the contents of each sample in a bucket and pouring the contents over a sieve. The contents were then placed under running tap water in the laboratory till all that remained were just solid material of plant fragments and seeds in the sample. The samples were then air dried at room temperature separately and identification of grass seeds from the feacal samples undertaken with the assistance of magnifying lenses. To determine the seed intake and availability in the faecal sample, the feacal samples were observed for presence of the grass seeds and in fact seeds could be seen germinating from faecal samples in the laboratorty (Plate 6). Seeds available in the samples were also picked and 25 seeds from each sample were picked by forceps and placed in Petri dishes for a germination test.

Plate 5: Washing of feacal matter for feacal matter for seed recovery at KALRO Kiboko laboratory

Plate 6: Range seeds germinating in feacal matter from pen-fed animals at the Kiboko laboratory

Preliminary results

- Some of the grass seeds were not readily acceptable to the animals – these include ENMA and CHRO even after pretreatment with molasses
- CECI and ERSU seeds were able to be recovered in the feacal matter
- Germination in the feacal matter was higher than in the seeds recovered and placed on petri dishes.

1.1.4 Managing Noxious Weeds in Pastures: The Case of Ipomoea spp in Kajiado County

Kidake B, Manyeki J K, Halima C, Kirwa E, Kubasu D, Ogillo B and Mnene W N

Introduction

Invasive plant species are hazards that have shown negative environmental and socio-economic impacts in East African drylands. They have led to degradation leading to serious impacts on local communities. One of the species which is becoming a serious invader species is *Ipomoea spp*, a plant ravaging larger parts of the southern rangelands ASAL districts (Plate 7). The species has been reported as one of the most undesirable forage species for livestock.

Plate 7: Pasture fields invaded with Ipomoea species in Ilbisil, Kajiado County

The objective of this activity was to develop technologies of managing invasive species in the ASALs. The activities to achieve these were:-

- Conduct a literature review to gather more information on Ipomea species
- Collect perceptions of key informants on Ipomea species and plant specimens for identification
- Prepare report and present to stakeholders and plan the way forward
- Identify and benchmark trial sites for testing Ipomoea control tecnonologies

Progress

Literature review and perceptions of key informants on the species were collected (Plate 8) and a report written. Part of the information was shared with relevant stakeholders in Kajiado County during a forum held in Kajiado by Agricultural sector development support program (ASDSP).

Plate 8: Focus group discussion in Kajiado central on noxious weeds from livestock keepers

The next phase of the activity involves identification of sites for trials of control and management of the species by use of different grass species. A proposal to that effect is being developed together with other stakeholders for this purpose.

1.1.5 National Performance Trials of selected range grasses and sorghum forages at KALRO Kiboko and KALRO Buchuma

Mnene W N, Kirwa E C, Kidake B, Kubasu D, Ogillo B and Muthiani E N

Introduction

This is an ongoing activity carried out in 6 sites namely Kiboko, Buchuma, Katumani, Mariakani, Kambi Mawe and Lanet.

Design of experiment

The design of experiment was carried out in consultation with KEPHIS. This is shown in Table 4 for the forage sorghums and Table 5 for the range grasses. The size of the plots was 5 by 5 meters with spacing of 1 m between the rows and blocks. The plating was then carried out under the supervision of a KEPHIS officer and the National Project Coordinator (NPC) on 21st November 2014 (Plate 9).

Table 4: Layout for the Sorghum forages at KALRO Kiboko

	Plot1		**Plot 2**		**Plot 3**		**Plot 4**
B1	BJ28		Nutrifeed		Sugargraze		BM30
B2	BJ28		BM30		Sugargraze		Nutrifeed
B3	Nutrifeed		BM30		BJ28		Sugargraze

Table 5: Lay out of the forage sorghums

	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
B1	MBARARA RHODES	ELBA RHODES	KP03	KP04	KP02	KP05	BOMA RHODES
B2	MBARARA RHODES	BOMA RHODES	KP04	KP05	KP02	KP03	ELBA RHODES
B3	BOMA RHODES	KP03	KP04	ELBA RHODES	KP02	MBARARA RHODES	KP05

B- Block, P – Plot

Plate 9: Planting of the forages and sorghums

All the plots are maintained through weeding and protection from birds and other animals. The weeding entails removal of unwanted plant materials by uprooting and slashing. No other cultural practices are undertaken as outlined in the protocol guiding National Performance Trials. Plate 10 shows the established Plots.

Plate 1: NPT plots at KALRO Kiboko

Data collection

This has been going on since the plants were planted. Any developments within the plots are noted. Monthly data collection is however carried out at both sites – Buchuma and Kiboko with plant establishment data being the main component at the bigining of the experiment. Other data include:-plant height, tillers, spread, disease incidence, stem lodging, root lodging, insect damage and plant counts.

1.1.6 Promotion of milk production and marketing among Dairy Farmers and agro pastoralists in Loitokitok, Kajiado County

Miano D M, Adongo A,, Kariuki J, Kidake B and Karebe S

Introduction

Kajiado County is one of the arid and semi-arid land (ASAL) counties in Kenya. The major economic activity carried out in the region is livestock production with a big percentage of inhabitants owning livestock. The farmers derive tangible and intangible benefits from livestock. In Loitokitok Sub County, most milk produced in the country originates from small holder farmers with most of them deriving their income from milk sales. It is imperative to understand and improve the productivity of livestock sector through interventions targeting different areas along the dairy value chain.

KALRO Kiboko is primarily involved in interventions targeting increased livestock productivity through different initiatives. Currently the ASAL-APRP project is involved in a project geared towards improving beef productivity in ASASLs. As a component of the project, the major focus is pasture work where research is carried out on various fodder and rangeland grass species. The aim of this report is to give progress and overview of activities that have been carried out with a focus on Loitokitok region where a collaborative activity with Inua Maisha organization, and Technoserve, an NGO is involved with milk producers.

Feed is an important aspect of milk production by dairy animals. KALRO Kiboko's overall goal is to ensure that the milk supply in the region is not hampered. This is through sensitizing and training farmers on how to ensure a frequent supply of quality feed to livestock. An action plan was developed during a visit to the site and through meetings by the team for activities to improve the milk value chain in this locality. These include;

1. Milk value chain analysis – to help the team understand the milk value chain in the area and identify constraints that will need to be addressed. The activities of this component will be led and funded by Technoserve. Technoserve has already carried out an initial survey together with New KCC Limited. Any information gaps will be identified and addressed when the report is ready.

2. Participatory evaluation of pasture grasses and fodder crops (including legumes). The farmers have already identified feed shortage especially during the dry season as a major constraint to milk production in the area. KALRO through ASAL APRP will lead and fund this component.

3. Capacity building on different topics including clean milk production, milk handling and marketing, feeds and feeding etc. AS farmers are moving from the traditional production system their skills need to be enhanced. The mode of capacity building will include farmer tours to other successful dairy producers (including the Kajiado Central Women Group) and Research Centres and demonstrations.

4. Develop marketing structures (including a milk collection system, collection centres and chilling equipment). This will be led and funded by Inua Maisha and New KCC

Establishment of demonstration plots for pasture and fodder species in Loitokitok

Demonstration sites having different range grasses and fodder species were established in different areas within Loitokitok (Plate 11-13). These demonstrations plots will act as the mother

trials and farmers will be encouraged to select from the materials available so that they can try them on their farms through farmer evaluation. From these, the farmers will be able to select the suitable species that they could plant on their farms to boost feed availability especially during the dry season.

Being a participatory activity the farmers were at the same time trained on issues to do with site selection, land preparation and planting, management of established pastures among other aspects of pasture and seed production. Species planted include Sorghum variety BM30, Bracharia hybrid cobra, *Chloris roxburghiana (horsetail grass),* Sorghum variety BJ28, Lupins, *Eragrostis superba (rye grass), Enteropogon Machrostachyus* (bush rye), *Cenchrus ciliaris* (buffel grass), *Chloris gayana* (Rhodes grass), *Chloris gayana extozi, Dolichos lablab and Brachiaria decumbensis. Most of the species failed to estsablish during the short rain season and were replanted during the long rain season.*

The other aspects of the project were handled by staff from other KALRO centres and partners. These include:-

- The Inua Maisha organization - marketing aspects of the milk together with New KCC
- KALRO Marsabit - Trainings on milk handling and processing
- KALRO Naivasha – Training on livestock management and diseases

Plate 2: Land preparation and planting at Forest area in Loitokitok

Plate 12: An FGD during one of the meetings in Entarara, Loitokitok

Plate 13: Participatory planting of pastures at the demonstration site in Loitokitok

The project is still ongoing.

1.2 KAPAP Projects

1.2.1. Effect of training of honey groups in selected CIGs Affiliated to Kibwezi women Bee Keepers

Kimitei, R.K, Muthiani, E.N and Ndathi A.J.N

Introduction

Honey quality is one of the important parameters that affect the marketing of honey. Since the Kibwezi Women BeeKeepers Group refinery (KWBG) is certified by Kenya Bureau of Standards, it has to make sure that the quality of honey from its members and others meets the required standards. As such, a lot of honey produced in Kibwezi Subcounty does not get into the formal market and the KWBG refinery is not optimally engaged as only a small proportion of honey meets the requirements.

Honey quality is not only dependent on the type forage plants used in making the honey, or the source of nectar, plant sap or honeydew from which the honey is made but is also determined by the method of harvesting as well as the post-harvest handling (Joshi, 2008). Even though the type of hive used in honey production may contribute to honey quality, inadequate skills in hive management compounded by poor methods of honey harvesting worsens the problem (Kimitei and Korir, 2012). KARI, has in the past one year organised training of the various groups associated with the KWBG by the Ministry of Livestock and Development on besides other subject, hive management and harvesting and handling of honey after harvest. The latter was to reduce the rate of rejection of honey supplied to the Kibwezi Women Beekeepers Refinery.

In addition, KALRO has intervened in various sections of the Honey Value chain in both the northern and southern rangelands particularly in Marsabit and Makueni Counties in the last two

years. There is need therefore to asses the status of the honey value chain and develop strategies for upgrading the value chain further

Therefore, the overall objective of the study was to monitor the effect of the beekeepers training by assessing the quality of harvested honey and the rate of rejection of supplied honey as well as to assess the effect of the various interventions in Marsabit and Makueni Counties

Objectives

1. Monitor improvement of quantity & quality of honey from CIGs and marketing strategies of KWG refinery.
2. Assess the status of the VC and the effect of the various interventions along the honey Value chain

Materials and Methods

Study area:

The study was carried out in Kibwezi sub county which is a semi-arid area located approximately 200kms South East of Kenya's capital Nairobi. The sub county covers an area of 3954.6 Km² and lies between the latitudes 2^0 6 S'. and 3^0 S' and longitude $37^0$36' E and $38^0$30' E, respectively. It is inhabited by Akamba community who are mainly agro-pastoralists. The area is typical semi-arid land characterized by low erratic and unreliable rainfall. The average annual rainfall, evaporation and temperatures are 600mm, 200mm and 23^o respectively.

Collection of honey samples and analysis

Eighteen honey samples were collected from the trained beekeeper for analysi from Makindu, Nyayo, Nthongoni, and Machinery. The honey samples collected were analyzed in triplicate using international methods as recommended by International Honey Commission (Bogdanov et al.,1999) and also according to the official methods of the Association of Official Analytical Chemists (AOAC,1990) to determine the **moisture content**, sugar composition, diastase activity, pH, acidity (Free, lactone and total acidity) and Hydroxymethylfurfural (HMF)

Results:

The following determinations were carried out: moisture, pH, estimation of HydroxymethylFurfural (HMF), Proline, Invertase, Diastase, Glucose and Fructose content. The physicochemical results of most samples that is, 83% were found to be within acceptable ranges of Codex Almentarius Commission Standard and Kenya Bureau of Standard i.e. moisture 17.2-20.2%, ash (100%), acidity (100%), pH 4.23 - 4.91, total acidity 28.93 to- 73.85 $meq.kg^{-1}$, HMF 0.1 – 2.3 $mg.kg^{-1}$, diastase 12.21 - 34.09 Schade units, glucose 33.49 - 37.42%, and fructose (36.11- 40.66%). The physicochemical results of most samples i.e 87% were found to be within acceptable ranges of international honey specifications, Codex Almentarius Commission Standard and Kenya Bureau of Standards, while a few 23% of the samples failed to meet expected standard mainly due to lack of appropriate handling during harvesting and storage of the product. The analysis of HMF showed that the majority of samples were fresh and had not been exposed to a high temperature while moisture content and proline of honey from the untrained beekeepers at producer level was high due to harvesting of unripened honey and improper storage condition, which increases the hygroscopicity of honey.

Conclusion

The physicochemical results of most samples, that is, 87% were found to be within acceptable ranges of Codex Almentarius Commission Standard and Kenya Bureau of Standard. The analysis of HMF showed that the majority of samples were fresh and had not been exposed to a high temperature while moisture content and proline of honey from the untrained beekeepers at producer level was high due to harvesting of unripened honey and improper storage. Generally, the mean of all samples were found to be within the acceptable range of international standards for all of the tested parameters except for HMF. This is an indication of its commercial potential both locally and internationally with few management interventions.

1.2.2 Application of farmyard manure to improve pasture production to enhance beef productivity in Southern rangelands

B.P. Ogillo, J.K. Manyeki and G.A. Keya

Background

The rangelands are continually being depleted of nutrients through removal of plant material by livestock, soil erosion and soil seed bank. There is also an increase in crop production among the pastoral communities. However, very little effort has been made to replenish soil nutrients either through application of organic or inorganic fertilizers. Application of organic fertilizer (manure) is preferable to the inorganic (chemical) because of the long term effects. In addition to increasing the nutrients and organic matter in the soil, manure also improves the soil structure and water holding capacity. Fortunately manure is widely available in the pastoral areas and is resource that can be utilized by both livestock and crop system. However, this great resource has not been tapped as most of the manure is either hipped near the homestead or the roadsides, burnt or sold to farmers from the high potential areas. This scenario is common in pastoral areas like Kajiado and Narok.

This project thus proposes to create awareness of the importance of manure for recycling nutrients and mobilize them to utilize manure. The project will target Kajiado and Narok counties. The project intends to strengthen the beef value chain at the production level whereby inadequate pasture has been identified as one of the key constraints affecting the efficiency of the chain.

1.2.2.1.Desk top research on use of farmyard manure for pasture improvement in rangelands

B.P. Ogillo, J.K. Manyeki

Introduction

Livestock/crop production is an excellent example of an integrated production system where fodder crops and agricultural residues provide the feed for animals. Animal manure makes the soil more productive than would be the case in their absence (Mohamed 2011). Animal manures are an excellent source of plant nutrients. Approximately 70-80% of the nitrogen, 60-85% of the phosphorus and 80-90% of the potassium in feeds is excreted in the manure. Manure contains all the nutrients needed for crop growth including trace elements. The availability or efficiency of manure utilization by a crop is determined by the method of application, time to incorporation and the rate of manure decomposition by microorganisms in soil. Nearly all the ammonium N can be lost from surface applied manure if it is not incorporated within a few days. The more stable organic N occurs is in the faeces and is slowly released. Approximately 40-50% of the stable organic N will be available the first year, 12-15% of the N remaining the year after, 5-6% in the third year and lessor amounts in each subsequent year (Herbert, 1998). Manure from different animals has different qualities and requires different application rates when used as fertilizer. Livestock manures, particularly solid manures add useful amounts of organic matter to the soil, acting as a soil conditioner and structural improver. The water holding capacity and drought resistance of light and heavy soils can be increased, though the greatest benefits are likely on sandy soils where structural stability is increased (Warren and Sweet, 2002).

There are different types of manure which vary in composition depending on their source or origin. Animal manure can occur in a liquid, slurry, or solid form. The nutrient content of the different manure is as shown in table 6.

Table 6: Approximate Nutrient Content of different FYM types

Type of Manure	Nitrogen %	Phosphorus %	Potassium %
Chicken	1.6	1.5 - 2.0	0.6 - 1.0
Pig	0.6	0.5	0.5
Cow	0.3	0.3	0.1
Horse	0.4	0.4	0.3

Source: http://www.poyntonallotmentgardeners.org/page30.html

Time of application

The rate, time and method of application depend on numerous factors including climatic conditions, soil properties, type of crop, and rate of nutrient mineralization. Maximum nutrient benefit from manure is obtained when it is incorporated immediately after land preparation to minimize nutrient loss (Sutt et al., 1984; AAFRD, 1984; Hoff et al., 1981). Up to 95% of FYM's nitrogen content can be lost following surface spreading. Manure application should be made immediately prior to or during active sward growth in the spring wherever possible. It also means rapid incorporation is important to minimise losses following spreading onto bare ground ahead of forage maize or other crops. Table 7 shows the rate of retention of nitrogen in manure. Smart use of FYM will further lower the environmental footprint of production by reducing nitrogen losses to the atmosphere and increasing soil carbon

Table 7: Estimated Nitrogen retention factor during application

Application Method	Retention Factor
Injection	1.0
Broadcast (incorporation in 24 hr.)	0.85
Broadcast (no incorporation)	0.75

To make optimum use of the N contained in organic manures, they should be applied at times of maximum crop uptake. If FYM and poultry manure are left on the soil surface following land application, typically 65% and 35% of the readily available N they contain can be lost to the atmosphere as ammonia. In the case of slurries, DM content has an important influence on ammonia losses – with a 6% DM slurry typically losing 20% more N than a 2% DM slurry. Reduced losses from low DM slurries are associated with more rapid infiltration into the soil, compared with high DM slurries which remain longer on the soil/plant surface. Livestock manures are the greatest source of avoidable nitrate leaching losses. The amount of N leached is mainly related to the manure application rate, readily available N content and timing of applications. The ammonium (readily available) N content of manures is rapidly converted to nitrate-N and can then be used by plants or lost by leaching. Slurries and poultry manures are 'high' in readily available N (40–60% of total N), compared with FYM which is 'low' in readily available N (10–25% of total N). The rest of the N that manures contain is organic N which is released (mineralised) slowly over a period of months to years. In this way, around 10% of the total nitrogen content may become available for the second crop following application. (Chambers *et al.* 2001)

Application rates

The organic manure field limit is 250kg N/ha/year which equates to approximately 42 tonnes/ha of FYM (17 tonnes/acre). Table 8 presents the rate of application of different manures.

