Fodder and Rangeland Good Practices in Eastern Africa
Table of Contents

Fodder Production, Utilization and Marketing Practices in Mixed Crop-Livestock Production Systems of the Highlands of Ethiopia
Mesfin Dejene, Ashebir T., Getnet A., Aemiro K. and Ameha S ............................................ 1

Fodder Production, Utilization and Marketing in High Potential Areas of Uganda
Juliet Sentumbwe ......................................................................................................................... 19

Fodder Production, Utilization and Marketing in High Potential Areas of Kenya
David Miano Mwangi .................................................................................................................. 35

Fodder Production, Utilization and Marketing in High Potential Areas of Rwanda
Ntegeyibizaza Samson, Twine Dacien ........................................................................................ 59

Fodder Production, Utilization and Marketing Practices in Mixed Crop-Livestock Production Systems in the Mid Altitude Areas of Ethiopia
Mesfin Dejene, Ashebir T., Getnet A., Aemiro K. and Ameha S ............................................ 67

Fodder production, utilization, marketing adoption in pastoral and agro-pastoral areas of Kenya
Donald M.G. Njarui ..................................................................................................................... 85

Rehabilitation of Degraded Pasture and Mainstreaming Livestock Nutrition into the Agro-Pastoral Field Schools In Karamoja, Uganda
Edward Okori, and James Robert Okoth .................................................................................. 123

Fodder Production and Marketing in Pastoral and Agro-Pastoral Areas of Kenya
Philip Kisoyan .......................................................................................................................... 137
Best Practices in Feed Management and Utilization in the Borena and Somali Rangelands of Ethiopia
Ashebir Tegegn, Mestin D., Getnet A., Aemiro K. and Ameha S. .......................................................... 145

Pastoral and Agro-Pastoral Systems in South Sudan
Daniel Pitta Tongun and Stanley Lado Severino .......................................................... 165

Best Practices in Fodder Production, Utilization and Marketing in Pastoral and Agro-Pastoral Areas in Kenya
J K Kiptarus, E.O. Esmall and F. Aloo ........................................................................ 169

Successful Practices in Range Improvement Adopted in the Karamoja Agro-Pastoral System of Uganda
Edward Okori ............................................................................................................. 177

Group Discussions and the Way Forward .......................................................... 187
Fodder Production, Utilization and Marketing Practices in Mixed Crop-Livestock Production Systems of the Highlands of Ethiopia

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Introduction

Agriculture is the main means of livelihood in Ethiopia and livestock contributes about 43.5% of the agricultural GDP (NABC, 2010). Livestock production systems in Ethiopia can be broadly categorized into mixed crop–livestock, pastoral and agro-pastoral, and urban and peri-urban production systems (Azage Tegegne, et al., 2010). Globally, mixed farming systems produce the largest share of the total milk (90%), meat (54%) and it is the main system of production for smallholder farmers in many developing countries (Sere and Steinfeld, 1996). The Ethiopian highlands comprises about 40% of the country's land area, inhabit nearly 90% of the human population and 70-75 % of the livestock population of the country (Mohamed-Saleem and Abate, 1995; Zinash et al., 2001) and hold about 95% of the cropped area (Zinash et al., 2001). They are characterized by predominantly subsistence smallholder crop-livestock mixed production system, in which they are interrelated and complementary. As an integral component of the overall farming systems, livestock husbandry is being practiced for food, fiber, draft power and cash income. Livestock provide: inputs (draft power, transport, and manure for crop production), saleable outputs (milk and milk products, meat, eggs, manure/dung and hides and skins) and has asset, security and investment functions in the farming systems. Despite the importance of livestock, the performance of the sector has been challenged with various constraints. The low quality and quantity of feed resources and seasonal fluctuations of feed resources form the greatest constraint to improving the productivity of livestock in sub Saharan Africa (Winrock International, 1992). In Ethiopia feed in the major challenge of livestock production, where natural pasture and crop
residues are the major sources of feed supply (Seyoum and Zinash, 1995; Zerihun, 2002). These feed resources are inadequate quantitatively and qualitatively to support reasonable livestock production (Mohamed-Saleem and Abate, 1995). In response to this challenge, national and international research institutions over the past decades have developed many fodder production, management and utilization technological options suitable for smallholder farmers to complement the available feed resources for livestock. But they have rarely been adopted by smallholder producers. Development projects have also introduced fodder banks and alternative cropping patterns to help introduce new fodder varieties (Alemayehu Mengistu, 1997) and feeding systems. Quite a number of useful forages have been recommended for the different agro-ecological zones and production systems although the adoption rate is extremely low. Currently, the contribution of improved cultivated fodder used as animal feed in Ethiopia was also reported very small (about 0.6%) (CSA, 2012). On the other hand, there are many available good practices related to improved fodder production and utilization that can be practical to promote its application in many similar areas in the sub region. However, the available best practices remain isolated in pockets and adopted by few farmers in central highlands of Ethiopia. This requires proper analysis and understanding of success factors and challenges of these best practices of fodder production and utilization. These best practices could be well adapted in many other areas with similar production and agro ecological conditions. The overall objective of this study was to assess the available best/good practices related to improved cultivated fodder production, utilization and marketing by smallholder farmers in the central highlands crop-livestock production system of Ethiopia. The specific objectives of the study were to investigate the detailed successful practices and challenges, identify appropriate approaches to scale up the technology to realize its potential and share this information for upscale these best/good practices to various partners in similar agro-ecologies and production systems in the sub region.