Table 8: The total N content of organic manures and maximum application rates to supply 250 kg N/ha of total nitrogen

Solid manure	Total N content kg/t	tonnes/ha	tons/acre
Cattle farmyard manure	6	42	17
Pig farmyard manure	7	36	14.5
Sheep farmyard manure	6	42	17
Duck farmyard manure	6.5	38	15
Poultry layer manure	16	16	6.5
Poultry broiler litter	30	8	3.2
Turkey litter	30	8	3.2
Horse farmyard manure	7	36	14.5
Goat farmyard manure	6	42	17
Slurry	Total N content (kg/m3)	m3/ha	gallons/acre
Dairy cattle	3	83	7,400
Beef cattle	2	125	11,200
Pigs	4	63	5,600

Source: defra, 2009

This is a maximum application rate for any one field and cannot be applied in every field as the overall average farm limit is lower at 170 kg N/Ha. It is also important to consider the 'N max' limit of the crop being grown as this specifies maximum average N applications from manufactured and livestock manures for a particular crop type. (Stackyard News Apr 2009)

Application Tools and methods

A manure spreader or muck spreader or honey wagon is an agricultural machine used to distribute manure over a field as a fertilizer. (Manure spreader Wikipedia)

Effects of plant and soil

Studies have been carried out to show the benefits of manure to plants including pasture. In a study by Muthiani *et al*. 2004 on the impact of cultivation on aboveground biomass production in Laikipia Kenya, there was a significant increase in biomass among plots with manure or fertilizer applied. In the land cultivated for 10 years plots without manure or fertilizer had 294g/$m^{2,}$ those with manure had 380g/m^2 and those with fertilizer 531g/m^2. For plots that had been cultivated for three years there was a similar trend 210g/m^2, 310g/m^2, 482g/m^2 of biomass in the plots planted without manure or fertilizer, planted with manure and planted with fertilizer, respectively.

In another study by Too (1995) on brush control, grass seeding and manure application there was a significant increase in biomass production compared to the un-cleared pots. Herbaceous biomass production was as follows; non-cleared treatment 1,800 kg/ha, manure and seeding 2,800 kg/ha, manure plots alone 2,380 kg/ha and seeded plots alone 2,570 kg/ha. Further both interventions were cost effective irrespective of subsequent management practice. However, the un-cleared plots were not cost effective.

The combined application of manure and chemical fertiliser has major effects on soil physico-chemical and biological properties, and it increases crop yields. A 4-year study was conducted to study the effects of the application of high (HM 22 500 kg/ha), medium (MM 15 000 kg/ha), and low (LM 7500 kg/ha) rates of manure in combination with conventional chemical fertiliser. Compared with CF-only and NF, manure combined with chemical fertiliser produced a lower soil bulk density and significantly increased the >0.25-mm water-stable aggregate content, which was higher with increasing manure application rates. Manure combined with chemical fertiliser

significantly increased crop yield and nitrogen (N) content of the crop organs, showing that this treatment enhanced the use of N fertiliser (Xianqing et al., 2012)

The effects of farmyard manure on the dry matter content of two cucumber varieties (Ashley and Palmetto) was evaluated at the Teaching and Research Farm of the Ambrose Alli University, Ekpoma, Nigeria. The farmyard manure was applied at the rates of 0, 5 and 10t/ha. The layout was a 2 x 3 factorial scheme with three replicates. The result of the study showed that increasing the farmyard rates led to an increase in the dry matter weights of the two varieties of cucumber. Farmyard manure at 10t/ha increased the dry matter content of cucumber (Eifediyi *et al*. 2010).

A study by Yossif and Ibrahim 2013 to compare the effect of fertilizers (urea, farmyard and chicken manure) on growth and yield of Rhodes grass revealed that yield parameters were significantly affected by fertilizers compared to the control as follows Urea (U) 3.57t/ha Farmyard Manure (FYM) 4.53t/ha, Chicken Manure (CHM) 4.76t/ha, U+FYM 6.19t/ha, U+CHM 5.24t/ha, FYM+CHM 5.48t/ha, U+FYM+CHM 4.76t/ha while the Control had 4.28t/ha.

A study by Beňová, et al., (2013) found out that as the manure rates were rising, the contents of dry matter (DM) and fibre were decreasing, while the crude protein (CP) content was increasing in fresh herbage. The highest values of the protein digested in the small intestine when nitrogen is limiting (PDIN; 92.82 g.kg-1 DM), the protein digested in the small intestine when energy is limiting (PDIE; 85.01 g.kg-1 DM) and also the productive milk potential (PMPPDI) were recorded at the respective V4 treatments. Any statistically significant effects of the manure application rates on the energy parameters - i.e. the net energy for lactation (NEL); the net energy for gain (NEG) and metabolisable energy (ME) – were not found.

Management of manure

Manure needs to be kept together to prevent contaminates from the manure from leaching into groundwater. Freestanding manure piles should be constructed on top of a concrete pad or heavy clay soil. In addition, consider covering the pile with a tarp. Manure can also be managed by composting. composting kills intestinal parasite eggs and larvae, destroys weed seeds, reduces flies by eliminating their breeding ground, reduces odour, reduces volume of manure, serves as an excellent soil amendment and produces an attractive product to use, give away, or sell to others. Composting provides a viable option for managing horse manure

If applying to cropland, spread and incorporate manure into the soil just before seeding. If applying to pasture, spread and harrow manure only during the growing season, when the grasses can use the nutrients (Warren and Sweet, 2002).

Precautions should be taken as manure generates heat as it decomposes, and it is possible for manure to ignite spontaneously if stored in a very large pile. Once such a large pile of manure is burning, it will foul the air over a wide area and require considerable effort to extinguish. Therefore, large feedlots must take care to ensure that piles of fresh manure do not get excessively large. There is no serious risk of spontaneous combustion in smaller operations. There is also a risk of insects carrying faeces to food and water supplies, making them unsuitable for human consumption.

Socio-Economic issues in manure application

Land application of animal manure is an efficient utilization alternative because of usually lower costs compared to treatment and the nutrient benefits derived by crops from the manure. Cattle FYM applied in winter before sugar beet saves up to £117/ha and Pig slurry applied as a topdressing in spring to winter wheat saves up to £85/ha (Warren and Sweet, 2002). Livestock manure from rangelands is marketed directly to individual traders or brokers (76%), farmers

(20%), and horticultural growers (4.6%). The mean annual livestock manure sales per household were 10.8 and 5.7 metric tonnes (MT) for small ruminant and cattle manure, respectively. Mean annual household gross income for small ruminant and cattle manure was KShs. 3,450 and 1,350, respectively. Other beneficiaries to the livestock manure business included truck loaders who received an average wage of between KShs. 200 and 270 per MT (Antony et al. 2013).

Marketing manure Composted versus raw manure most gardeners tend to prefer composted manure, because it contains little or no weeds. Commercial Users Professional landscapers, organic farmers and land reclamation companies are also viable marketing options. (Warren and Sweet, 2002).

1.2.2.2 Survey on use of manure in Narok and Kajiado counties

B.P. Ogillo, Kidake B. and G.A. Keya

Key informants were interviewed and Focus group discussions were held with communities in Kajiado and Narok counties on the current status of manure and its utilization. From the interviews and FGDs the following issues emerged:

- Cattle, goats, sheep still important. Poultry is now common mostly kept by women. Livestock number ranges are: Cattle 10-50, Shoats 10-200, donkey 1-5, poultry 2-20. Bee keeping is practiced by a few pastoralists.
- Cultivation of crops is also important for income generation with beans and maize being the crops mostly grown. Other crops include potatoes and wheat in Narok County.
- Individual land ownership is also common in the two counties with only few places having communal land ownership.
- Kajiado land sizes are bigger acreage (70 to 300 acres) as compared to the Narok counterparts (average 50 acres). However, less than 10% of the land is used for crop cultivation.
- The education level has improved as most of the young generation attains secondary education with a few attaining tertiary level as compared to the older generation whereby most did not have any formal education. The composition of female with education though still low is gradually rising.
- Manure is available in plenty with most household having up to about 70 tonnes in their homestead. However, this manure is not utilized despite the fact that most of the pasture is in poor state for the better part of the year. Manure use is minimal even for crop production.
- Challenges in use of manure include:
    - Ignorance of the importance of manure in pasture improvement
    - Inadequate capital for manure application
    - Labour and capital, limited manpower for transport and application
    - Erosion of the manure in the field by rainfall
    - Rapid growth of weeds where manure is applied e.g. *Ipomoea spp*. in Kajiado
    - Previous intervention and assistance by the ministry has significantly reduced
    - Land size is too large
- To counter some of the challenges, capacity building is required
- Opportunities are many given that the manure itself is available in plenty although underutilized.
    - Improve the range and crop production
    - Energy production e.g. biogas

- It can also be sold
- In all this, the participation and involvement of the young generation is key

1.2.2.3 Results of Stakeholders' forum on application of manure for pasture improvement

B.P. Ogillo, J.K. Manyeki , Kibet P.F.K , Muthiani E.N, Mnene W.N and G.A. Keya

A stakeholders' workshop was held in Machakos town, Machakos County to share the findings of the desktop study carried out on the use of farm yard manure for pasture improvement. There were 17 participants (3 extension officers, 5 pastoralists, and 8 researchers). The participants were dived into three groups:

Term of references

1. Literature search on the work done to enhance level of knowledge on manure use in rangelands
2. Identify technologies/information available on manure use for dissemination and up-scaling
3. Identify the researchable areas based on the challenges identified by the survey including Policy issues especially how the County govermnment can be brought in.

Group 1 Presentation: Areas of research on use of manure in forage production

Members Kibet (Chair), Musyoki, Ogillo (Secretary), Rutto, Tausen and Masiaine

Table 9: Areas of Research on use of Manure in forage Production

TOPIC	Activities/Research Intervention Points	By Whom
Areas of research	• Determination of the application rates, timing. • Approaches to apply • Socio-Economic viability of manure • Impact assessment	KARI Farmers Extension
Dissemination of proven technologies	• Package the dissemination materials • Pilot the technologies • Awareness creation • Upscale the technologies	KARI Farmers Extension
What we already have available on use of manure	• Literature search • Synthesis report and share with stakeholders	Researcher Beneficiaries
Policy	• Developing policy briefs on FYM use and sharing with county government	KARI County Government Extension

Group 2 Presentation: Challenges constraining use of Manure in forage production

Table 10: Challenges constraining use of Manure in forage production

Challenge	Topic	Activities	Responsibility
Land size Capital labour	Researchable areas -Economic analysis of manure utilization	-Literature search to identify gaps -conduct research to fill the gaps	- KARI
Rapid Growth of weeds	Identify weeds associated with different sources of manure Identify grass species that can tolerate weeds Identify effect of manure storage period on weed proliferation	On station experiments	KARI
Perception/ ignorance	Desk top	• Awareness creation on the use of manure	KARI, County Government - Livestock dept.
Dissemination- Technologies for extension	Literature search on appropriate (ecological and economic) use of manure	• Packaging of technologies • Dissemination of extension technologies	KARI, County Government - Livestock department

Group 3: Presentation Literature search – form a team to address;

Known to unknown on manure utilization technologies including ecology and economics, any livestock production policy on manure utilization. Table 11 and 12 presents the level of knowledge and suggestations on how to deal with constraint to manure use in the rangelands

Table 11: Known to unknown manure utilization technologies including ecology and economics

	Status	***By Whom***	***Suggested lit***	***By When***	***Mode of dissemination***
Level of knowledge	Desk top study to be finalized	PI	1. Muhammed 2. Kirigia et al 3. Dr. Too PhD thesis 4. The Nutmon project – Gachibi *et al.* 5. Kironchi	End July 2014	Report
Information available for dissemination	Compile a dissemination package from the existing information	Team		End August 2014	1. Brochures 2. Demonstration
Research Areas	1. Characterize and broadly categorize the quality of manures in different areas	Team Team			- Brochures - Radio doc
	2. Determine the effects of different mode of manure application - Tools of application - Time of application - Interval of application – nutrient budget (fertility trends due to manure and grazing)	KARI Kiboko	1. Kimani S. 2. Lekasi – Muguga 3. Dr. Nguluu		- Demonstration - Brochures
	3. Determine the Effect of storage and management of manure on quality	KARI Kiboko			
	4. Determine the effect of manure on pasture production	KARI Kiboko			Demonstration
	5. Establish the socioeconomic dimension of manure application on rangeland productivity	KARI Kiboko			Feedback /publications

Table 12: **Challenges on using manure on rangelands and how to deal with them**

Challenges	Suggested solution	By Whom
High capital requirements	1. Demonstrate the benefits of manuring 2. Promote farming as a business 3. Get credit from financial institution	Farmer /Extension
Weeds menace	1. Research to identify strategies of management of undesirable weeds 2. Package and disseminate known technologies for management of weeds in pastureland	KARI Kiboko
Poor perception on value of manure	1. Conduct demonstration on positive aspects of manure 2. Capacity building on use and management of manure	KARI Kiboko and County government

Way forward

1. Finalize the literature review report
2. Writing of the proposal based on the researchable areas

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1.2.3. Apiculture and Climate Change: Identification of Drought Tolerant Bee Forage Species and Strategies for their conservation and propagation for increased Honey Production in ASALs

Muthiani E.N, Kimitei R.K, NdathiE. AJN

Kenya is ranked position 17 worldwide in honey production while producing an estimated 20,000 metric tonnes (Intertek 2013). This Level of production is 20% of the estimated potential of 100,000 metric tonnes of honey and 10,000 metric tonnes of wax (GOK 2008). Most honey in Kenya is produced in the ASAL which constitute about 80% of the country whose potential for honey production is underutilized. Bee keeping is said to be constrained mainly by infrastructural challenges and underdeveloped markets. However, land degradation and habitat destruction that affect bee forage have hardly been addressed as well as; land use change, climate change which is characterised by frequent droughts and adversely affect bee forage status in the ASAL.

A study was carried out in Kibwezi and Mashuru Subcounties with a broad objective of documenting the drought tolerant bee forage species for conservation. Specifically, the objectives of the study were to

1. Identify key bee forage species
2. Identify drought tolerant bee forage species
3. Establish the perceived population trends and reason for the trends

Methods

Four Focus Group Discussions were held; two in Makueni at Kibwezi and Kambu and two in Mashuru at Odarpoi and Osilale. Pair wise ranking of the ten most important drought tolerant bee forage species was done in Kambu and Kibwezi. In Mashuru, drought tolerant bee forage plants were listed and ranked on agreement without pairwise ranking as group members in the groups indicated that bee keeping was not a major enterprise and many people were not keen on the production. This was attested by one of the groups (Enyuata) having place hives in July 2013 but had not harvested by May 2015 as they did not know how to.

Results

A total of 45, 37 and 17 species were listed as bee forage species in Kibwezi, Kambu and Mashuru respectively (Table 13, 14 and 15). Besides natural vegetation, planted crops also contribute to bee production. The bee forage species ranged from trees, shrubs, grasses, forbs and herbs.

Trees and shrubs

Grasses

Climber

Table 13: Bee forage plant species at Kibwezi

Kamba name	Botanical name	Kamba Name	Botanical name
Muthiia	Acacia mellifera	Ndata kivumbu	Cenchrus ciliaris
Muaa	Acacia tortilis	Mulawa	Grewia Sp
Ikonge	Agave sisalana	Kya kya usi	?
Mwaitha	Entada Africana	Thaalwa	Lannea rivae
Ututi	Thurnbergia holst.	Kiuuku	Terminalia brownie
Mukuswi	Acacia brevispica	Muthingii	
Mwela ndathe	Mimusops kummel	kilului	Balanited aegyptica
Muarubaine	Melia azadracta	Muvuavui	
Mukau	Melia volkensii	Musovi	
Kiungu	Impomoe kituensis	Mukaakaa	Hosludia opposite
Mbemba	.Zea mays	Muvu	Grewia sp
Muemebe	Magifera indica	Kiamba	Adansonia digitata
Kisivu		Mukengesya	Commelina bengalensis
Kingole	Acacia nilotica	Kikuku	Dactylotenium aegyptica
Musekele	Calyptotheca taitensis	Mbwea	Panicum Spp
Kisaya	?	Muthunga	
Kitae	?	Mulaa	
Mboso	Beans	Musemei	A. Senegal
Mukame	Brucei antidysenterica	Kyusya	Asparagus africana
Mutavisi	Lantana camara	Mulela	Acacia xanthoploea
Munina	Acacia geradii	Kithaalwa	?
Muthui	Newtonia sp	Nthooko	Cow peas
Ivavai	Paw paw		

Table 14: Bee Forage Plants at Kambu

Kamba name	Botanical name	Kamba Name	Botanical name
Muaa	Acacia tortilis	Muembe	Magifera indica
Musovi		Kinguuthe	
Muthiia	Acacia mellifera	Mutitiu	
Ututi	Thurnbergia holst	Mjora	Cassia spectabilis
Kingole	Acacia nilotica	kiamba	Adansonia digitata
Kiungu	Impomoe kituensis	Mululi	
Kisemei	Acacia Senegal	Mukiliulu	
Kiuuku	Terminalia brownii	Kisungwa	Orange
Mwela ndathe	Mimusops kummel	Mukau	Melia volkensii
Mukuswi	Acacia brevispica	Kikwasu	Tamarindus indica
Ikonge	Agave sisalana	Uthui	Newtonia weightii
Mutoo	Azanza garkeana	Ndongu	Solanum incanum
Mbemba	Zea mays	Mutavisi	Lantana camara
Munina	Acacia gerradii	Mbwea	Panicum spp
Nthooko	Cow peas	Muvilisya	
Kyusya	Asparagus africana	Kitandamboo	Caparis tomentosa
Nzuu	Pigeon peas	Mukame	Haplocoelum foliolosum
Muvya	Millet	Mukenea	Fagara chalybea
Mwee	Pearl Millet		

Table 15: Bee forage Species and flowering phenology in Ordapoi, Mashuru Location

Month	Botanical Name	Month
Oiti	A. mellifera	Jan/Feb, Aug/Sept
Ol ntepesi	A. tortilis	Jan/Feb, Aug/Sept
Ol ngoswa	Balanites aegyptica	Jan/Feb, Aug/Sept
(Emperepapapa)	Asparagus sp	Jan/Feb, Aug/Sept
Oltiameleteti		April/May, Nov/Dec
Ntulele	Solanum incanum	April/may. Nov/Dec
Nyanyi/ Naibor Inkunya		April/May. Nov/Dec
Oremit		April/May. Nov/Dec
Oloikororomi		April/May. Nov/Dec
Erankau		April/May. Nov/Dec
Ol Mukutan		April/May. Nov/Dec
Ol Kiloriti		April/May. Nov/Dec
Enkaiteteyia		April/May. Nov/Dec
Eseki		April/May. Nov/Dec
Oirri – Grewia bicolor		April/May. Nov/Dec
Ositeti		April/May. Nov/Dec
Enkamai		April/May. Nov/Dec

The drought tolerant bee forage species in both Kibwezi and Mashuru Subcounties ranked in order of tolerance is as shown in table 16 and 17.

Table 16: Ranking of bee Forage species in order of Perceived Drought Tolerance and population trends

Area					
Kibwezi			**Kambu**		
Plant species	**Population trend**	**Rank**	**Plant species**	**Population trend**	**Rank**
Acacia mellifera	Decreasing	1	Thurnbergia holst.	Decreasing	1
Acacia tortilis	Decreasing	2	Acacia tortilis	Decreasing	2
Boscia angustifolia	Decreasing	3	Ipomoea kituensis	Increasing	3
Brucei antidysenterica	Decreasing	4	Acacia mellifera	Increasing	4
Thurnbergia holsti.	Decreasing	5	Agave sisalana	Decreasing	5
Mumina	Decreasing	6	Tamarindus indica	Increasing	6
Musekele*	Decreasing	7	Terminalia brownii	Decreasing	7
Agave sasilana	Increasing	8	Acacia brevispica	Decreasing	8
Acacia xanthophloea	Decreasing	9	Musovi	Decreasing	9
Entada Africana	Decreasing	10	Fagara chalybea	Decreasing	10

- Species flowers throughout the year, termite resistant, propagated by cutting

Table 17: **Drought tolerant bee forage species in Mashuru ranked in order of importance**

Common/local name	Botanical name
Oiti	Acacia mellifera
Ol ntepesi	Acacia tortilis
Ol ngoswa	Balanites aegyptica
Emperepapapa	Asparagus sp
Oltiameleteti	
Ntulele	Solanum incanum
Nyanyi/ Naibor Inkunya	?
Oremit	?
Oloikororomi	?
Erankau	?

Bee keeping is a relatively new enterprise among the Maasai even though honey is valued in the community as medicine and food. However, they have in the past relied on harvesting honey from the wild. There are a few individual and groups who have taken up bee keeping through the effort of the previously MoLFD. However, the groups have yet to be passionate about bee keeping and bee keeping is very basic.

The population of all but one (Agave sisalana) of the drought tolerant species in Kibwezi area were perceived to be decreasing. On the contrary, the population of 30% of the drought tolerant species in Kambu were perceived to be increasing. Several reasons were advanced for the increase in population in some bee forage species. In Kibwezi, the increase of Agave sisalana was attributed to planting by the farmers as it was being used in demarcating land boundaries. The increase of Acacia *mellifera* in Kambu was also attributed to planting where farmers were said to be planting it not only as fencing material but also as feed for goats.

The decrease in bee forage plant species in all the areas was attributed to cutting of trees such as Acacia tortilis for charcoal burning. Acacia tortilis decline was also attributed to drying in Kambu where respondends indicated started after the El Nino rains in 1998. Increasing frequency of drought and dryness as well as land use change manifested in clearing land for cultivation was said to be the cause of decline of *Acacia brevispica (*Kamba *–Mukuswi)*, *Fagare chalybea (*Kamb*a Mukenea)*, Hoslundia opposite (Kamba *–Musovi*).

The Nkatu bee keepers in Mashuru said they did not know bee forage species. The group memebers are based at Nkatu town while the hives are placed on the farm of one of the members which is about 10km away on a hill. However the group members indicated that bee forage species had declined gauging by the volumes of honey harvested in the world.

The Enyuaata Self Help group has twenty (20) members, fourteen (14) women and six (6) men and have various activities as a group which include;

1. Funding children in high school which makes the group have an annual general meeting
2. Have a merry go round

The group keep cattle (sahiwal), Galla goats and dorper sheep as individuals. Bee keeping was an activity the group had started in 2013 after they got funding from Njaa Marufuku Kenya.
Reason for starting bee keeping were shared as;

1. Sensitization and training of the group in bee keeping
2. Observation that bees have been living with the community
3. Honey has a lot of uses within the community
4. Bees are inexpensive to keep

The group explained that the Maasai do not keep bee because they do not know the value of honey and that honey is only used in traditional ceremonies which are periodic.

Major constraints in bee keeping in Kibwezi and Mashuru Subcounties

The main constraints to increasing honey production in Kibwezi and Kambu were;

1. Increasing dryness
2. Decrease in bee forage
3. Increasing frequency of droughts
4. Poor occupation of hives
5. Pests like the honey badger and others
6. Lack of knowledge in production

In Kajiado, the groups indicated that the volume of wild honey has been declining due to;

1. Cutting of trees for charcoal
2. Increased drought frequency

Discussion

The bee forage species may not be exhaustive but it shows that there is a high diversity of bee forage species. The results indicate little change in bee forage species list since 2001 (Musimba et al. 2001) probably because large/expansive areas of uncultivated land are still in existence. Most drought tolerant bee forage species were on the decline due to cutting for charcoal burning and clearing land for cultivation. The latter could be due to limited understanding of ecological linkages in the production systems or low value attached to bee keeping.

Conclusion and Recommendations

The Maasai community in Mashuru have limited skills in bee keeping when compared to those in Makueni. There is still a large diversity of bee forage species in both Subcounties but the potential for honey production is underutilized. The bee forage in both Subcounties is under threat due to habitat destruction caused by change in land use and activities. There is urgent need for the groups in Mashuru to be trained so that they can benefit from the project investment.

1.2.4 Vision 2030 Flagship Project 3 on Establishment of Disease-free zones – Range seed and Hay production

B.P. Ogillo

This is mainly to harvest range grass seeds and hay within the KALRO Kiboko ranch. Part of the hay is stored for use by the centre's livestock and some is sold to farmers. The grass seed is mainly distributed as starter seed material to farmer groups interested in improving their natural pastures. From the funding allocation (Ksh.20,000) for harvesting seed, approximately 160 kg of *Cenchrus ciliaris* was harvested. Harvesting of *C. ciliaris* demands more labour i.e. 1 man-day to harvest only 2 kg while a kilo of *C. ciliaris* is sold at 1,000/=.

1.3 Publications

1.3.1 Resilience and Impact of HIV/AIDS among the Nomadic Pastoral Communities in Kenya

*R.K.Kimitei[1] And P.N. Katiku[1]

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Paper presents at the IGAD conference on health held inAddis Ababa, Ethiopia December on 3rd - 6th 2014

Abstract

HIV/AIDS is the single most significant crisis in Africa today, Kenya included and has the fourth highest number of Aids infections in the world. The HIV prevalence in the country stands at 1.6 million people, with an estimation of at least 100,000 new infections annually. Nomadic pastoralism has been undergoing transformation over the years – from nomadic pastoralism to sedentarization and /or urbanization. These changes are tied to other dynamics in the society including HIV/AIDS infections and ethnic conflict. Areas with low awareness rates especially in pastoral areas are at higher risk from the onslaught of HIV/AIDS. In pastoral counties, the average prevalence among the pastoral population is estimated at 5.7%. However, infection rates are being accelerated by factors related to human rights and gender, access to and control of resources, socio-cultural environment, conflicts and displacement and also the fact that pastoral communities refuse to admit the presence and impact of HIV/AIDS within their families with high stigma attached to the affected and infected. HIV/AIDS awareness among the pastoral communities is also low standing at 79.5% against the national average of 97%. This paper analyses the interface between pastoralism and HIV/AIDS infections. Based on the overall analysis and evaluation of the households and corroborated information from secondary data, this study found HIV/AIDS is at present, threat to livelihood of pastoralists and pastoralism as a way of life. They also have other social economic attributes that compromise their resilience. This include; widespread poverty, lack of respect for human rights for women, disempowerment, conflict and cultural impediments. Exercabating the situation is the effects of global climate change scenarios. Immediate measures are needed to arrest this worrying trend. This requires that proper planning, implementation, budgetary support and tracking procedures are instituted and applied in pastoral counties. There is also need for conflict prevention and building resilience in the light of scarcity and climate change.

Keywords: HIV/AIDS, pastoralism, Livelihoods, conflict, climate change

2.0 LIVESTOCK SECTION

Research projects which were on-going during the year under review included the following;

2.1 Genetic improvement of Small East African Zebu cattle for milk production in ASALs

J.N. Mburu[1], S.M. Mbuku[2], M. Ngige[1], D. Kihurani[3], P.N. Katiku [4], I.S. Kosgey [5]
[1] *Egerton University*
[2] *KALRO –Lanet*
[3]*University of Nairobi.*
[4] *KALRO Kiboko*
[5]*Laikipia University*

Introduction

The Small East African zebu (SEAZ) constitutes about 80% of the total cattle population in Kenya. They are found in virtually all agro-ecological zones, but with higher concentrations in arid and semi-arid lands (ASALs). Compared with exotic cattle breeds, they are relatively better adapted to the harsh conditions that characterize the ASALs. This makes them a major source of livelihood in such areas, which constitute approximately 80% of the Kenyan landmass, albeit their low production potential.

SEAZ cattle have not received much formal genetic improvement and conservation attention, as has their *Bos Taurus* counterparts. Therefore, breeding initiatives for SEAZ have largely been left under the control of the resource-limited agro-pastoralists in the ASALs. This has resulted in inferior genotypes mainly due to inbreeding. Consequently, African indigenous cattle breeds should be conserved because of their economic importance to allow use by both present and future generations.

The project overall objective is to contribute to enhancement of productivity and competitiveness of the dairy sub-sector in ASALs of Kenya through optimization of breeding program for local SEAZ genotypes utilizing modern assisted reproductive techniques such as: multiple ovulation and embryo transfer (MOET); Estrus synchronization and artificial insemination (ES&AI) and Estrus synchronization and use of Bull mounting of breeding cows. The specific objectives are: to optimize and operationalize a breeding program for high milk yielding (>3lt) local SEAZ cattle through strategic use of reproductive technologies especially embryo transfer; to study the reproductive parameters of zebu cattle; and to conserve genetically superior genotypes through appropriate *ex-situ* and *in-sit* conservation techniques. The project is a multi-institution and multi-discipline funded by the Eastern Africa Agricultural Productivity Program (EAAPP).
The work is building on Mr. Mwacharo's breeding wok at the centre, KALRO-Kiboko. The entire on–station research herd which also constitute part of the herd of SEAZ cows from Mwacharo's foundation stock is kept at the centre. The centre is also the focal point for all assisted reproduction (MOET, ES&AI and ES&Bull) practical work .

The MOET exercise consisted of 8 cycles, each involving 2 donor cows and 16 recipients (surrogates) and begun in July 2014. The calving of the first successful implants is supposed to be in May of 2015.

2.2 Integrated Agricultural Production Systems for Poor and Vulnerable in Dry Areas

Katiku, P.N, Manyeki, J.k, Kibet, P.F.K and Keya G.A

The International Centre for Agricultural Research in Dry Areas (ICARDA), one of the CGIAR Centres with a mandate for research in dry areas, is implementing an International Fund for Agricultural Development (IFAD) funded project on collaborative basis. The participating countries of the Project are Ethiopia, Sudan, Egypt, Eritrea, Kenya and Yemen. The focus of the project is on upscaling of tested economically feasible, farmer friendly, gender sensitive and climate change smart technologies within a research to business (R2B) model. Kenya Agricultural and 1ivestock Research Organization (KALRO) was invited to participate in implementing Phase II of the project. In Kenya, the rainfed wheat-small ruminant production system in lower Narok is the designated country site. Two cluster sites, Nturumenti and Olulunga in Narok East/North and Narok south, respectively are the implementation sites.

This is essentially a technology upscaling project within a research to business model for the vulnerable and poor in dry areas. This is a two year project targeting the wheat-range small ruminant livestock system in lower Narok. The Project aims at providing gender responsive best bet technologies that are climate change-proof, user friendly and inexpensive to about 5,000 beneficiaries of smallholder farmers in order to improve their livelihoods. The goal of the Project will be to enhance smallholder farmers' livelihoods in the Nile Valley and Sub-Saharan Africa Region through innovative research to business (R2B) platform. The objectives of the Project are:
(a) Develop profitable and climate change-proof packages/models of tested and proven technology options.
(b) Facilitate the institutional and policy environment for an accelerated scaling up of these technologies.

The activities of year one will mainly involve the development of the model as an intervention package while year two will concentrate on up scaling of the intervention package. Sheep component involves the development and commercialization of a research to business (R2B) model for fattened sheep. The R2B model will involve on-farm lamb feedlot finishing of 200 lambs of 4 months old that will be fattened for 3 months and collectively marketed under a public auction. The 200 lambs will be donated by the participating farmers. A Pilot 10 acre feedlot plot will be established at Nturumeti and planted with Boma Rhodes grass undersown with wheat for fattening the lambs. The project will initially work with 40 individual farmers, 20 from Nturumenti and 20 from Olulunga. The participating farmers will each plant 2 acres of improved wheat varieties donated by the project. The project will also provide 6 breeding rams, Dorper, to farmers for genetic improvement of their local sheep. Fattening of the sheep will start after harvesting of the wheat.

Three innovation platforms to train farmers on improved sheep husbandry practices-feeds and feeding, strategic deworming and better housing -will be conducted before and during the period of sheep lamb fattening. Before the start of the intervention, a baseline survey will be conducted to benchmark and document the existing production practices.

2.3 Publications

2.3.1 The use of LIFE-SIM as a management decision support tool for small-holder farms: the case of Mbeere dairy cattle farmers

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Abstract
The objective of the study was to evaluate the accuracy of Livestock Feeding Strategies Simulation (LIFE-SIM) model in prediction of dairy cattle productivity of smallholder dairy farming in Mbeere District of Eastern, Kenya. Longitudinal data using individual animal card were collected from 27 lactating dairy cows in six farms in each division for twelve months. The study covered farms with stall managed lactating dairy cows, where data on breed, age, parity, lactation length, daily milk yield, feed types and their daily intake, calving intervals and fortnightly weights were collected. Aryshire, Friesian and their crosses were reared and fed on roughages and concentrate on as is basis at 20.2 kg and 3.3 kg respectively in Siakago and 16.5 kg and 2 kg respectively in Evurore, with a range of 7-38 kg/day for roughages and 2.0–8.0 kg/day for concentrates. Feeds were sourced from both within and outside the farms. During the dry period, when forage feeds were scarce, banana stems and cereal by-products were used to sustain the animals. The model predicted lactation yield of 2351 ± 380kg equivalent to 7 kg/d (305 days), below potential (would-be) yield of 2649 ± 222kg. There was close correlation (0.97, 0.97 and 0.98) between the actual yield and the predicted yield for the three, early, mid and late, (1, 2, 3), stages of lactation respectively. The model predicted an annual methane and manure yield of 95.44 ± 28.98 litres and 1290 ± 532 Kg respectively while the predicted body weight change for 365 days was 0.44 ± 0.24 Kg per day. The model predicted the milk yield during the three stages of lactation, 1-3, of cows in smallholder dairy farms in the District to a reasonable degree of 96 %. The study concluded that the LIFE-SIM model predicted the milk yield accurately.

Keywords: Dairy cattle; LIFE-SIM; milk yield prediction; natural pastures.

Correct citation

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2.4 Research Proposals

2.4.1 Comparative performance of three range grass species and BrachiariaMulato II on growth rate of Small East African Zebu entire male weaners

Bii, J.C

Introduction

Grass will remain to be the main feed for cattle in the Kenyan arid and semi-arid lands (ASAL) for a long time to come. This is because other sources of feed are expensive and may not be afforded by majority of the farmers. In the ASAL are found several species of grasses including *Cenchrus ciliaris* (CECI), *Eragrostis superba* (ERSU) and *Chloris roxburghiana* (CLRO).These grasses are utilized mainly in form of standing hay. Whereas proximate analysis has been done by several authors to determine %CP, Ash, %DM, %acid detergent Lignin, and %Acid Detergent fibre, it is also important to study the animal performance when fed on these grasses.

Justification

There is a need to improve productivity of range livestock in order to boost farmers' household economy and consequently improve their livelihood.The best way to do this is to improve the quality of feed especially grass since it is the cheapest feed for ruminants in the ASAL. There are several species of grasses in the ASAL and it is necessary to identify the high yielding ones in order to improve ruminant productivity.

This can be done by determining the quality (nutritional analysis) and quantity (DM yield) of the grasses through laboratory analysis and feeding trials. A study of *Bracharia* Mulato II nutritional characteristics will assist in boosting range cattle productivity.

Objectives

Overall objective

- To improve the productivity of the Small East African Zebu (SEAZ) in Arid and Semi Arid Lands of Kenya.

Specific objectives

- To compare three range grasses and *Bracharia* Mulato II on growth rate and feed intake of SEAZ entire male weaner calves.
- To determine the Cost: Benefit ratio of three range grasses and *Bracharia* MulatoII on growth rate of SEAZ entire male weaner calves.

2.4.2 Effects of selected supplements on beef cattle productivity and rumen microbiology in Makueni County

Bernard Korir

During the year under review my proposal for PhD research was finally approved by the Faculty Board of Post Graduate Studies in the Faculty of Veterinary Medicine at the University of Nairobi. The title of the proposal is 'Effects of selected supplements on beef cattle productivity and rumen microbiology in Makueni County'.

The overall objective of the study is to assess the suitability of *Brachiariamulato* II, Cassava leaf meal and Azolla as supplements to cattle for increased growth rate in agro-pastoral production systems. It is part of the ASAL APRP Beef Mega Project.

The Specific objectives are:-

1. To collect baseline data on the yield, and chemical composition of Brachiaria, leaves of popularly grown varieties of cassava and *Azolla* in Makueni County.
2. To formulate and evaluate feed supplements from Brachiaria, Cassava and Azolla for grazing beef cattle in Makueni County.
3. To determine the influence of these feed supplements on rumen microbial characteristics and fermentation patterns in beef cattle.

As part of the preparation, *Azolla* which is one of the feed supplements was collected from the Mwea Integrated Agricultural Development (MIAD) Centre in Kirinyaga County. During the same period, Cassava leaves were collected from the Cassava multiplication fields at KALRO Kiboko. Brachiaria grass hay was also harvested and stored. All these were in preparation for the feeding trials which was to be carried out at a later date.
Arrangements were made to carry out the microbial study at BecA-ILRI Hub. The nutritive value of the experimental feeds was also carried at the KALRO Dairy Research Institute Naivasha.
The feeding trial will be carried out using Small East African Shorthorned Zebu heifers and steers. The animals will be taken out for grazing during the day as is usual in the rangelands. In the evenings, the animals will be kept in groups according to their treatments in separate night sheds. The feeding experiment will be a completely randomized design (CRD) with six treatments and each treatment will comprise of four animals which will be group fed. The animals will be weighed every 2 weeks to determine weight gain.
The feeding experiment will target the long dry season when quality of available forage is expected to be deficient in available nutrients such as crude protein (CP) and this has an antagonistic effect on microbial protein synthesis. Rumen liquor samples from the experimental animals will be collected by inserting a flexible rubber pipe into rumen via mouth and polythene tube then introduced through the flexible pipe to suck the liquor from the rumen with the help of plastic syringe (60 ml capacity). Weighed samples of rumen liquor for the microbial study will be taken from the experimental animals before feeding. The samples will be taken immediately to the laboratory, where the samples will be freeze-dried, ground and stored at -72^{o}C to await molecular study.

3.0 SOCIO ECONOMICS AND APPLIED STATISTICS

3.1 Role of Socieconomicsin Range Research

Manyeki J.K

3.1.1 Introduction

Socioeconomics and Applied Statistics initially referred to as Socioeconomic and biometrics division was created in the Kiboko National Range Research Station (NRRS) in 1983. This was about 13 years after the establishment of Kiboko NRRS in 1970. The rationale behind the creation of this division was that the ongoing research was not fielding good results. In the past biophysical scientists were doing research in a mono-disciplinary manner. It emerged later that the technologies and recommendations that these scientists were developing were not being adopted by farmers in a bigger way. The major reason was found to be due to the fact that when these scientists were developing those technologies and recommendations, they were not taking into account the social and economic effects of those technologies and recommendations on the farmers and their families. This was attributed to the lack of socioeconomic inputs during planning, designing and implementing of these technologies or recommendations. If the farmers have to adopt new technologies in order to improve agricultural production, the development of those technologies (at the research stage) must include an assessment of their social viability and economic feasibility in order to enhance their acceptability and profitability to the people who will use them.