Methodology

Selection of study areas

The study was conducted in Girar Jarso and Tiyo districts in the central highlands of Ethiopia. The districts were selected using purposive
sampling technique and identified in consultation with resource persons (actors), key informants from ministry of agriculture and regional bureau of agriculture and from available secondary sources (published reports) related to the available best practices on improved fodder cultivation, utilization and marketing. Purposive sampling technique was also employed to select the specific villages within the district and farmers within the villages in consultation with key informants.

**Characteristics of the study areas**

Girar Jarso district is located in North Shewa zone, Oromiya regional state, about 115 km northwest of the capital, Addis Ababa while Tiyo district is located in northwestern central part of Arsi zone. Asella is the capital of the district and located at 175km from Addis Ababa. The biophysical and socioeconomic description of the study areas are presented in Table 1.

**Table 1. Characteristics of the study areas**

<table>
<thead>
<tr>
<th></th>
<th>Girar Jarso</th>
<th>Tiyo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of villages (Kebeles)</strong></td>
<td>21 (17 rural and 4 urban administrative units)</td>
<td>21 (18 rural and 3 urban administrative units)</td>
</tr>
<tr>
<td><strong>Production system</strong></td>
<td>Mixed crop-livestock</td>
<td>Mixed crop-livestock</td>
</tr>
<tr>
<td><strong>Major crops grown</strong></td>
<td>barley, wheat, sorghum, faba bean, and chick pea</td>
<td>wheat, barley, field pea, faba bean, teff and maize</td>
</tr>
<tr>
<td><strong>Livestock population during 2010/11</strong></td>
<td>60,039 cattle, 43,188 sheep, 7673 goats, 14870 donkeys, 2324 horses, 388 mules and 73,354 chickens.</td>
<td>82,122 cattle, 63, 508 sheep, 7,066 goats, 7,632 horses, 480 mules and 92,667 chickens</td>
</tr>
<tr>
<td><strong>Livestock potential</strong></td>
<td>Dairy</td>
<td>Dairy</td>
</tr>
<tr>
<td><strong>Altitude (m.a.s.l)</strong></td>
<td>1300 to 3400</td>
<td>1780 to 3500</td>
</tr>
<tr>
<td><strong>Rainfall (mm)</strong></td>
<td>850–1500</td>
<td>900–1100</td>
</tr>
<tr>
<td><strong>Population density (N/km²)</strong></td>
<td>203</td>
<td>121</td>
</tr>
<tr>
<td><strong>Livestock density (TLU/km²)</strong></td>
<td>135</td>
<td>118</td>
</tr>
<tr>
<td><strong>Livestock ownership (TLU/household)</strong></td>
<td>3.92</td>
<td>4.72</td>
</tr>
<tr>
<td><strong>Input and output market access</strong></td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Available best practices</strong></td>
<td>- Fodder oats and vetch production and utilization</td>
<td>Fodder oats, vetch and maize production and utilization</td>
</tr>
</tbody>
</table>