Vision and Mission of the section

Vision

The vision of the section is to be an effective and dynamic programme that ensures KALRO-Kiboko centre develops and disseminates market oriented, economically viable, socially acceptable and scientifically sound technologies and information within an enabling policy environment, thus contributing to positive impacts of agricultural research.

Mission

The mission of the section is to generate and provide to KALRO scientists and managers appropriate socio-economic information and biometrics inputs required during the development, adaptation and adoption of agricultural technologies.

3.1.2 Objectives of the Socioeconomics section

a) *Participate in Programme formulation (Priority setting)*

The broad objective of priority setting is to arrive at areas of intervention that would have the highest impact at farm or community level. Programme formulation/priority setting involves characterization and diagnosis of farming systems and identification of biophysical, social, cultural, political, economic and environmental constraints limiting agricultural production. It therefore involves:-

- Value chains analysis and prioritization Agricultural Product Value Chains (APVC)
- Reviewing and prioritizing proposed projects at the centre/programme levels for Ex-ante analysis (impact assessment) of R&D projects

b) Social, gender and participatory research methods

This involves:-

- Analysis and incorporation of social and gender dimensions in planned on-going/completed R&D project
- Assessment of social and cultural dynamics in groups for R&D project
- Ex-ante; on-going and ex-post impact assessment of proposed/completed R&D projects on social indicators such as food security, poverty alleviation/income generation, gender equity, health/nutrition, education, empowerment of marginalized communities/vulnerable groups level of community participation in R&D projects
- Development /testing of participatory research methods/approaches and assessment of their effectiveness and efficiency

c) Marketing research, analysis and development

This involves:-

- Analysis of the structure, conduct and performance of different agricultural inputs/output markets
- Assessment of marketing costs and margins for various players along Agricultural Product Value Chains
- Development and utilization of appropriate market information systems
- Organizing producers into producer/marketing groups and assess their effectiveness
- Development of approaches to link farmer(s) groups to input/output markets

d) Policy research and analysis

This involves:-

- Conducting policy research and analysis studies for key agricultural policies, including ex-ante and ex-post impact assessment of various policy
- Development of policy briefs for policy makers from the different studies
- Participation in policy formulation processes, especially under the new constitution
- Organizing policy discussion fora to disseminate research findings

e) Project monitoring, evaluation and impact assessment

This involves assessment of economic viability, social acceptability and market responsiveness of the technologies developed by KALRO and assess the levels of adoption and impacts of released technologies at different stages of technology generation, adaptation and adoption for wider usage (up-scaling). This process includes:-

- Economic analysis of research technologies/recommendations
- Assessment of economic competiveness of various enterprises/products (Profits, gross Margins, Cost-Benefit Analysis, Net Present Value, internal rate of Return and Marginal Rate of Return) in different farming systems and their relative contribution to household incomes
- Socioeconomic evaluation/review of on-going/completed R&D projects
- Conducting adoption and ex-post impact assessment studies for completed projects/released technologies

f) Adoption studies

This involves assessment of the levels of adoption of released technologies and the factors influencing adoption at different stages of technology generation, and adaptation for wider usage (upscaling). This stage is done together with stakeholders and includes:-

- Identification of the target and control samples in clients in the intervention areas as per the baseline
- Developing a data collection instrument to gather the relevant data on different variables and in particular the key performance indicators as established in the baseline
- Data collection
- Analyzing the data and marking inferences/conclusion

g) Provision of Applied Statistics input

The biometricians are involved in the designs of experiment/surveys, data analysis and interpretation of results, capacity building of scientists in use of statistical packages, and development of methodologies through:-

- Assistance to scientists in the design of experiments and surveys
- Depending on the level of precision required for the various explanatory variables or factors, the biometrician suggests the best design but agrees with the scientist(s)
- Participating in the field lay-out exercise
- The biometrician fits models that relate to the objectives of the study
- The biometrician interprets the results in consultation with the scientist

However, the scientist has to state the problem and the objective of the study, decides the sites in which the experiments are to be carried out in case of multi-locational experiments or areas in which the survey is to be conducted as well as gives the treatments in case of an experiment and the sampling frame in case of a survey

3.2: Sociaoeconomic Research Activities

During the year under review, activities which were carried out were funded by KAPAP and ICARDA

3.2.1 Enhanced marketing of beef cattle, sheep and meat goats through development and promotion of appropriate feeding strategies in Southern Rangelands of Kenya

Manyeki J.K., Ndathi A.J.N., Muthiani E.N., Korir B.K., Mnene W.N., Keya G A and Kibet
PFK

Introduction

The livestock sector's contribution to Kenya's gross domestic product (GDP) range from 5.6 percent (KNBS 2009, 2010, 2011) to 12.5 percent (Behnke and Muthami 2011) while estimates of the contribution to agricultural GDP range from 30 percent (Muthee 2006, MoLD 2011) to 47 percent (FAO 2005). Cattle are the major supply of red meat contributing over 70% (Behnke and Muthami 2011, Farmer and Mbwika 2012, FAOSTAT Food Balance Sheet, 2012) followed by goats and sheep at 14% and 10.5%, respectively. Marketing of red meat was worth 67.15 billion Kenya shilling (KES) in 2009 with cattle, sheep, goats and camels contributing 53.96, 3.70, 7.54 and 1.95 billion respectively (KEBS 2010, Benhke and Muthami 2011). The average consumption is 15-16 kg of red meat (meat and offal from cattle, sheep, goats and camels) per capita annually (Behnke and Muthami 2011) and with a population of 38,610,097 persons, the demand is approximately 600,000 MT (KEBS 2010). This demand is expected to grow at the same rate with the human population which is 3.2 percent (KEBS 2010). However, not all livestock is exchanged through the official marketing channels and data on animals consumed at home is not captured. Therefore, only a portion of the size and organization of the livestock sector is captured in the national statistics.

In Kenya, pastoralists account for majority of meat suppliers (60-65% of the total), of which 35-45% come from the ASALs (KEPZA, 2005). The rest (20-25%) comes from neighbouring countries (Ethiopia, Somalia, Tanzania and Uganda) (Deloitte, 2006). Culls from dairy farms contribute another 30% of beef, while ranches provide 4% of which 15% is slaughtered for home consumption. As reported in 2014, in the year 2005 annual deficit of beef and mutton was 38,323 and 12,879MT respectively which was expected to increase to 49,835MT and 18,885MT respectively by 2014, (GoK 2011). On the other hand report indicated a positive increase in the production and surplus of goat meat. Projections of goat meat supply between 2005 and 2014 show that the surplus will increase from 5,775 MT to 7,739 MT (GoK 2011). The lack of timely quantity and quality supply and efficient marketing infrastructure for live goats and their products was recognized as a major factor hindering the improvement of gains that accrue to the pastoralists (KARI 2012).

Over 70 percent of the national livestock herd is raised by pastoralists (KNBS 2009). Pastoralists in Kenya are found in all the arid and the semi-arid lands – including the southern rangelands (Kajiado, Narok and Transmara), West Pokot and parts of Laikipia and Lamu (RoK 2011). In Kenyan arid and semi-arid lands (ASALs), the livestock sector employs 90% of the workforce and contributes about 95% of the household incomes (FAO 2005, Nyariki 2005, KEBS 2010, Behnke and Muthami 2011). It is estimated that 10 million Kenyans living in the ASALs derive their livelihood largely from livestock industry (MoLD Strategic plan, 2008-2012; MoLD sessional paper No. 2 of 2008).

The mismatch between the supply and demand of beef, sheep and goat meat was attributed to inadequate production and market planning resulting to a 'market failure'. To enhance efficiency in marketing of beef, sheep and goats meat, the livestock APVC Report (KARI, 2012) recommended research on beef should focus on its production to meet the national deficit and market development aiming at meeting the quality and safety standards for international markets, while that of sheep and goats meat should focus on market development (finishing strategies) for both national and international markets.

The premise of this study was therefore to develop and promote appropriate feeding technologies for market-oriented beef cattle, sheep and goats production in the ASALs in order to make the value chain of their products more efficient, profitable and competitive. The specific objectives were to: 1) assess and document the market requirement for live beef cattle, sheep and goat meat for domestic and export markets, 2) identify and package best bet feeding technologies that are appropriate for large and small-scale market-oriented beef cattle, sheep and goat production in agro-pastoral and pastoral systems, 3) pilot and evaluate selected market-oriented feeding packages in large and small-scale beef cattle, sheep and goat finishing in agro-pastoral and pastoral production systems, 4) disseminate and promote appropriate feeding packages for improved market-oriented beef cattle, sheep and goat production in ASALs of Kenya and 5) formulate and recommend policy guidelines for sustainable market-oriented beef cattle, sheep and goat production systems in the ASALs of Kenya.

Due to constraints associated with time and inadequate funding from the donor, the project team managed to implement only objective one that aimed at: 1) identifying the main markets (local and export) for beef, sheep and goats meat, 2) gather and synthesise information on requirements in terms of quality, quantity and sanitary standards for both local and export markets, 3) document constraints hindering producers from attaining the markets requirements and the possible solution in achieving the market requirements and 4) establish and document the quality of animals being presented to the different local markets for cattle, sheep and goats.

Methodology

This study was carried out in Makueni, Nairobi and Kajiado. The team adopted a participatory methodology in carrying out the study where key persons and institutions consulted were the ministries in charge of Agriculture, Livestock and Fisheries (MoALF) – Livestock market division, Kenya Agricultural Research Institute (KARI) headquarters, Kenya Meat Commission (KMC) and Kenya Livestock Marketing Council (KLMC). The same institutes were visited for consultations for primary information.

Further the team reviewed a wide range of documents accessed through the internet for the information on market requirements for the export markets for live animals and meat in the African countries, Middle East and market for meat in the European Union.

Literature search to gather baseline information on production parameters against the required standards was also conducted. Information was gathered through intensive one-on-one interviews of key informants and livestock production and marketing division officers in Kajiado county and Kathonzweni Sub-County. Information on the constraints and opportunities on production parameters in meeting the different markets requirements were solicited based on designed interview checklist as well as a desk review. A structured schedule and a body condition score guide was applied to collect data on the quality of animals being presented at the different local markets for cattle, sheep and goats.

Results

The results of the first objective of this study which was to identify the major markets (local and export) for livestock products and review the market requirements in terms of quality, quantity and sanitary standards for both local and export market are summarized below;

Major Local Livestock Markets in Kenya

The major local livestock markets are presented in table 18. Though not indicated in the table, Burma is the major wholesale market within Nairobi. Other major livestock markets are Mombasa, Nyahururu, Isiolo, Meru, Nyeri, Emali and Machakos. The different classes of butcheries within Nairobi County are presented in table 19. Nairobi County is the major consumer of livestock and livestock products in Kenya. High class butcheries specializing in selling special beef cuts are located here. These (specialized cuts) include sirloin, fillet, rump steak, T-bone among others. They source their meat from ranches which slaughter and deliver and from distributors who specialize in high grade meat. Middle to lower class categories mostly deal with boneless and meat with bones as well as sheep and goat meat. Low class butcheries are common in low income estate and many only deal with beef and occasional sheep and goat meat. They purchase the lower grade meat from butcheries and meat suppliers from rural slaughter slabs.

Table 18: Main Local and National Markets in Kenya

Main livestock markets	Supply areas in Nairobi
Dagoretti	West, North and North west
Njiru	North, North eastern and Eastern
Kiamaiko	North eastern and Eastern
Kiserian	West and South west
Mlolongo	Eastleigh and Eastern

Table 19: Classes of butcheries within Nairobi County

Type of butcheries	Meat products	Areas
High class butcheries	Special beef cuts (*sirloin, fillet, rump steak, T-bone, etc*)	Westlands, Langata, Karen, Muthaiga, Lavington, Hurlingham, e.t.c.
Middle class butcheries	Boneless, meat with bones and sheep and goats meat	Otiende, Onyonka, Madaraka, Nairobi west, Githurai, Zimmerman, Kahawa West, Ngumba, Buru Buru, Huruma, Kariobangi, Dandora, Uhuru, Komarock, Kayole, e.t.c.
Low class butcheries	Beef and occasionally shoats, mostly low grade meat	Low income areas, mostly slums (Mathare, Majengo, Ziwani, Kariokor e.t.c.)
Extra low class butcheries	Low grade meat, occasionally un inspected meat	Low income areas, mostly slums (Mathare, Majengo, Ziwani, Kariokor etc.)

Major Export Livestock Markets for Kenya

The major export markets for livestock from Kenya are presented in table 20. The Middle East and European Countries host the major markets although Kenya also exports livestock and their products to countries in East, Central, North and West Africa.

Table 20: Main export markets

Region	Countries
Middle East	United Arab Emirates (UAE), Kuwait, Qatar, Oman, Saudi Arabia, Yemen, Syria, Bahrain, Iran, Dubai and Jordan
East Africa	Tanzania, Uganda, Seychelles, Rwanda, Burundi, Somalia, Ethiopia, Eritrea, Djibouti, Comoros, Mauritius
Central Africa	Democratic Republic of Congo (DRC)
North Africa	Sudan and Egypt,
West Africa	Nigeria, Mali and Ghana
Europe	Netherlands, Switzerland and United Kingdom

Meat Quality Grading in the Main Livestock Markets in Kenya

Meat produced by the livestock is graded depending on the Cold Dressed Weight (CDW), fat distribution, age, bruises and blemishes. Grades and prices given by Choice Meats of the Farmers Choice and the KMC slaughter houses are presented in Table 21. The CDW is about 50% of the live weight. Animals of 2 to 3 years and weighing between 400 to 500 Kgs live weight are most preferred for the grade.

Table 21: Meat Grading in Farmer Choice and KMC

Grade	CDW (Kg)	Price (Kshs/Kg)
Class 1: High grade (Prime)	More than 175	285
Class 2: High grade (Choice)	165 - 174	270
Class 3: Fairly Average Quality (FAQ)	150 - 164	265
Class 4: Standard	Below 150 but fat	245
Class 5: Commercial	More than 170	260
	160 - 169	250
	150 - 159	220
	Below 150	210

Source: Ms. Beth Sila, KMC livestock production and marketing officer; CDW Cold Dressed Weight

Classes 1 and 2 meat should have well distributed white fat cover with no bruises and blemishes. At KMC, the Standard grade is divided into two grades, Standard A (Black) with fat and Standard B (Red) which has no fat. The KMC grading also has a Manufacturers' grade which is meat from animals that are too weak to move.

For sheep, class 1 has CDW of between 13 and 22kg (medium size) and is paid at Kshs 320 per kg. The mutton should have nice conformation with a nice spread out fat cover with no visible bruises and blemishes. Class 2 is either below 13Kg or above 22Kg and is paid at Kshs 300 per kg. Male goats having live weight between 12 and 13kg are highly demanded at the KMC slaughter house.

Local livestock markets requirements

Male goats having live weight between 12-13.35 kg are highly demanded by livestock traders locally and more so by KMC. These give a CDW of between 5 and 7 Kgs. The livestock preference is also given by different local markets based on the CDW, age, fat distribution, bruises and blemishes. For instance

- A High grade (Prime) animal – cattle age 2-2.5 yrs.'; well distributed white fat cover with no bruises and blemishes; CDW more than 175Kgs for cattle and sheep and goats aged 1 year with CDW 5 and 7kgs for goat and 13 and 22kg for sheep
- Choice – Age 2.5-3.5 yrs.; CDW cattle 165 – 174Kgs for cattle
- Fairly Average Quality (FAQ) – Age not a factor, CDW for cattle 150 – 164 Kgs
- Standard – Age not a factor, CDW for cattle below 150Kgs but fat
- Commercial - weak to move

Galla goats, dopper and merino sheep are the breeds highly preferred by local and national market. The animal should be free from notifiable diseases.

The export market requirements for livestock (Jude Akhidenor and Mohamed Taha 2012)

The livestock products traded in the international market include live animals and value-added meat products. Live animals are either traded for breeding and slaughter. In the case of Kenya, the exports are usually for exotic breeding stock to neighbouring countries and exports of live animals to Middle East and Mauritius. Meat products traded include beef and veal, boneless, meat extracts, sausages, canned beef, beef preparations, homogenized beef preparations, goat meat, mutton and lamb. The most important importers of East African live animals are Libya and Egypt in North Africa, Middle East countries (Bahrain, Jordan, Iran, Oman, Qatar, UAE, Saudi Arabia and Yemen) and Mauritius. Egypt is the most important importer of camel and cattle while Oman, UAE and Yemen are the major importers of goats. Saudi Arabia is the most dominant in imports of sheep.

The market requirements for live animal for export market are: -

For sheep and goats, the export markets require young animals (less than 1 year) and preferably males. The skin-off weight for goats should be between 5 and 7.5Kg while for sheep should be between 8 and 12Kgs. For breeds, the Galla is preferred for goats while Merino and Dopper are the preferred sheep. Non-castrated goats with lower proportions of fat are also preferred. For instant, Rwanda or Burundi offers premier price ranging between Kshs 12000-15000 for young male goat, aged between 1-2 years and with a live weight of 13-45 kg.

However, Kenya is not a major exporter of red meat. The export market is only 1% of the meat produced. The major constraints have been highlighted as the high prices of livestock and meat, traceability and diseases.

Requirements for lives animals and meat export to the Middle East (Farmer personal communication), Elisabeth and Mbwika James. 2012.)

The general principles of the Middle East States Import and the Sanitary and Phytosanitary requirements for Live Animals and beef are summarized in this section. Conditions for export of small stock and its meat follow the same principles with the nature of the diseases (Studies have also shown that the supply of red meat from domestic cattle, shoats and camels falls short of demand, especially in Kenya (Agrisystems 2003) and the animal type. The requirements are as follows:

i. The animal must come from a country/zone which are not under sanitary ban and where FMD, Rinderpest, PPR, CBPP and RFV are notifiable
ii. No cases of RVF must have occurred in the country/zone for three months prior to the shipment
iii. The country/zone must be free from Rinderpest or routine preventative vaccination is carried out
iv. FMD, Rinderpest and PPR must not have occurred within 10Kms of the production/holding zone for a period of 3 months (FMD) or 3 weeks (others)
v. The animal must have been kept for at least one month before quarantine where specified livestock diseases have not occurred for a specified period. For example, FMD must have not occurred for 3 months before the one month period of holding.
vi. Animals must be kept in quarantine for 30 days prior to shipment. Animals must be dispatched directly to quarantine from holding grounds, examined before entry to quarantine for clinical signs of disease, the quarantine station and an area of 10km around it is disease-free.
vii. Exported animals must have laboratory tests with negative results for FMD and any other diseases requested by the importing country.
viii. The animals must be vaccinated against FMD at time of entry and 20 days after entry into quarantine. A specified vaccination programme for Rinderpest, PPR and RVF must be followed.
ix. Animals must be treated against external parasites at time of entry into quarantine and kept protected. Wounds must be treated against myasis at the beginning and end of quarantine
x. Animals must show no sign of contagious disease. Animals are not to be destroyed under a national disease eradication programme
xi. Animals must not have been fed with ruminant meat and bone meal and were not treated with growth factors
xii. Meat must have been derived from animals slaughtered in approved abattoir, designated for export and under regular veterinary supervision fully eviscerated and deboned chilled to > 2 ^{0}C for 24 hours and at least PH < 6.0, processed under hygienic onditions considered fit for human consumption, processed should ensure destruction of FMD and Rinderpest virus

Requirements for lives animals and meat export to the EU Countries

http://ec.europa.eu/food/international/trade/index_en.htm

For meat and meat products from all animal species, countries of origin must be on a positive list of eligible countries for the relevant product. The eligibility criteria are:

i. Exporting countries must have a competent veterinary authority which is responsible throughout the food chain. The Authorities must be empowered, structured and resourced to implement effective inspection and guarantee credible certification of the relevant veterinary and general hygiene conditions.

ii. The country or region of origin must fulfil the relevant animal health standards. This implies that the country should be a member of the World Organisation for Animal Health (OIE) and should meet that organisation's standards and reporting obligations. Adequate veterinary services must ensure effective enforcement of all necessary health controls.
iii. The national authorities must also guarantee that the relevant hygiene and public health requirements are met. The hygiene legislation contains specific requirements on the structure of establishments, equipment and operational processes for slaughter, cutting, storage and handling of meat. These provisions are aimed at ensuring high standards and at preventing any contamination of the product during processing.
iv. A monitoring system must be in place to verify compliance with EU requirements on residues of veterinary medicines, pesticides and contaminants.
v. A suitable monitoring programme must be designed by the competent authority and submitted to the European Commission for initial approval and yearly renewal.
vi. Imports are only authorised from approved establishments (e.g. slaughterhouses, cutting plants, game handling establishments, cold stores, meat processing plants), which have been inspected by the competent authority of the exporting country and found to meet EU requirements. The authority provides the necessary guarantees and is obliged to carry out regular inspections.
vii. For the import of meat from bovine, ovine or caprine animal species (cattle, sheep and goats), exporting countries have to apply for determination of their BSE status. This status is based on a risk assessment and is linked to specific BSE-related import conditions.
viii. An inspection by the Commission's Food and Veterinary Office is necessary to confirm compliance with the above requirements. Such an inspection mission is the basis of establishing confidence between the EU Commission and the competent authority of the exporting country.

The export consignments are whole carcasses (beef, lamb and goat), prime cuts (rump steak, sirloin, topside, fillet, etc), canned products (beef, ox-tongue, pet food, etc) and other value added products (meat balls, beef burger, marinated products, stir fries, sausages, pet food, etc).

Quantities required by different international markets (Farmer, Elisabeth and Mbwika James. 2012.)

Under the Lome and Cotonou Agreements and the European Beef and Veal Protocol, some African countries have been allocated quotas as follows: Botswana 18,916MT, Namibia 13,000MT, Zimbabwe 9,100MT, Madagascar 7,579 MT, Swaziland 3,363MT and Kenya 142 MT. Kenya has not met its quota since the year 2000 due to sanitary and other constraints.

Livestock production parameters constraining livestock keepers in attaining the livestock market requirements and suggested solutions

This section summarizes some of the finding on livestock production parameters against constraints and solution in meeting livestock market requirements for both local and export markets for live animal (Table 22). Feeds were the main challenges the livestock keeper faces. Southern rangelands of Kenya are in different stages of land degradation resulting from recurrent droughts, overgrazing and soil erosion which result to shortage of feeds and water, the key factors of livestock production. Others include poor breeds, inadequate knowledge in breeding, lack of routine vaccination of notifiable diseases and lack of record keeping. Lack of information by the farmers on market requirements in terms of age and weight was also reported as a factor hindering production of the livestock required by the market. The main solution for the above problems was extensive training on producing market-oriented beef, sheep and goats meat.

Table 22: Summary of constraints and suggested solution in meeting livestock market requirements for local and export markets for live animals

Livestock production parameters	Constraints	Suggested solution
Feeding regimes	1. Inadequate feed quantities and qualities throughout the year	• Training on fodder production (pasture improvement), harvesting and conservation techniques/technologies
	2. Long distance to look for pasture and water – lose weight	• Training on fodder production (pasture improvement), harvesting and conservation techniques/technologies • Training on water harvesting technique • Construction of boreholes/shallow wells • Training on finishing strategies
Breeding program	1. Poor breeds – Pure breed of galla goat, boran and Sahiwal etc very expensive and not readily available	• Training on the best breed that can attain the required weight within the require time • Multiplication of the best breed at a reasonable prices
	2. Lack of breeding techniques/technologies – high rate of inbreeding	• Training on the breeding techniques/technologies
Health program	1. Lack of routine vaccination of notifiable diseases.	• Regular vaccination
	2. Lack of knowledge/skills on disease diagnosis.	• Training on disease diagnosis skills
	3. High cost of drugs.	• Increase the number of agrovets • Subsidize drugs
	4. Irregular spraying of animals – un-operational dips. Low strength of dipping/spraying wash 5. For pure pastoralist eg Maasai there is increase of external parasites from wildlife	• Operationalize the dips
	6. Improper housing of lambs, calves and kids – retarded growth	• Training on housing improvement • Improve nutrition of young stock
Others include	1. Lack of record keeping	• Training on record keeping and offer writing materials
	2. Lack of information on market requirements in terms of age and weight	• Enhance information sharing through baraza/workshops/media/phones

The quality of animals being presented in the local markets

The project implementing team visited livestock markets for beef, sheep and goats meat. The markets visited were Emali, Ilbisil and Dagoretti for cattle and Emali, Kiamaiko, Dagoretti and Ilbisil for sheep and goats. On average, more than 430 and 680 cattle and sheep and goats (shoats) were marketed in every marketing day. Breed required by the national and export market were

available although they did not attain the age and live weight required as shown in table 23. Average body condition score (BCS) ranges from 2-3. Overall, animal presented were smooth and well covered; dorsal spines could not be seen, but are easily felt. Ribs were usually visible, little fat cover and dorsal spines barely visible. Transverse processes visible and usually individually. Phytosanitary requirements were met as there were no cases of notifiable diseases and no external parasites

Table 23**:** Quality of animals supplied in the different livestock markets against livestock market requirements

Livestock species		**Cattle**	**Sheep and Goats (Shoats)**
Markets		Emali, Ilbisil, Dagoretti	Emali, Kiamaiko, Dagoretti, Ilbisil
Volume (Animals/mkt day)		430	680
Breeds	**Supplied**	Sahiwal, Boran, Zebu and Crosses	Galla, Local and crosses
	Highly preferred	(No breed specified)	Galla, Merino and Dorper
Av. Age (yrs)	**Supplied**	4.0	2.5
	Highly preferred	2-2.5	< 1
Av. Live Weight (Kgs)	**Supplied**	255	25
	Highly preferred	> 300	National and Export; Goat 10-15 and Sheep 16-24 Local; goat 12-14 and Sheep 26 and 44
Av.Body Condition Score (BCS)	**Supplied**	2-3 (Fairly Good)	2-3 (Fairly Good)
	Highly preferred	1(Export) 2-3 (National and Local)	1(National and Export) 2-3 (Local)
Male	**% Castrates**	57	80
	% Entire	57	75
Sources		Kajiado, Tanzania, Eldoret	Garissa, Marsabit, Makueni, Kajiado, Wajir, Eldoret
Destinations		Nairobi, Mombasa, Machakos, Thika, Makueni	Nairobi, Machakos, Kitui, Kiambu, Thika, Makueni
Phytosanitary regulations		- No notifiable diseases - No external parasites	- No notifiable diseases - No external parasites

Table 24 below summarizes the quantities of livestock supplied in different markets in Kenya in every market day. The averages range from 260 to 560 for cattle and 630 to 650 for shoats. The number is reasonably enough to supply for the national and international markets. Appropriate finishing strategies for a market-oriented beef, sheep and goats meat need to put in place.

Table 24: Quantity of animals supplied in the main livestock markets in Kenya

Market	Livestock species	Volume (animals per day)		
		Average	Minimum	Maximum
Emali	Cattle	260	190	340
Njiru	Cattle	360	300	450
Dagoretti	Cattle	560	430	700
Kariobangi	Shoats	650	500	750
Kiamaiko	Shoats	630	500	750

Stakeholders' Forum: Highlights and the suggested way forward

Tasks for groups

A stakeholder forum was held and the result of the literature search and market survey presented. The main objective of the stakeholder workshop was to chart the way forward in producing a market oriented beef, sheep and goats in order make their value chain efficient and profitable. The participants were grouped into three groups and the tasks were to discuss on the challenges and solution in producing animals required by national and export markets. The focus was mainly on feed and feeding regime, breed and breeding management. This section summarizes the finding by each group;

Group 1. Discussed on aspect of feed resources as shown in table 25 - 28
Team members: Mnene, Musyoki, Muthoka, Marieta, Kasyoka, Ndathi
Feeds resources

1. Pastures and fodders
2. Crop residues (Stover, hauls and straws)
3. Industrial by products (bran, maize germ)
4. Minerals
5. Water

Table 25: Problems of feed availability

Feeds	Availability	What can be do?	Research Issues	Affordability	What can we do?	Research Issues	Quality	What can we do?	Research Issues
Pastures and fodders	Seasonal	Conserve during times of plenty. There is need to promote knowledge on conservation	How to conserve the browse? What is the nutritive value of the feed	Yes but there is lack of knowledge on economics	Generate the data and enlighten the people. Demonstrate	Why are the producers not practicing the recommendations?	Seasonal	Cut and conserve	Adoption studies
Crop residues (Stover, hauls and straws)	Available						Straw yes Stover	Cut and conserve	Trials and demonstrations on improving quality
Industrial by products (Wheat bran, maize germ) Minerals Water	Available			Cost is high	Start producing the by products				

Table 26: Feeding regime

Problems	What can be done?	Recommendations
Good young stock feeding	Enough milk - Enough water Enough minerals and Deworm	Recommend these appropriate feeding practices
Good finishing	Improve the quality Improve intake and digestibility Increase feeding hours	Researchable issue – why are farmers not doing this?? There is need to develop/ adapt the finishing packages for the cattle and small stock.

Table 27: Breeds

Problems	What can be done?
In breeding Good breeds	Create awareness Develop breeding systems Use AI to improve spread of breeds

Table 28: Breed management

Problems	What can be done?
Disturbing entire males	Herd the entire male together far from settlements. House and herd the males and females separately.

Group 2. Discussed on issues of management to production of preferred entire animals
Team Members: Keya, Ahmed, Tausen, Bii, Ogillo Bryan

Preferred breeds
Goats - Galla
Sheep - Dorper and Dorper/Merino crosses.
Cattle no specific breeds

Traditional methods of controlling entire males especially to control inbreeding
- Research intervention on appropriate breeds is required

Feed and feeding
- Natural pasture which may not give all requirement (protein and energy)
- Dorpers prefer pastures and water available within 10km
- Feed at stage when the nutrients are optimal
- The Dorper prefer *Digitaria macroblephara*
- Reseeding with appropriate grass (collection of grass seeds)
- Proper grazing management to allow for pasture to recover
- Need for research on the appropriate range grasses
- Capacity building on reseeding and conservation of pastures (e.g. Hay making)
- Work on changing culture attitude that prevent the farmer from adopting some of the technologies
- Browse *spp*. Management of shrubs (e.g. Acacia tortilis (*Ondebesi)*, Acacia mellifera (*oiti*), *sarai*, (Commiphora sp (silale)
- Conservation through harvesting of pods to feed during periods of shortage

Breed Management
- Disease control through regular vaccinations and treatment for diseases
- Mineral supplementation
  - There is no supplementation of animals before offtake. This is done mainly by traders
  - Need to train the livestock keepers on how to finish (only groups are assisted to finish their animals).
- Strategic deworming (e.g. 2 weeks into the rains and after the rains) and vaccination at the right time with the right drugs
- Control of ecto-parasites (fleas, ticks)
- Young stock management mainly housing
- Strategic Marketing - Awareness creation on the right time to offtake before animals lose condition
- Wildlife/livestock interactions

–Compensation to loss of livestock caused by wildlife
–Counties creat tourism boards to manage wildlife resuorces
–Counties make recommendations to national government on compensation

Group 3: Discussed on researchable aspects of feeding and breeding management . The results are presented in
tables 29 - 31

Team Members: Elizabeth N. Muthiani, John K. Manyeki, Philip F.K. Kibet, James Aetua and James Waema.

Table 29: Feed

Market requirement	Challenges	Suggested solution	By whom
Weight and age required	Inadequate feed	Match the animal numbers with the available feed – use the right carrying capacity	KALRO/County government – capacity building Farmer
		Increase forage production – pasture improvement	KALRO/County government – Capacity building
		Feed conservation	KALRO/County government – Capacity building
	Poor feed quality	Introduce high quality feed materials	KALRO/County government – Capacity building

Table 30: Feeding

Market requirement	Challenges	Suggested solution	By whom
Weight and age required	Poor quality feed during dry season	Strategic supplementation – formulated feed	KALRO/County government – Capacity building
	Lack and/or inadequate feed supplement in the market	Feed formulation	KALRO
	High cost of mineral supplement	Subsidies	County government
	Poor health management affecting feed utilization by the animals	Institute routine animal husbandry practices e.g. on health management.	County government - subsidies

Table 31: Breed and entire management

Market requirement	Challenges	Suggested solution	By whom
Age and weight	Inbreeding	Capacity building	KALRO /County government
		Use of AI for cattle – subsidies	County government
	Poor breed	Upgrading through cross breeding	KALRO /County government
		Introduce high yielding animal eg Sahiwal and galla	KALRO /County government
	Management of the entire males	Synchronize mating so that kidding is at the same period	Farmer
		Separate and finish within the 2-3 months	Farmer
	Poor management of breeds – farmer not able to meet the improved breeds	Provide the management packages for improved breeds	KALRO/County government

required standards

Way forward by the plenary

- Package and disseminate technologies for quality beef, and sheep and goats production
- Share information on different livestock market quality requirement standards
- Design and disseminate herd and pasture management techniques
- Enhance the grass seed production system
- Economic sense in terms of market share along the different livestock marketing stages

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3.2.2 ICARDA PHASE II PROJECT

3.2.2.1 Highlight on the Baseline survey on integrated sheep-wheat value chains in Narok County in Kenya

Manyeki JK and Katiku P

Introduction

The baseline involves providing a snapshot of the standard of integrated sheep and wheat value chain in Narok County. The objective is to provide a benchmark for monitoring and evaluation of the disseminated sheep and wheat technology options that are tested and proven to be profitable and climate change-proof for enhanced livelihood of the communities leaving in the areas. The integration of sheep and wheat farming is thus a common practice in Narok County. Integration is for the purpose of diversification of incomes as well as for the benefits that sheep get from the crop residues while cropping benefits from sheep manures.

Narok County with an area of 1839.8 km^2, human population of over 850,920 people, sheep population of 1059342, goat population of 683132, lie South West of Kenya and has diverse climatic conditions and land use types spanning the agro ecological zones (1-V1). The low lands are largely semi-arid areas that account for the bigger part of the land mass in the county. It is only 8497 km^2 of the total area of the county that is arable. The Narok community practice either pastoralism or agro pastoralism. Quite often, community livelihoods revolve mainly around agriculture and agro pastoralism with a very low diversity of other income streams and hence placing inordinately high pressure on the land. Crops such as maize, beans, sweet potatoes, millet and wheat are grown while livestock species kept include sheep, goat, beef and dairy cattle and bee-keeping. In East Mau, the community is largely agro pastoral. In Narok Central and Narok North, pastoralism is practiced while mixed farming is practiced in Mulot area.

Methodology of the study

This section provides a detailed outline of the overall study and describes the design of the tools, the sampling strategies and the methods that was used for gathering the data.

Selection of the research location/geographical context

Narok County was purposively selected and sites were selected based on pre-developed criteria that establish the degree of integrated sheep and wheat production system. In this case, two sites were selected, these were Nturumeti and Ololunga in Narok East and South Sub-Counties respectively. For Nturumeti (Ongata Nadoo location) site, the clusters were Nturumeti and Ntulele sub locations whereas in Ololunga, the clusters Ololunga and Olkiriane sub-locations.

Unit of analysis

Unit of analysis were heads of the household. A household in this case is a group of individuals, who may or may not be related, living under the same roof and under the care of a head of household whose authority is recognized by all the members of the household. An ordinary household is made up of the head of household, his/her spouse(s) and their own unmarried children, possibly with other family members or persons with no family relationship. The

household may be reduced to one person living alone or with his/her children. In the case of a polygamous household, where one of the wives lives in a different concession, she is the head of that household.

Data collected was both quantitative and qualitative

Sample size and sampling procedures

Seven Key informant and four focus group discussion (FGDs) were conducted. In addition, a total of 32 household interviews were conducted to triangulate the information obtained from key informant and FGDs.

Systematic random sampling was employed to select households for interview. This procedure allows us to take a representative sample with characteristics that can be generalized for the entire population which it represents. This increases the confidence level in a generalization about sub-groups or specific regions. This involves choosing one household at random and every ith household thereafter from the series. Random-walk method was employed to select the household to be interviewed. The method entails (1) randomly choosing a starting point and a direction of travel within a sampled site, (2) conducting an interview in the nearest household, and (3) continuously choosing the next nearest household for an interview until the target number of interviews will be obtained. In this study, Random-walk method involved (1) going to a central location in the cluster and selecting a travel direction at random by drawing a compass direction with the help of GPS coordinates, (2) moving in a straight line in that direction and counting all of the households until next to be sampled is reached, and (3) randomly choosing a number between 1 and 5 of households counted as the starting point for the survey.

Preliminary Results

Wheat Production

Average acreage under wheat ranges from 5-20. Wheat varieties preferred differ from site to site with Njoro II, Mwamba, Robin, Kwale and Heroe in that order being the varieties preferred in Nturumeti site while Njoro II, Robin, Eagle 10, Mwamba and Kwale being the varieties preferred in Ololunga site (Table 32).

Table 32: Attribute to wheat production

Indicator	Nturumenti	Ololunga
Wheat varieties (ranked in order of preference)	Njoro II, Mwamba, Robin, Kwale and Heroe	Njoro II, Robin, Eagle 10, Mwamba and Kwale
Type of seed	Certified and recycled for more than three time	Certified and recycled for more than three time
Sources of seed	Stockists, other farmers and KARLO Njoro	Stockists and other farmers
Major diseases	Yellow leaf rust and stem rust	Yellow leaf rust and stem rust
Major Pest	Aphides, cut worms and army worms	Aphides, cut worms and army worms

Farmers used certified seed but recycle them more than three times. Main sources of wheat seed are stockists and other farmers but the group in Nturumenti indicated that they also get seed from KARLO Njoro. The diseases that affect wheat production are yellow leaf rust and stem rust while the pests that attack wheat are aphides, cut worms and army worms.