TLU – Tropical livestock unit, Source: The districts office of livestock development and health agency, 2012.
Data collection
Data was collected using rapid appraisal techniques including key informant interviews [producers, traders, consumers and agricultural experts and development agents (DAs)] and analysis of secondary data collected from the records/documents of governmental and non-governmental organizations. The first set of data was collected from purposively selected Kebeles and farmers (fodder producers) and/or traders and consumers, in the study area using rapid rural appraisal techniques highlighted by key informants of agricultural experts and development agents (Das). Pre-prepared checklists were used to query farmers on their fodder production/cultivation, conservation, utilization, and marketing practices, and fodder adoption decisions, seed supply issues, and other relevant topics. In addition, data generated through personal observations in field visits was also considered. Results were based on qualitative analysis of key informant interviews, and quantitative analysis of secondary and primary quantitative data.

Fodder production, conservation and utilization practices

Fodder types and production practices
The major improved forages grown by farmers are fodder oats (*Avena saliva*) (locally called *Shallo*) followed by vetch (*Vicia species*) in their farmlands either in pure stand and/or in mixture (Figure 1-a, b and d). Moreover, farmers also grow elephant grass (Figure 1-c), fodder beet in backyards and fodder trees such as tagasaste (Figure 1-e) and sesbania in homestead areas as fences. However, utilization of these fodder trees as fodder is very minimal. According to farmers and experts, almost all households in Girar Jarso district were cultivating fodder oats and used as fodder. Some farmers in Tiyo district also grow alfalfa and buffalo grass in their backyards. Hizikias Ketema, et al. (2012) pointed out that farmers grow fodder oats and vetch on their farm land while in the backyard the farmers mainly plant fodder beet, alfalfa, elephant grass, buffalo grass, tagasaste and sesbania.
Previous reports also indicated that herbaceous legumes (vetch species and alfalfa), fodder grasses (Oats and elephant grass) and fodder trees (tagasaste and sesbania species), and fodder beet were cultivated by the majority of the respondents in Tiyo district of Arsi zone (Mesfin et al., 2012). Moreover, farmers intentionally grow maize in their farmland for fodder mainly targeting for dairy. The maize was normally grown for human food but there is a shift of use as fodder for dairy in the district. For instance, in Gora Sillingo village it was said that up to 100% of the maize is currently primarily grown for fodder. Community in Gora Silingo village of Tiyo district also intercrop vetch with maize for fodder and over-sow vetch species on natural pasture to improve its productivity and quality. Farmers apply farmyard manure and fertilizer to improve fodder production.
The land size allocated for fodder oats and vetch production ranged from 400 m$^2$ to one hectare per household while the land size allocated for fodder maize production as a sole crop or intercrop with vetch species for fodder ranged from 500 m$^2$ to 1250 m$^2$ per household. Relatively less fertile and waterlogged areas are allotted for the production of fodder oats in Girar Jarso district but drained and good lands are used for production of vetch. The planting time of fodder oats practiced by most of the farmers in Girar Jarso district is either in April/may and/or June. Two harvests are possible from fodder oats in one season if the first harvest is made before the heading stage of the crop. If a planting time is in April/May, the first harvest will be made in June/July and the farmer allow the plot for re-growth and used either for hay production (in October) made from the second harvest or for seed production (in November). On the other hand, if a planting time is in June, green fodder oats will be available in early September. Planting of vetch is either in April/May like fodder oats or as a double/sequential crop in September after harvesting of a cereal crop mainly barley and vetch harvested in January and February for fodder and seed production respectively. According to farmers vetch production following barley have the advantage of producing quality forage for livestock and maintaining soil fertility for subsequent cereal cropping.