Land is individually owned and wheat production in the area is mechanical from land preparation to seed harvesting (Table 33). High cost was reported in seed for planting, land preparation and seed harvesting in which it is charged Ksh. 3,200, 2,300 and 2,000 per acre, respectively. The small scale farmers do not receive any form of credit either individually or as a group. Major buyers of wheat are people from outside and the price depend on supply and demand which ranges from Ksh. 2,800 -3,200 in Nturumeti and Ksh. 2,500-2,800 in Ololunga

Table 33: Summary of wheat production parameters

Indicator	Nturumenti	Ololunga
Land ownership	Individual and hired	Individual and hired
Land preparation	Tractor at an average cost of Ksh. 2,300	Tractor at an average cost of Ksh.2,300
Planting	Mechanical at avg. of Ksh.3,200	Mechanical at avg. of Ksh. 3,200
Weeding	Use 24D at an avg. cost of KES 300 per acre	Use 24D at an avg. cost of Ksh. 300 per acre
Fertilizer	DAP at an avg. cost of Ksh 2,500-3,500	DAP at an avg. cost of KES 3,300
Harvesting	Mechanical at avg. cost of Ksh. 2,000	Mechanical at avg. cost of KES 2,000

Innovation on new variety, seed bulking, natural resource management and participatory selection of wheat variety were introduced by KARLO Njoro but the adoption rate ranges from high to low. In the two sites there are farmer groups that are engaged in wheat production. For instance in Ololunga there is a group called Cereal growers association and in Nturumeti, there is AFAPO, all comprising of youth and old people.

Sheep Production

The breed of choice ranked in order of priority include indigenous, Black head Persian and crosses in Nturumeti while in Ololunga they include crosses of Red Maasai and Dorper followed by Pure Dorper (Table 34).

Table 34: Attribute to sheep production

Indicator	Nturumenti	Ololunga
Sheep breed	Indigenous, Black Head Persian & crosses	Red Maasai and Dorper
Twining rate	20%	20%
Average weight for lambs at birth	Indigenous 3kgs and crosses 5 Kgs	Indigenous 3kgs and crosses 4 Kgs
Average mature body weight for female	Indigenous 24-26 Kgs and crosses 30-40 Kgs	Crosses 30-40kgs
Average mature body weight for male	Indigenous 30-34 Kgs and crosses 40-70 Kgs	Crosses 50-60 kgs
Health challenges	Olodua, PPR, Nagana, FMD and Olomorooch	olomorooch, olodapa, PPR, worms and ECF
Main sources of feeds	Natural grazing and grazing in the wheat fields	Natural grazing and grazing in the wheat fields
Common cause of death in sheep in order of importance	Diseases, drought, excess feeding on wheat and predation	Diseases, drought and predation
Mortality	Lambs (20-30%) and mature sheep (5-10%)	Lambs (20-30%) and mature sheep (5-10%)
Proportion of lamb death due to helminthes	More than 60%	5%

A least each household has a sheep but the number significantly differ ranging from 50-200 heads. The two sites reported a twining rate of 20% and mostly they milk the crosses and the minimum milk yield was 500-1000 millilitres per day. During the time of plenty, 50% of the milk is sold. The average weight for lambs at birth is 3 and 5 Kgs for indigenous and crosses respectively. The

average mature body weight for female in 24-26Kgs and 30-40 Kgs for indigenous and crosses respectively while male weight 30-34 Kgs and 40-70 Kgs for indigenous and crosses respectively.

Main health challenges in sheep are Olodua, PPR, Nagana, FMD and Olomorooch in Nturumeti while in Ololunga main diseases were olomorooch, olodapa, PPR, worms and ECF. Deworming was the measure taken to control worms but the frequency differed from place to place and season to season.

Main sources of feeds for sheep are natural grazing and grazing in the wheat fields. Conserved feeds are used especially wheat straw. Feed shortages are experienced between October to December and migration is the coping mechanism.
Common causes of death in sheep in order of importance are diseases, drought, excess feeding on wheat and predation. High number of mortality was recorded in lambs (20-30%) while mature rams recorded the lowest (5-10%). High proportion of lamb died as a result of helminthes in Nturumenti as compared to the number reported in ololunga.

The breeding programme is seasonal and inbreeding is controlled through separation and castration of unwanted rams as well as buying breeding rams from far (Table 35). The factors that are considered when selecting breeding ram are body size, colour, breed, survival, age and productivity of the dam.

Table 35: Summary of sheep production parameters

Indicator	Nturumenti	Ololunga
Planned breeding programme	Seasonal	Seasonal
Land preparation	Tractor at an average cost of KES 2,300	Tractor at an average cost of KES 2,300
Control of inbreeding	Castration, separation	Buying sire from far
Sources of breeding sire	Buy from Kajiado (Isinya)	Buy from FTC and neighbor
Factor that determine choice of breeding ram	Body size, fast growth, colour, survival and age	Body size, breed, productivity of the ram and health of offspring
Special management practices for the breeding ram	Supplementation with concentrate and mineral salt, special paddocking and selective deworming	Special paddocking and selective deworming

Special management practices for the breeding ram include supplementation with concentrate and mineral salt, special paddocking and selective deworming. Males are separated and grazed separately before marketed. The same as for the wheat production, there is no credit scheme for sheep production. Health services are majorly obtained from extension staff at the ministry of agriculture, livestock and fishery (MoALF). Veterinary care and supplementation recorded the highest cost in the two sites

Innovation on appropriate breed and breeding, feeds and feeding, nutrition, helminth control, sheep fattening and management were not introduced but farmers through their own initiative, they have managed to acquire some information from relevant institution and from their fellow farmers. In the two sites, there were some groups which are involved in sheep production namely Eor-Esimu youth group in Nturumenti and Eleng'o in Ololunga. There are no other project and/or NGOs that operate in the two sites in regard to sheep production but in wheat, Lackland assisted in supplying with herbicides in Nturumenti and CGA assisted in demonstration and seed supply in Ololunga. The group in Nturumenti indicated that they have not received any formal training while that of Ololunga said that they have received training in sheep husbandry from MoALF, field demonstration on the best wheat seed variety, resistance and water conservation.

Main sources of market information are agricultural show and local radio stations. KALRO Njoro has also been assisting in supplying with new technologies especially on wheat production and marketing. All gender are involved although the decision making remain with the head of the household in this case the husband. In utilization of the proceeds from the enterprise the decision is made by the husband in consultation with his wife.

3.2.2.2 Economics of sheep production and marketing in the integrated sheep-wheat value chains in Narok County

Manyeki JK, Katiku P, Nginyi P, Keya G and Kibet PFK

Sheep production and marketing

Farmers in Narok produce livestock and livestock products both for domestic consumption and for sale to meet their financial needs. The products are sold for consumption within the local market or transported outside Narok to neighbouring towns. The study considered two scenarios when recording the number of livestock supplied in different markets outlet and their respective market prices. These scenarios were a) a normal and b) special occasions. Normal occasions were those considered as being any other day except those falling within the schools opening periods while special occasions included public and festivities days. The study revealed that the animals are purchased by local consumers (other households/neighbours), local and outside businessmen and abattoirs, majorly Kenya Meat commission (KMC) (Table 36). Considering sheep market during the survey period, 100% of households participated as net sellers, selling their livestock majorly to traders from outside. Other households/neighbours offered better farm gate prices than other market outlets. We hypothesised the reason for this could be that the sheep sold via this type of outlet were for breeding. It is worth noting that local abattoir offered the least prices perhaps because the livestock sold in this market are graded depending on the Cold Dressed Weight (CDW). There was no contract farming reported by the small scale farmers leaving in this area.

The limitations on marketing raised during focus group discussion and single subject household interviews were similar to those of key informant surveys. The survey revealed that farmers are faced with various challenges in marketing their livestock that include low market prices, exploitation by brokers and poor infrastructure facilities. These challenges are compounded by lack of market information, delay in payment by KMC and lack of breeding technology leading to poor returns on investment value.

Table 36**: Average number of Sheep sold and market prices on normal and special occasion**

Market outlets	Average number of animals sold to this outlet on				Average Farm gate price per animal (KES) on			
	Normal days – except school opening period		Special occasion (e.g. public holidays, festivities)		Normal days – except school opening period		Special occasion (e.g. public holidays , festivities)	
	Female	Male	Female	Male	Female	Male	Female	Male
Other households/neighbours	3 (0.7)	5 (1.9)	4 (2.5)	3 (1.1)	5,000.00 (2345.2)	6,950.00 (3684.8)	10,166.67 (6930.2)	10,500.00 (6763.9)
Traders (local)	8 (1.1)	13 (1. 9)	3 (0.4)	6 (0.8)	3,242.86 (138.8)	4,309.52 (237.7)	4,238.89 (550.3)	7,670.00 (2039.1)
Traders (from outside)	15 (9.1)	21 (12.4)	34 (33.0)	73 (59.2)	2,173.33 (1086.1)	2,513.33 (1245.1)	1,800.00 (1700.0)	3,050.00 (1478.5)
Self-help group/ cooperative	0	0	0	0	0	0	0	0
Abattoir	14 (3.4)	25 (5.0)	5 (3.0)	7 (3.5)	700.00 (200)	950.00 (250)	1,600.00	2,700.00
Contract	0	0	0	0	0	0	0	0

Parentheses are the standard deviation

Sheep production cost

Since a cost estimate is the approximation of the cost of a project or operation, then estimate accuracy is a measure of how closely the estimate is able to predict the actual expenditures for the project or operation and this can only be known after the project is completed. For this study the cost were estimated in Kenya shillings for one year for a flock of 100 sheep (Table 37). The estimates were used in calculating the equivalent expenditure for one sheep in one year (Table 37). The results indicate a large portion of the production cost was realized from sheep herding and mineral supplementation. From the survey data, until attaining market weight, a sheep's production cost is about KES 1,581.50 (Table 38). This average cost was used in estimating economic profitability of sheep production enterprise. It is worth noting that the cost of marketing animals was not included in the estimate as farmers were not able to estimate the figures. The marketing cost is relative to the price the animals received on the market and varies from site to site.

The Cost Benefit Analyses of sheep production were estimated based on the current average production cost of KSh. 1,581.60 and market price of KSh 5,134.60 per sheep (Table 39). Cost and benefit associated with sheep production and marketing were evaluated through estimating the expected net present value (NPV), gross margin (GM) and cost benefit ratio (CBR). Based on these cost benefit parameters, a positive NPV and GM and a CBR above one was reported as indicating that the costs invested in the sheep production are recovered and high benefit realised. The discounted net benefit was far above zero implying that it worthy investing in sheep production for enhanced future benefit. In addition, a sensitive analysis was conducted. An increase in price of sheep through strategic fattening technologies, breed and breeding programme and collective marketing bargaining approach would enhance the profitability of the enterprise. Equally a better result would be realized through the reduction of production costs through strategic deworming regime and proper utilization of wheat straws. A combination of the two scenarios would improve the profit of small scale farmers by a greater margin.

Table 37: Estimated production cost for 100 sheep/year in Ksh.

	Sheep herding cost	Mineral supplementation cost	Tick control	Veterinary care cost	Construction of lamb pen cost	Cost of cleaning of lamb pen	Cost of shearing	Cost of notching	Cost of hoof trimming
Mean	23,870	14,939.30	11,082.80	11,673.30	10,730	8,900.00	2,000.00	500.00	750.00
N	30	30	29	30	30	25	1	1	4
Std. Error of Mean	3939.0	2337.9	2018.4	2466.3	2208.5	2166.8			144.3

Table 38: Average production cost for one sheep for two years in Ksh.

	Sheep herding cost	Mineral supplementation cost	Tick control	Veterinary care cost	Construction of lamb pen cost	Cost of cleaning of lamb pen	Cost of shearing	Cost of notching	Cost of hoof trimming	Total
YR1	238.70	149.40	110.80	116.70	107.30	89.00	20.00	5.00	7.50	844.40
YR2	238.70	149.40	110.80	116.70	0	89.00	20.00	5.00	7.50	737.10
Total	477.40	298.80	221.60	233.40	107.30	178.00	40.00	10.0	15.0	1,581.50

Table 39: Cost Benefit and Sensitivity analysis for sheep production

Parameters	Current status	10% increase in selling price	10% reduction in production cost	Both
Gross Margin	3,553.00	3,908.30	3,711.10	4,224.60
Cost Benefit Ratio	3.2	3.5	3.6	3.9
Net Present Value (30% discounting value)	2,733.10	3,006.40	2,854.70	3,249.70
Possible options		✓ Strategic fattening technologies ✓ Breed and breeding ✓ Collective marketing bargaining approach	✓ Strategic deworming regime ✓ Proper utilization of wheat straws	Combination of all

Recent studies suggest possible improvements in return on livestock production and marketing that include promotion of auctions (Green et al., 2005), that would stimulate increased competition in long-distance, perhaps through improved organization of local-level marketing and motorized transport cooperatives. Such interventions remain largely under tested and understudied. This calls for the government and development agent investments in information forecast on prices, creation of pastoralist marketing cooperatives and the opening of financial institutions that might serve as safe repositories for livestock sales proceeds, etc.

Stakeholder involvement

Stakeholder involvement in sheep production

In Narok, there are several organized groups like women groups, self-help groups, youth groups and community based organization (CBOs) registered under gender and social services. These groups are involved in merry go rounds, farming and other socioeconomic activities. The study revealed that there are very few groups in the area that help farmers realize better return in sheep production. Only 16% of the households sampled reported were aware of such groups (Table 40). Some of the existing sheep production groups and cooperatives in area surveyed were AFAPO CBOs, Eor-Esimu Self Help Group and Ilmejooli Youth Group. Majority of the groups (60%) were registered. There are strict rules for entry of new members enforced through serious vetting.

From the questionnaire administered in the target area only 14% of the households indicated having received assistance in accessing markets, production inputs (e.g. drugs, supplements and pasture seeds), veterinary services e.g. vaccination or disease control and financial services. The survey showed a very low level of activeness of the members (14%) - an indication of poor group cohesion and dynamism. Membership to organized groups was found to be evenly distributed amongst gender with male and youth taking the big portion (Figure 1). Women had a high representation in the groups (16%); an indication of improvement in empowerment among Maasai community.

Table 40: Farmer Group/Association

	Sheep	
Variable	**Yes**	**No**
Any group/association dealing with sheep	16%	84%
Group registered	60%	40%
Type of activities the group manages/ coordinates/ assists		
Access to market	14%	86%
Access to production inputs (e.g. drugs, supplements and pasture seeds)	14%	86%
Access to veterinary services e.g. vaccination or disease control	14%	86%
Access to financial services	14%	86%
Is the group open to new members	14%	86%
Are you a member of the existing group/association dealing with sheep	29%	71%
Is the group active (governance – constitution, office bearers, regular/general meetings and elections, accountability etc.)?	14%	86%

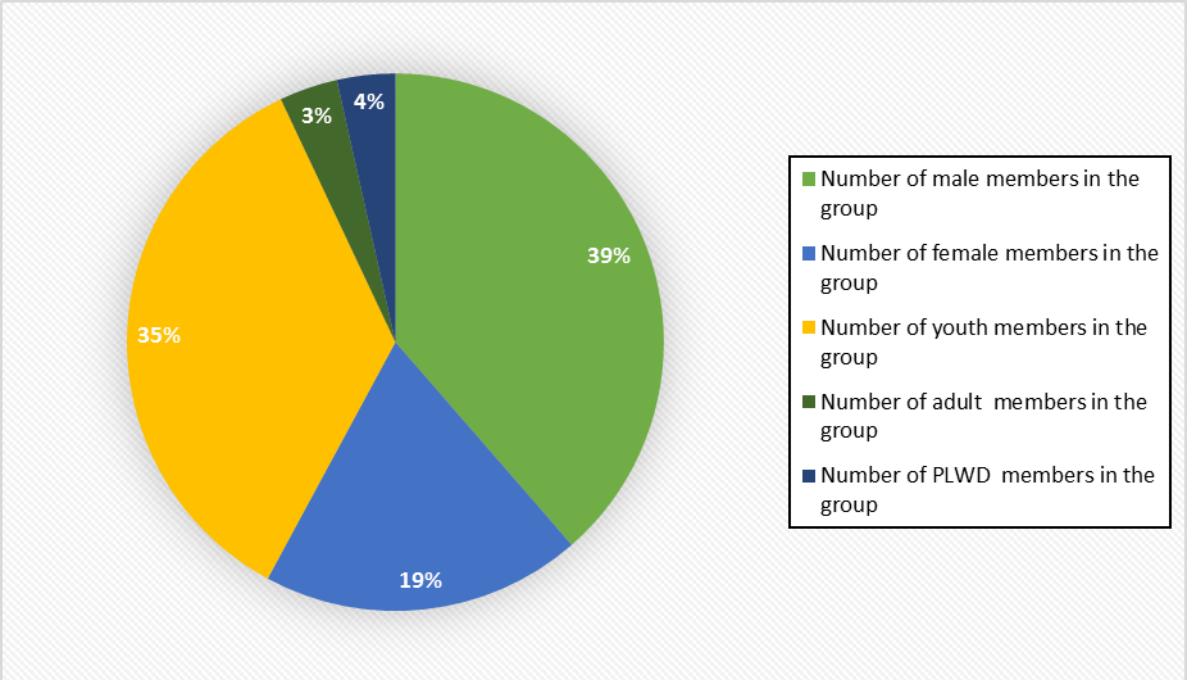

Figure 1: Gender representation in the group mentioned

Other Stakeholders

The survey showed that implementation of sheep production interventions is done by several actors, including government of Kenya (GoK) ministries and development agencies. Therefore identification of institutions engaged in sheep production matters a lot in the study area. Equally, identifying the activities the development actors are involved in formed a very important component of the baseline survey. This is because it was necessary to identify the potentials areas for partnership and synergies. Unfortunately and except for GoK Ministry of Agricultural

Livestock and Fisheries (MoALF) especially department of livestock, the respondents indicated that there were no other projects or non-governmental organizations (NGOs) involved in sheep production in the area (Table 41). Nonetheless, the respondents indicated that they receive animal health advice from GoK MoALF extension staff (66%) and NGOs (34%) (Figure 2)

Table 41: Other Project or NGOs operation in the area on sheep production

	Sheep	
Variable	**Yes**	**No**
Projects or NGOs operating in the area	0	100%

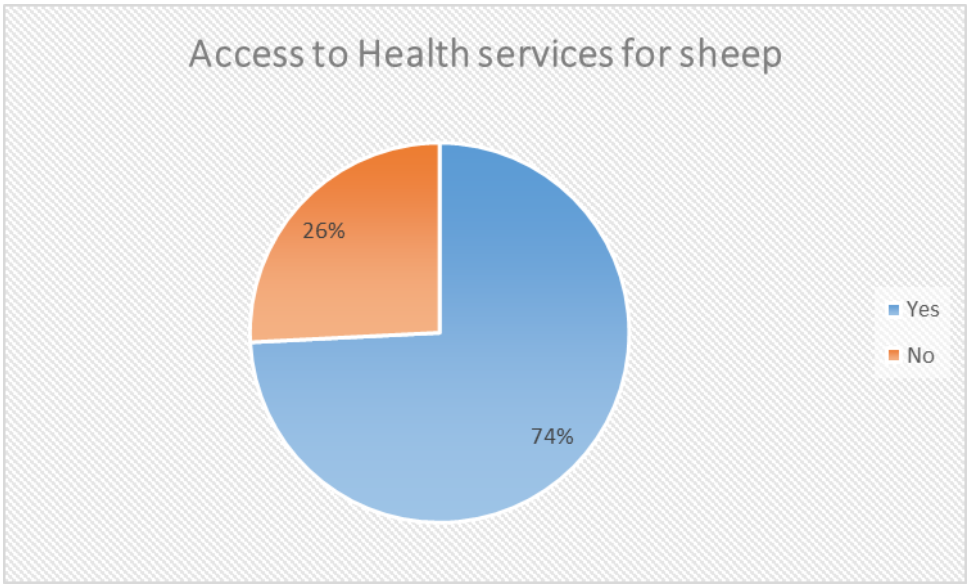

Figure 2: Health service providers

Access to Information and Technologies

Access to market information and technologies in sheep production

Access to market information and new technologies in any production system is very important as it enhance competitiveness and profit accrued at all the time of investment. There have always been frequent complaints about the poor state of livestock market information reporting systems and the disadvantage this creates for herders wishing to transact on the market (Barrett et al. 2003). Respondents to household survey were asked to cite up to three type of market information and their corresponding sources. On average, out of the households interviewed, about 56% of the respondents received information from two sources; that is, informal farmer to farmer interactions and organized exchange visits (Table 43).

Respondents gathered information about price on sheep, breeds type and body size highly demanded, type of customer and their choice and also from brochures they receive on sheep marketing. Interestingly, over 70.6% of the households received new sheep technologies through informal farmer to farmer interactions (Table 42). The kind of information on new technologies they received was: best breeds and breeding; drought tolerant breeds; milk and meat production; new crossbred types, fattening techniques and fertility of different breeds. However, the 100% of the sample interviewed reported that the information on marketing and new technology in sheep they obtained was not adequate.

Table 42: Access to market information and new technologies in sheep

	Yes	No
Access to market information	56%	44%
Access to new technologies	70.6%	29.4%

Role of Credit

Role of credit in sheep production

Financial institutions are important in availing financial resources that eventually impact on sheep production. Presence of these institutions and their relationships with small scale sheep producer were investigated through structured responses sought from the household questionnaire surveys. Although majority of the respondents (83.9%) indicated that they don't have access to credit facilities (Figure 3), there are several institutions (Figure 4) such as Agriculture Finance Corporation, Equity Bank, Family Bank and microfinance institutions from which livestock keepers can access financial assistance. The respondents indicated that the access to credit was majorly limited by high interest rates and lack of awareness.

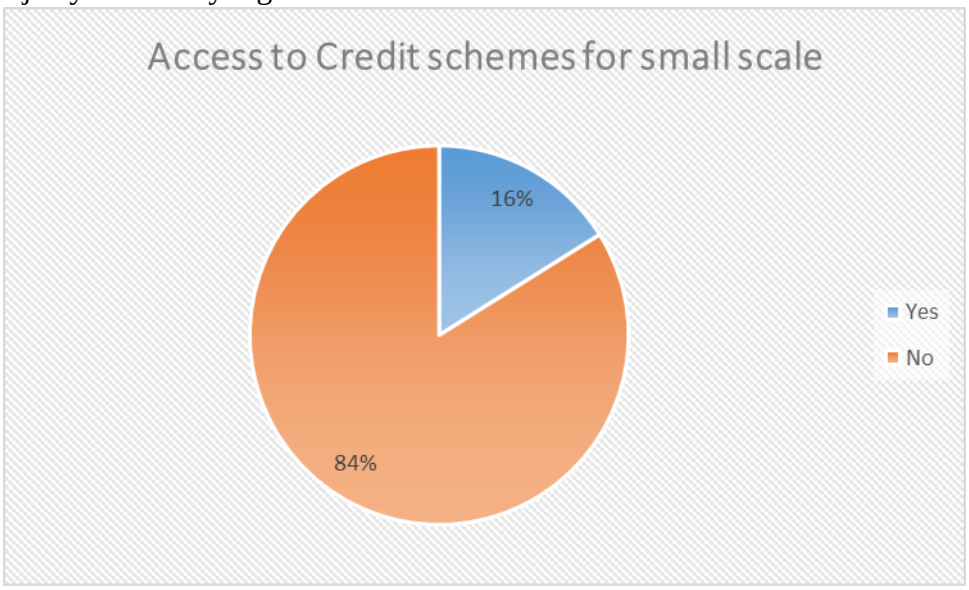

Figure 3: Access to credit schemes for small scale farmers in Narok

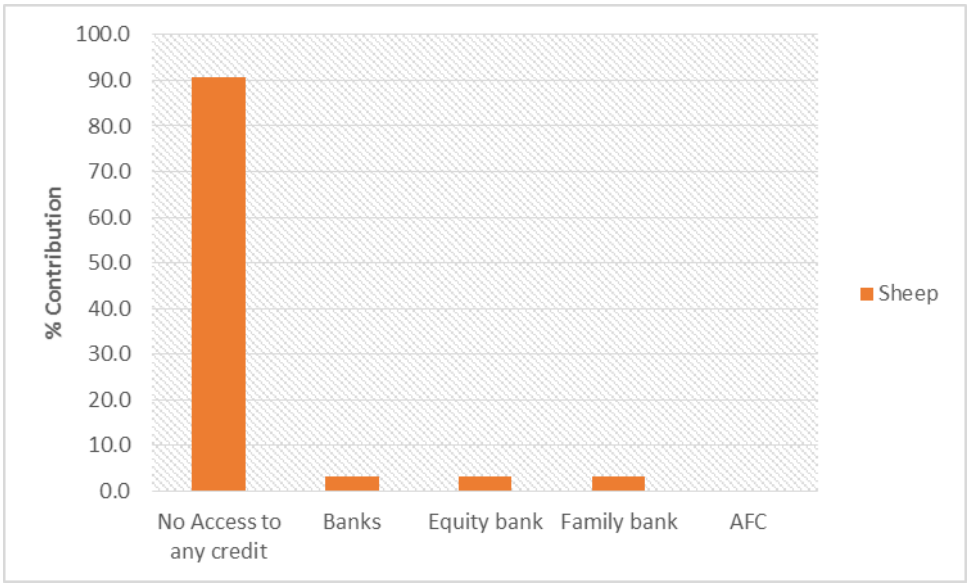

Figure 4: Financial institution offering financial credit to small scale farmers in Narok

Capacity Building

Capacity building in sheep production

Assessment was also done to identify capacity needs for stakeholders. This was done through assessment of whether the household has had any formal training in sheep production, management and marketing. The survey was also interested in identifying the sources of training and the degree of the training conducted. Surprisingly enough, all the respondents interviewed indicated that they have never received any formal training in sheep production (Table 43). This was confirmed by their inability to classify the breeds currently produced in Narok area.

Table 43: Capacity building in sheep production

	Yes	No
Any training conducted in the area	0%	100%

Gender Roles and Decision Making Processes

Gender roles and decision making processes (including labour) in sheep enterprise

Gender role and decision making in sheep marketing

This section analysed gender roles and decision making in sheep production and marketing. The analysis revolves not only around the family member obligations and responsibilities, but also power. Gender role involves analysing and incorporation of social and gender dimensions in planned research and development project for a quick and wider adoption of the proposed intervention.

Decision on when to sell and what to sell was investigated and results analysed. Figure 5 below shows that men perform a major role in deciding when to sell, but on what to sell, they decide after consulting their wives. This is because for example, Maasai women retain primary responsibilities for dairy-related activities and when selling a milking animal then she has to be consulted.

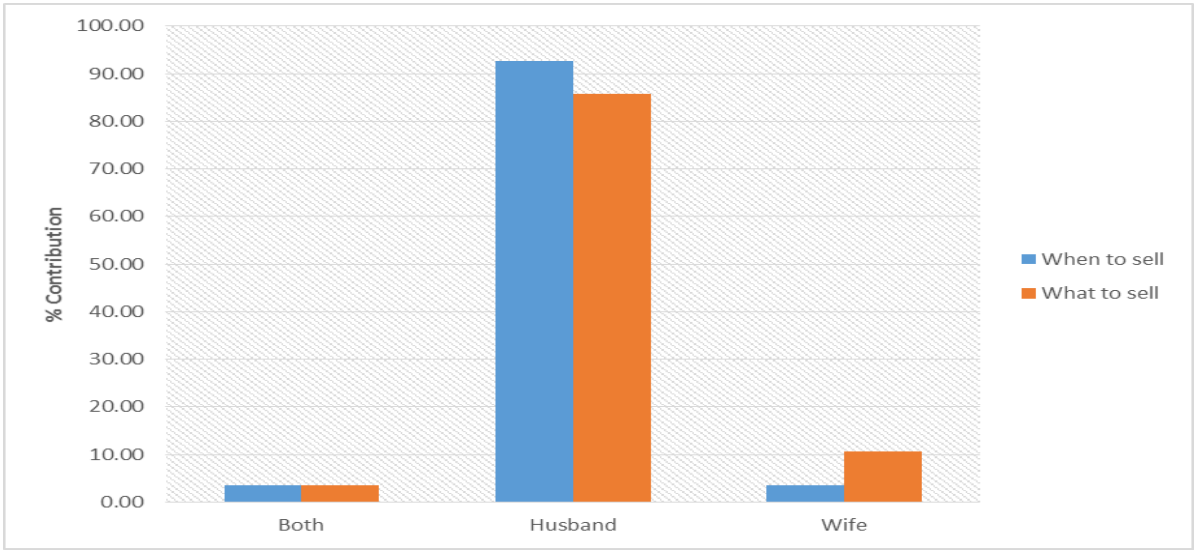

Figure 5: Gender role in decision marking on sheep marketing

Gender role on labour deployment in sheep enterprise

Gender division of labour in agro-pastoral societies is distinct but not very rigid as indicated in the figure10 below. Maasai women retain primary responsibilities for sheep milking and utilization of the milk and marketing of surplus milk. They also do pen cleaning and assist in providing sick animals with water. In Maasai society, men supervise more than 60% of the entire sheep production enterprise. On the other hand, men responsibilities include deworming, vaccination, marketing, breeds selection and searching forage materials for sheep production. Gender division of labour in agro-pastoral society is also static. As indicated in the figure 6 below, when necessary, family members are also consulted in the actual vaccination of the animals only when need arises. The household also hire labour for herding and watering of sheep.

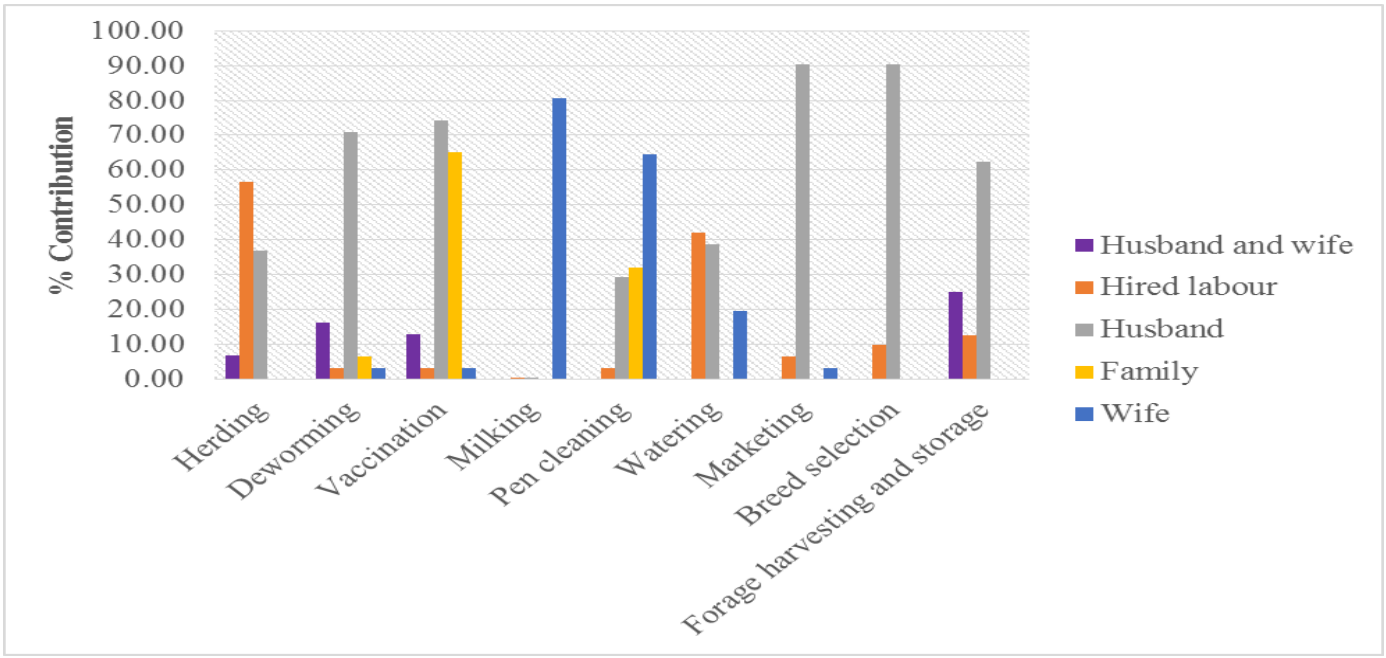

Figure 6: Gender division of labour in sheep enterprise

Gender roles in sheep management, inputs and proceeds utilization

Livestock are the central means of survival for pastoralists. Access to livestock and their products is therefore indispensable for the economic, social and cultural survival of these households. Men are generally associated with animals as herd managers and are generally considered owners of cattle, with women and children having very little privileges. In the area where the survey was conducted, 100% of the respondents indicated that the overall management of the small ruminants is done by the entire family (Figure 7). The result also indicated that although men decide on when and where to purchase and deploy sheep production inputs, they do not make some decisions such as utilization of proceeds from the sale of sheep in isolation; in such cases, other household members, particularly women are consulted. This is because men and women have varying degrees of ownership, access, rights of disposal (e.g. sale, transfer) and use of incomes from sales of livestock and their products.

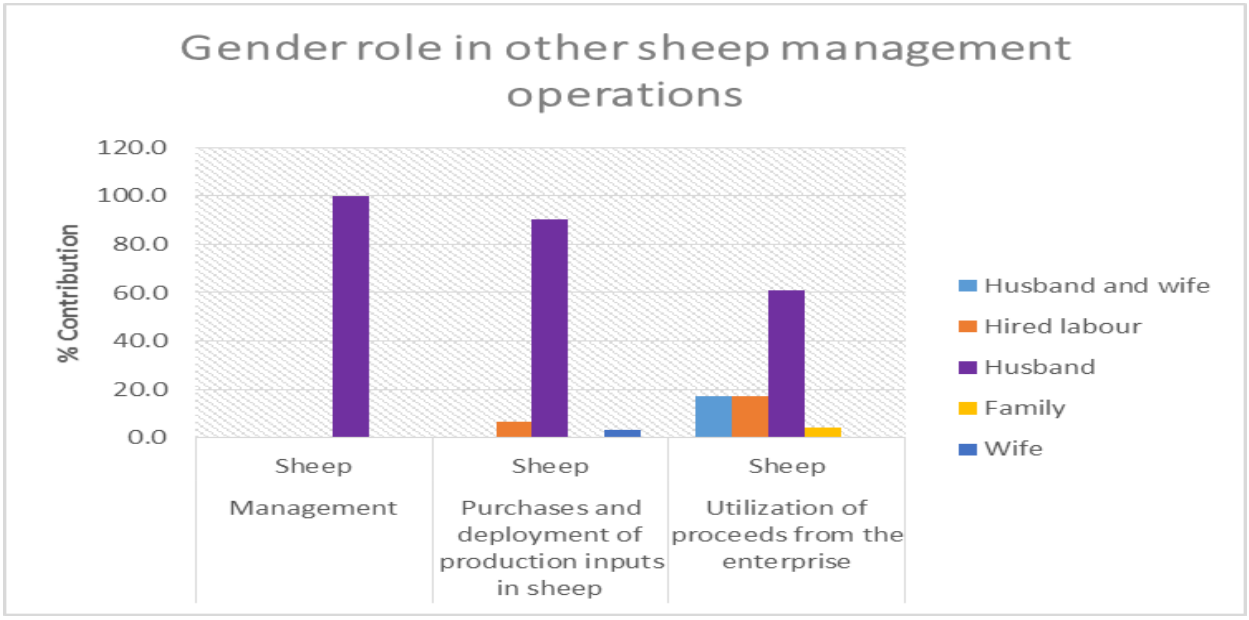

Figure 7: Gender roles in sheep management, inputs and proceeds utilization

CONCLUSIONS

Marketing, stakeholder involvement, capacity building and gender role in sheep enterprise

- Enhance linkage to credit schemes and service providers on market information and new technologies in wheat and sheep production
- Efforts in building producer associations for collective access to markets: enhancing the collective livestock marketing bargaining power. The strengthening and formation of other marketing and cooperative societies would provide an ideal platform for implementing of sheep production enterprise.
- Marketing information systems: scaled up to benefit pastoralist marketing initiatives.
- Enhance group dynamic and cohesion through capacity building
- Capacity building in efficient (in terms of cost, social, profit and environment friendly) sheep production and marketing strategies/technologies
- Ensure gender consideration and involvement in development and dissemination of sheep technologies for a wider adoption and diffusion

Reference

Green, A.M., C.B. Barrett and W.K. Luseno (2005). "Market Functioning in Northern Kenya,"Cornell University working paper.

Barrett, C.B., F. Chabari, D. Bailey, D.L. Coppock, and P.D. Little (2003). "Livestock Pricing in the Northern Kenyan Rangelands." *Journal of African Economies* 12,2: 127-155.

CONSTRAINTS OF THE SECTION

- The section is understaffed as currently has only one research officer making it very difficult in addressing the core business of the section.

3.3 Outreach and Partnerships

Korir B.K

The section participated in a field day held at Mukaa sub- County, Makueni County which was jointly organized by Kenya Dairy Board and the County Government of Makueni. The following is a narrative of the methodology used to reach the various stakeholders with KALRO-ARLRI Kiboko technologies and innovations.

A. Seven posters were used to demonstrate technologies i.e, KALRO banner; Rangeland feed challenges; Range grass species (*Chloris roxburghiana, Enteropogon macrostachyus, Eragrostis superba, Cenhrus ciliaris);* seed quality testing; Land preparation and reseeding; Galla goat breeding stock; Milk value addition (Yoghurt and mala preparation): this was to show various technologies in print and pictoral formats.
B. Seeds of five grass species displayed in gunny bags i.e *Chloris roxburghiana, Enteropogon macrostachyus, Eragrostis superba, Cenhrus ciliaris* and Boma Rhodes (Ex-Toxi)- this was used to demonstrate sowing methods and also farmers to appreciate that grass seed harvesting is possible.
C. Seed quality testing apparatus used to demonstrate the procedure of testing for germination percentage and subsequent determination of seeding rate.
D. Hay box used to demonstrate hay baling technique to farmers.
E. Grass seed was offered for sale. Five Potted grass species were displayed for the farmers to easily relate the harvested grass seed with the plants as they appear in the field.
   There were 189 people (104 males and 85 females) who visited the stand and were sensitized on the various technologies.