**Fodder conservation and utilization practices**

Every household that owns livestock conserves fodder. Storage practices differ according to the types of feed available. Crop residues from small cereals (either in pure forms or sometimes in mixtures) are stacked in heaps of conical or pyramidal forms commonly at homesteads (open air or shade) and in some cases in the fields (Figure 3). Forage produced from natural pasture and cultivated fodder oats are conserved as hay. These forages are harvested at the end of the rainy season where the forages reach to a stage of blooming. The natural grazing lands are protected from grazing by livestock starting from peak rainy period until the end of the rainy season for hay making. Fodder conservation as hay for use during the dry season is a common practice in most parts of the district. Conserving crop residues and hay under a shade in this areas is not most often practiced. The common practice is to pile near the farmers homestead in the open air and well protected from access to animals. The heaps are made normally in conical shapes, which help effective drainage of water during raining. The heaps in the field are also fenced to protect them from animals. As reported by farmers, a properly made heap
(compact and tilted slope from the top to the foot) can stay for several months with minimum quality deterioration. Some farmers in Tiyo district also practicing small scale silage making.

As reported by key informants, farmers and experts, farmers use high seed rate to enhance maize biomass growth and then harvested at milk stage of growth either directly feed to animals as cut and carry system or conserve as silage for future use during the dry season. Fodder oats also harvested before 10% heading stage and/or at 10 to 100% of the heading stage and used as a cut and carry system or conserve as hay or silage. Silage is made from maize fodder, elephant grass harvested at 1m height and fodder oats. Molasses and salt are included in the silage as additives.
Depending on season, lactation status and milk yield, cows were fed with crop residues, natural pasture/oats hay, silage and green grasses as basal diet and home-made concentrates mainly from mixtures of oat grain/wheat bran and oil seed cake as supplements. Depending on availability, the grains of oats, vetch and barley are used as ingredients of dairy rations. However, the amount and type of feed utilized varied from farm to farm and even within the individual farm from time to time (Lobago et al., 2006). Generally farmers manage their animals on grazing lands and supplement conserved feeds or green fodder over the different season of the year.

Table 2. Fodder utilization practices for dairy and fattening cattle

<table>
<thead>
<tr>
<th>Districts</th>
<th>Dry season</th>
<th>Wet Season</th>
</tr>
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<tbody>
<tr>
<td>Girar-Jarso</td>
<td>- Natural pasture/oats hay and either urea treated or untreated crop residues, fodder beet and elephant grass as a basal diet &lt;br&gt; - Home-made concentrate mixture composed of wheat bran/oats grain (roasted and ground), oil seed cake and salt as supplement. &lt;br&gt; - Molasses and vetch grain (roasted and grinded) also included in the concentrate mixture depending on the availability. &lt;br&gt; - Local brewery (<em>Tellia atella</em>) and Liquor (<em>Areqe atella</em>) also used as supplemental feeds</td>
<td>- Crop residues, green grass (green fodder oats and/or elephant grass), supplementing with homemade concentrate mixture &lt;br&gt; - The amount of concentrate mixture offered/cow/day usually adjusted according to the type of basal diet and season &lt;br&gt; - Vetch is also used as supplement to low quality basal diets</td>
</tr>
<tr>
<td>Tiyo</td>
<td>- Natural pasture and/or oats hay, crop residues and silage as a basal diet supplementing with concentrate mixture composed of wheat bran, oil seed cake and salt. &lt;br&gt; - If there is silage farmers do not use oilseed cakes in the concentrate mixture. &lt;br&gt; - Tagasaste, sesbania and alfalfa are also used as a supplement to low quality basal diets. &lt;br&gt; - Depending on availability, farmers also use agro-industrial byproducts</td>
<td>- Crop residues/hay, green fodder oats, elephant grass, maize fodder alone or maize-vetch mixture as a basal diet supplementing with concentrate mixture composed of wheat bran excluding oilseed cakes (reduced by half compared to the dry season feeding) and salt. &lt;br&gt; - Vetch and alfalfa are also used as supplement to low quality basal diets</td>
</tr>
</tbody>
</table>
The supply of agro-industrial by-products such as wheat bran, oilseed cakes and molasses over the seasons of the year are inconsistent, which is the major constraint for dairy and fattening operations in the area. Consequently, farmers use locally available feed ingredients like oats and vetch grains as a supplement for their livestock. Farmers use roasting and grinding of oats and vetch grains as a processing technique before mixing it with concentrate mix. Some farmers also use baking as bread of vetch and oats grain flour to feed their dairy and fattening animals, while boiling of oats grain is used for fattening animals. Green fodder oats is available from June to September and usually fed to lactating cows, calves and oxen as cut and carry system.

In the study area dairy production is more often practiced by farmers compared to fattening. Farmers are well aware that extensive grazing of milking cows and fattening animals reduce performance and hence they keep milking and fattening animals most often indoor and feed them by cut and carry or conserved feed. In general, dairy cows and fattening animals managed under indoor feeding, while oxen, local cows, small ruminants and equines are kept under grazing. The housing and the hygiene condition of dairy cows in the study area is relatively good (Figure 5).

Figure 5. Small holder dairy managed under stall feeding in the study area.

Most of the farmers practice two fattening cycle per year and two animals per fattening cycle targeting holiday markets such as Ethiopian Easter and Ethiopian New Year. Farmers in the study area reported that fattening activities during the rest of the season depend on the availability of feed reserve and the purchase price of animals to be fattened. Farmers
that kept enough feed reserve are the ones that fatten animals during the dry season.

**Marketing of fodder, forage seed, livestock and livestock products**

Marketing of fodder such as pasture field for hay making, loose hay and crop residues, green oats fodder (Figure 6) are a common practice in the study areas. Farmers with inadequate land and feed resources purchase natural pasture hay and crop residues from other farmers and friends. Crop residues such as wheat and/or barley straws sold in sacks, donkey loads or heaps. If there is no short rainy (Belg) season, the demand of hay is very high and most of the farmers looking for buying natural pasture hay.

![Figure 6. Production and marketing of green fodder oats (Avena sativa) in tied bundles in the North Shewa (Selalle) areas](image)
According to farmers, price of hay is increasing time to time as a result of deteriorations and shrinkage of grazing land area. However, the price is relatively cheap during harvesting season. Hay is sold in situ at harvest or lease in plot for hay production, in human and donkey loads or heaps while green fodder oats sold in human and donkey loads (Figure 6). The lease price of a unit of land is usually less than the hay that would be bought in situ at harvest. According to farmers the price of fodder is relatively cheap during harvesting season but it is generally sharply increased over the last few years. Agro-industrial by-products such as wheat bran, oil seed cakes, molasses and barley germ (farmers near Assela malt factory), salt and home brewery by-products such as *Tella* and *Arege atellas*, also marketed in the area. However, the overall supplies of supplement feeds including agroindustrial byproducts is declining and make dairy a difficult agricultural investment for smallholders.

Most of the farmers practicing marketing of fodder seeds/planting materials in the study area. The major fodder seeds/planting materials marketed in the area are oats (Figure 7), elephant grass cuttings/root splits, fodder beet seeds (Figure 8), vetch and alfalfa seeds. Prices of seeds/planting materials were varied across the locations.

![Figure 7. Fodder seed of different oats (*Avena sativa*) varieties in open market, North Shewa (Selalle).](image)

In Girar Jarso district, the price of fodder oats seeds marketed in the study area ranged from 1.5 to 3.5 Birr/kg (1US = about 18 Ethiopian Birr) depending on season and sites. However, the study conducted in central highlands of Ethiopia indicated that, a kilo of fodder oats and a cutting of elephant grass sold with the price ranged from 2.0 to 5.0 Birr and from 0.15 to 0.25 Birr respectively. Vetch Species and fodder beet seeds were sold with price ranged from 5.4 to 6.0 Birr/kg and 100 to 150
Birr per kg respectively (Mesfin et al., 2012). In Tiyo district, some farmers sold alfalfa seed to the district office of livestock development and health agency and other farmers by an average price of 200 Birr/kg and to NGOs by 400 Birr/kg. According to Hizikias, et al. (2012), seeds of oats, vetch, fodder beet and alfalfa primarily used for own use for their next planting season and to expand their backyard forage development. They sell the remaining seeds to other farmers. But, in the case of the other types of forage seeds and seedlings such as tree legumes and grass species they give to other farmers free of payments.