The Centre participated in an exhibition of technologies held at Wote, Makueni County during the world food day. The pasture seed for arid and semiarid ares technology was exhibited.

4.0. KIBOKO RANCHING UNIT

By Levi M Wambulwa

4.1 Summary

Both cattle and goats are kept on the ranch for commercial and research purposes.The two species of livestock on the ranch were experimental animals that were handed over to the Centre management at end of projects. They are maintained on natural pasture as the main feed source. Water is obtained from Kiboko and Makindu springs. Funding is from the Government of Kenya (GOK). The labour force is from both casuals and permanent staff. The cattle and goat herd and flock structure are as shown in Table 44 and 45, respectively.

Table 44: Monthly livestock inventory (cattle)

Description	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Cows after 1st calving	156	155	155	154	149	157	195	153	153	153	181	186
Bulls over 1 year	8	8	7	6	6	10	10	10	10	10	6	6
Steers over 1 year	35	35	35	35	34	34	34	34	34	34		
Heifers over 1year	70	70	70	69	69	69	69	69	68	67	131	126
Weaner (7-12mnth)female	57	57	57	57	57	57	57	56	56	53	7	9
Weaner (7-12 mnth) male	57	57	57	57	57	57	57	55	54	46	90	90
Calves (0-6mnth) male	38	38	38	37	58	58	58	58	55	57	52	56
Calves (0-6 mnth) female	43	43	43	43	75	75	74	74	72	72	66	68
TOTAL	**464**	**463**	**462**	**458**	**505**	**517**	**554**	**550**	**543**	**531**	**533**	**541**

Table 45: Monthly livestock inventory (goats)

Description		Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Does	Females	216	213	204	204	193	189	189	188	181	178	183	182
Bucks	Entire	5	5	5	5	5	4	4	3	3	3	3	3
Yearlings	Female	3	23	23	33	23	23	23	23	23	23	21	11
	Entire	7	5	5	5	5	4	4	3	3	3	59	59
Weaners	Female	78	77	77	77	77	77	58	46	44	44	88	86
	Entire	67	65	65	65	65	65	59	48	45	38	32	30
Kids	Female	84	71	71	59	50	42	42	42	37	37	36	36
	Male	80	79	79	84	79	78	78	78	74	74	37	37
Total		**567**	**538**	**538**	**522**	**497**	**482**	**457**	**431**	**415**	**405**	**459**	**454**

The changes in herd and flock structure due to births, sales and deaths are shown on table 46;

Table 46: Livestock changes due to births, sales and deaths in 2014

	Cattle			Goats			
MONTHS	**Births**	**Sales**	**Deaths**	**Births**	**Sales**	**Loss**	**Deaths**
JAN	2	-	-	28	-	-	22
FEB	-	-	1	-	-	-	31
MARCH	-	51	1	12		-	28
APRIL	-	-	4	-	-	-	8
MAY	54	1	6	-	-	-	13
JUNE	-	-	3	-	1	-	14
JULY			4				25
AUG			4				26
SEPT			7			1	15
OCT	2		12				15
NOV	1		7	67			11
DEC	11		3				5
TOTAL	**70**	**52**	**52**	**107**	**1**	**1**	**213**

4.2 Disease control

Routine dipping (using Amitraz acaricde) on every Tuesdays at boma 1C for cattle and hand spraying of goats weekly was instituted, although there were inconsistencies in supply of acaricide and shortage of water due to breakage of water pipes. Calves and all goats were dewormed using Albendazole 10%.

Trypanosomosis cases were noted to increase on the farm especially in Otober to December of the year under review. Prophylactic treatment was done. Other cases of bacterial, protozoan, fungal, rickettsial were successfully treated as they occurred.

4.3 Feeding and Watering

Proper grazing regime was difficult to enforce because of the heavy bush encroachment. Some areas with *Acacia mellifera* and *Commiphora* shrubs excluded grazing animals and inhibited good pasture undergrowth. Ranch animals relied on non-improved natural pasture as only and main feed. Throughout the year there was enough feeds.

There were instances of wild fires in between October and December, hence, there was high competition for feeds on the farm for both agro and pastoralist farmers who had moved into the ranch from as far as Kitengela and Loitoktok seeking pasture and water.

There was rationing of water to the livestock boma due to drastic reduction in water volume at the Makindu spring.

4.4 General livestock management and practices

Identification of stock

Calves and kids were identified by tagging within 7 days of birth. Weaner calves were branded at weaning time.

4.5 Ranch Infrastructure

For many years, Bomas, dips, water reservoirs, firebreaks and farm roads have not been rehabilitated intensively apart from minor repairs. Within the year, seven bomas were used for livestock and other 2 remained vacant but for emergencies in case others breakdown.

Amongst three plunge dips, one for cattle was in use at boma 1C. Amongst 4 Concrete water tanks only two provided minimal services i.e due to old age they do leak. For the firebreaks and road networking the ranch, they remained ungraded.

4.6 Ranch security

The ranch was heavily invaded by wildlife especially elephants from Amboseli that caused frequent damage to water pipes, farm structures and vegetation. Illegal herders with camels, cattle, sheep and goats competed with KALRO livestock. In addition, the trespassers illegally harvested trees and hardcore.The Centre management involved County Administration to address the vice.

4.7 Constraints

The Ranch was faced with challenges such as;

1. Lack of a Veterinary Officer to guide on herd health of livestock.
2. Sometimes lack of prompt means of transport to attend to livestock sick cases.
3. Delay in supply of drugs and acaricide.
4. Illegal grazers invading the ranch in great numbers and introducing diseases and depleting pastures for Centre Livestock.
5. Frequent lack of water for livestock due to breakage of water pipes by elephants and delay in purchase of replacement materials.
6. Lack of sufficient funds to purchase supplements to mitigate on malnutrition.
7. Predation by wildlife especially on small stock.

5.0 ACCOUNTS

By D. Y, Mbithi

5.1 Accounts: Introduction

During the year, two officers retired from the section. Due to this, there is need for more staff at least one officer to strengthen and improve on operations in the section. However, the accounting functions at the Centre were properly conducted in the year.

The Centre received Ksh 12,469,385/80 in form of Appropriation In Aid (AIA) from various sources and funding support from development partners and donor community, which included Recurrent GoK, AIA, KAPAP and ASAL-APRP as shown in the table 47 and 48 below;

Table 47: **Main Centre details of donor funding and GoK**

Programme	**Amount (Ksh)**
Gok Recurrent	1,039,998.00
AIA	1,564,560.00
ASAL APRP	6,150,000.00
KAPAP	680,700.00
Total	**9,435,258.00**

Table 48: Ranching Unit

Programme	**Amount (Ksh)**
AIA	3,034,127.80
Total	**3,034,127.80**

6.0 PERSONNEL AND ADMINISTRATION

By A M Odanga

6.1 Staff establishment

The number of staff at the Centre as of 31st December 2014 was 74 inclusive of 13 scientist, 7 technicians and support staff. During the year, no transfer was made to the Centre. Dr. S.K. Karimi continued to serve on secondment with National Commission for science Technology and Innovation as a Chief Science Secretary. The Centre has suffered in terms of staff deficiency that we attribute to transfers without replacement, natural attrition and retirement. The most affected carders are technical, auxiliary and drivers. If this is not addressed, the Centre will likely be incapacitated to conduct research activities effectively. It is important to report that the centre was up graded to the level of an Institute. The Centre Director was appointed as the Arid & Range Lands Research Institute Director in An acting capacity.The 2014 establishment strength of the Centre is shown in the Table 49 below:

Table 49: Staff in post as of 31st December 2014

No.	Designation	Job Group	No. In Post
1	Senior Principal Research Officer	R.I.13	1
2	Principal Research officer	R.I 12	1
3	Senior Research Officer	R.I.11	1
4	Research Officer I	R.I.10	6
5	Research Officer II	R.I.9	2
6	Technical officer I	R.I.9	1
7	Senior Technical assistants	R.I.8	7
8	Accountant II	R.I.9	1
9	Accounts Asst	R.I.8	1
10	Administrative Assistant	R.I.8	1
11	Senior Technical Asst	R.I.8	7
12	Supplies Officer III	R.I.8	1
13	Senior Clerical officer	R.I.7	6
14	Assistant House Keeper	R.I.7	1
15	Technical Asst	R.I.7	1
16	Secretarial Asst I	R.I.7	1
17	Clerical Officer	R.I.5	2
18	Telephone operator I	R.I.6	1
19	Telephone operator II	R.1.5	1
20	Driver III	R.I.4	1
21	Driver II	R.I.5	2
22	Driver I	R.I.6	1
23	Senior Driver	R.I.7	1
24	Principal supervisor	R.I 5	2
25	Senior Auxiliary staff	R.I.4	2
26	Auxiliary staff I	R.I.3	12
27	Auxiliary staff II	R.I.2	7
28	Security guard	R.I.2	1
29	Security guard I	R.I.1	1
30	Artisan III	R.I.6	2
31	Artisan I	R.I.4	1
32	Senior Lab Technologist I	R.I.11	1
33	Lab technologist III	R.I.7	1
34	Junior Lab Technologist	R.I.5	1
	Total		74

Staff Movement

a) Transfer in

There was no transfer.

b) Transfer out

There were no transfers' out.

c) Retirement

During the year, one officer transferred service to SEKU University and three Auxiliary staff retired.

d) New Appointments

The Centre Director was appointed Institute Director in an acting capacity.

Staff promotion

There was no promotions.

Capacity Building

Two scientists continued with their PhD training as shown in Tabl 50. Relevant support was accorded to them as appropriate.

Table 50: Details of staff on training

NO.	NAME	P/NO.	DESIGNATION	DEGREE PROGRAM
1.	B.K Korir	7107	ROI	PhD
2	E.C Kirwa	7295	ROI	PhD

6.2 Staff Welfare

a) The KARI Kiboko Welfare Association (KAKISWA)

KAKISWA performed commendably well during the year. The association provided financial support to staff members by advancing loans at a reasonable interest rate thus improving their living standards.

A farewell party was conducted at the Centre's Club House. During this event, members were urged to be active. Also members were advised to engage in income generating activities to aid them once they retire.

b) Centre Choir

The centre choir stopped training due to lack of a choir master. However, arrangements will be put in place to ensure that the choir resumes training.

c) Drinking Water

As previously reported water remains a major constraint especially for human consumption. The salinity is usually too high. There were no practical recommendations forthcoming. Lack of a pick up vehicle makes it impossible for portable water to be fetched from Kibwezi or Emali. The Centre Management is still committed towards providing soft water to staff. It is necessary to get a pick up for the purpose.

d) Health Facility

The Centre Dispensary was re-opened in August, 2011. The dispensary remained operational until May 2013.The facility was closed unprocedurally without even involving the centre management. The centre is following up the issue with the county Health Department to ensure the facility is re-opened.

e) Market access

The Centre has a minibus to ferry staff to Makindu and Kiboko markets. This assists staff to access fresh groceries and other social amenities with ease.

h) School

KARI Mwailu Boarding/Day Primary School performed well in local and National examinations. The mean score for the year 2014 KCPE results was **353.66** marks (Table 51). It is necessary to conduct a feasibility study to ascertain if a secondary school can be established. This will absorb pupils who perform so well in primary exams yet fail to secure good secondary school due to shortage in the region. It is important to note that the school has serious management problems which include; mismanagement of school resources by the head teacher.

Table 51: KARI Mwailu Primary School Students Performance Analysis in 2014 KCPE

No.	Marks out of 500	No of students
1	400	22
2	350-399	114
3	300-349	72
4	250-299	21
5	Below 250	3

6.3 Visitors to the Centre

During the year the Centre received 400 visitors among them, senior officers from KARI headquarters. Other groups who visited the centre included NGOs, CBOs, Universities, public schools and farmers.

7.0 LIBRARY SERVICES

Ruth Mwangi and Odanga A

The Centre Library is equipped with reading materials. The materials include annual reports, textbooks, periodicals, thesis reports, magazines, journals among others. Acquisition of journals via subscription was not undertaken during the year.

Deliberate effort was made during the year to catalogue the books. Also arrangements were made to ensure that the library is equipped with current Journals and publications. The facility also was used by students on attachment and visitors to gather information on different areas of their interests.

The library offered photocopying and printing services to scientist and other members of staff.

The Centre management acknowledges well-wishers greatly and requests them to continue supporting the library with the reading materials.

8.0 SUPPLIES AND STORES

By *James Nyaga Kinyua and Joseph M. Mbindyo*

8.1 Introduction
The Supplies section is charged with the responsibility of all procurements, storage and issuance of requirements (goods and services) when requested by user sections. The section was manned by one Supplies Officer, one Senior Clerical Officer and one Auxiliary Supervisor in the year 2014.

8.2 Review of activities undertaken during the year
Thirty nine sets of quotations were floated with orders for supply being awarded thereafter for supply of various goods and rendering of services. In all of the orders given, a Centre Procurement Committee was convened to award the contracts.

8.3 Purchases/ services
During the year under review various goods/services were acquired as follows:-

8.3.1 Spare parts/tyres
Spare parts and tyres for motor vehicles totalling Kshs 218,915.00 were procured for the Centre vehicles.

8.3.2 Hardware/maintenance
A total of Kshs 582,769.20 was spent on procurement of hardware materials for the Centre and Kshs 94,317.00 on materials for maintenance.

8.3.3 Drugs/Chemicals
The total purchases of veterinary drugs/ chemicals for livestock was Kshs. 580,820.00

8.3.4 Fuel and lubricants
A total of Kshs. 581,720.00 was spent on procurement of fuel/lubricants.

8.3.5 Stationery
Kshs.70376.00 was spent on purchase of stationery. We also received quite a number of stationery from H/quarters which were purchased under the ASAL–APRP funding the value of which cannot be exactly ascertained.

8.3.6 Grass seeds and tree seedlings
A total of Kshs. 225,380.00 was spent on grass seeds and tree seedlings.

8.3.7 Foodstuff for luncheons, visitors and staff meetings
A total of Kshs.549, 367.00 was spent on the above activities in the year.

8.3.9 Services
Payment for various services carried out on vehicles, machines and electrical wiring worth Kshs 422,454.59.00 were made.

8.4.0 Electricals
A total of Kshs 23,000.00 was spent on purchase of electrical items

8.4.1 Fertilizers
Kshs. 9,350.00 was spent on purchase of fertilizer.

9.0 LABORATORIES

Peter Mweki: Senior Laboratory Technologist

Introduction
The mandate of the laboratory section is to provide laboratory Technical Support Services to research activities at the centre. The mandate was upheld throughout the year, 2014. The section also participated in offering technical training services to students from various institutions of higher learning on their field training attachments.

9.1 Technical research support services
Different sample materials generated by various research projects were presented to the laboratory for analysis, testing, quantitative and qualitative determinations and diagnosis to provide technical scientific data for the centre research scientists. These samples were of forage, forage seed, blood and faecal samples as in the table 52 below;

Table 52: Samples received and handled in the laboratory

Code	Type of sample	Quantity	Type of analysis
1	Forage	190	Dry matter
2	Forage seed	151	Viability tests
3	Blood	20	Diagnosis
4	Faecal	96	Bio-reseeding
	Grand Total	**457**	

Technical training services
Students from various institutions of higher learning were trained in technical laboratory techniques during their technical field training attachments as presented in the table below:

Table 53: Students handled by the Laboratory staff

Code	Student Name(s)	Institution	Course	Duration of Field Attachment.
1	(2) Students: Mr.Moris Mutinda and Ms. Ndanu Musyoka	Egerton University	3rd year, Bsc. Agricultural Education and Extension	20th Feb.2014
2	(1) Student: Ms. Margaret M. Wanjiku	Kenyata University(KU)	BSc .Dryland Agriculture and Extension	6th March-10th March,2014
3	(1) Student: Ms. Caroline N. Mwango	Kenya Institute of Management	Diploma in Business Management	11th -13th August,2014

The Technical Research Support Services and Technical Training Services continued to be the two main laboratory activities in the year 2014. However the section continued to operate at a technically minimal level due to inadequate laboratory equipment. It was therefore hoped that with adequate laboratory equipment the laboratory activities would greatly be enhanced as well as the capacity, efficiency and quality of technical services offered in the laboratory.

10.0 TRANSPORT AND ESTATE MANAGEMENT

Odanga A. M

10.1 Introduction

The section handled a number of issues during the year under review as here-below itemized and whose details are given thereafter:
1) Transport
2) Water
3) Security

10.2 Transport

During the year the centre had 9 vehicles, 1 Tractor and 4 motor cycles out of which 3 were operational. It is worth noting that the cost of maintaining these vehicles is high and this can be attributed to their age in terms of number of years they have served upon procurement and mileage. To deal with this problem it is important to have a policy in place to deal with motor vehicle disposal based on their years of service or mileage whichever comes early. This will go a long way in saving cost of maintenance and enhance efficiency in research and coordination of centre activities.

Table 54. 1: List of motorcycles, tractor and vehicles at the Centre

REG. No.	Type	Remarks
KAN 910U	L/Rover 110 Dit TDI	Mobile
KAN 911U	L/Rover 110 Dit TDI	Mobile
KAL 638U	L/Rover 110 Dit TD_5	Grounded
KBQ 285D	N/Double Cabin	Mobile
KAJ 750S	Suzuki Grand Vitara	Grounded
KBQ 532	Tractor (New Holland)	Mobile
KAN 418U	Mistubish P/up	Grounded
KAD 289M	Suzuki Vitara	Grounded
KAN 339U	Yamaha (Motor cycle)	Mobile
KAN 350U	Yamaha	Grounded
KAJ 259S	Yamaha	Grounded
KAJ 721C	Honda	Grounded
KBW 016	Toyota Land Cruser	Mobile

Most of the vehicles are old and the cost of maintaintenace is high hence the need to replace them with new ones. This will go a long way in reducing the cost of maintenance and fuel consumption.

10.3 Estate Management

Most of the institutional houses are in deplorable state. The institute initiated programme for repairing the houses in phases with junior staff houses being given priority and most of them have been repaired, thanks to Director KARI for the financial support. This problem cuts across the board where the Kiboko water line pipes are old and often break down. This leads to waste of man-hours in terms of repairing the system. There is need to replace the entire system with new PVC pipes which are durable. It is important to note that despite the financial challenges, we were able to replace some of the broken pipes.

10.4 Water

Water remains a major challenge for human consumption because of the high salinity levels. Notwithstanding the piping system is old and breaks down regularly. The cost of repair is high. There is need for a total overhaul so as to reduce the cost of maintenance.

10.5 Security

During the year, the contracted security company did not deliver its services to the expectations of the centre management. A number of theft cases were reported. This was attributed to laxity on the side of the security personnel. Concerns have been raised in terms of competence of the security personnel deployed by the security firm. The latter lack relevant training that is necessary to perform their duties effectively. It is important for the security firm to be compelled to recruit personnel with relevant skills to enable them perform their duties effectively.

The Ranch was invaded by illegal grazers from various parts of the country majorly camel and cattle herders, posing a major challenge to the health of Centre livestock due to feed scarcity and diseases.