Figure 8. Backyard fodder beet seed production for sale in North Shewa, Selalle

The dairy and fattening practices in the study area are market oriented. Farmers keep most often crossbred dairy cows and fatten local animals. According to the Girar Jarso district office of livestock development and health agency there were about five primary dairy cooperatives having a total of 577 (475 male and 102 female) members and one dairy union (Sellale farmers’ dairy Union) in the district. Moreover a total of 2780 (2580 male and 206 female) dairy farmers were not the member of the dairy cooperatives but were suppliers of milk for the dairy cooperatives during the study period. On average the supply of milk from one primary dairy cooperative was about 9500 liters per day.

Farmers sell their milk to dairy cooperatives. The farm get milk price around Sellale was increased from 3.50 in 2009 to 6.6 birr/liter in 2012. A Torban Ashe primary dairy cooperative collects all milks from the surrounding farmers and sells it to Sellale farmers’ dairy Union. The
current daily milk produced per household by the interviewed farmers in Torban Ashe kebele ranged from 15 liters to 35 liters. Of which 3 to 4 liters of milk used for home consumption while the rest for sale. Torban Ashe primary dairy cooperative collects milk from farmers at a price of 6.5 birr/liter and sell it to Sellale farmers’ dairy Union at 6.6 birr/liters (in 2012).

Private dairy farms such as Mamma, Sholla and Family dairy are also active in the study area in milk processing and marketing. However, there was a problem of milk marketing in Tiyo district because of lack of alternative markets to sell their milk. Only one private dairy enterprise called Saron dairy and dairy products enterprise has been collecting milk from farmers. Consequently, communities in Gora Sillingo kebele of Toyo district established a cooperative called Gora Fana milk marketing cooperative and one dairy farmer in Gora Sillingo kebele opened his own cafeteria in Assela town to sale his milk in the form of boiled milk and yoghurt. Milk demand was high in towns and it was sold up to 9 Birr/liter. However, communities in Gora Sillingo sell their milk to Gora Fana milk marketing cooperative with a price ranging from 5.5 to 6.25 Birr/liter in 2012. The milk price was increased from 4.0 to 4.5 birr/liter in 2009 to 5.5 to 6.25 Birr/liter in 2012.

Milk marketing is characterized by the high demand during non-fasting seasons (Orthodox Christians) and vice versa. The price of milk rises during non-fasting season due to the high demand and falls during fasting season. Milk production increases during the wet season due to availability of green fodder. Farmers fatten cattle as well as sheep for sell in the nearby markets. Fattening practice is done by most of the farmers once or twice a year targeting holiday markets. Farmers reported that they get market information informally from colleagues and neighbors.

**Inputs, stakeholder participation and support services**

Introduction of improved forages has been facilitated through a number of projects like Arsi Rural Development Unit (ARDU) (Hizikias Ketema, *et al.*, 2012), the Fourth National Livestock Development Project (FNLD), the Smallholder Dairy Development Project (SDDP) and the National Livestock Development Project (NLDP) using government nurseries for multiplication and seed production during the last three to four decades. Moreover, the central highlands of Ethiopia have been
benefited from the distribution of crossbred heifers (dairy stock distribution), co-operatives development, strengthening of AI service at field level and milk marketing and processing facilitated through these projects which resulted in increased sustainable smallholder dairy production (Ahimed et al., 2003). However, most of these projects were not very successful to address genetic improvement and the feed shortage/nutritional problem simultaneously.

Farmers reported that animal health and vaccination services are available at an affordable price and provided solely by government organizations. However, there is a critical shortage of humanpower for effective medication and vaccination services for livestock. Breeding was done either by artificial insemination (AI) or with a shared crossbred bull (Lobago, et al., 2007). Because of unavailability/shortage of semen and technicians, AI is not widely distributed. Consequently, farmers are using bull service from individuals. Payment for the bull service ranged from 40 to 100 Birr/service depending on the quality of the bull. This is also not available for every farmer. Discussions conducted at various levels showed that AI service provision is not well equipped with the required facilities and trained technicians to meet the ever increasing demand for AI service. Furthermore, the demand for crossbred cows/heifer is very high in central highlands of Ethiopia due to an interest to replace the local/low yielding animals with better producing breeds. For instance, crossbred and local cattle ownership per household of the interviewed farmers in Girar Jarso district ranged from 4 to 12 and 0 to 4 respectively. Whereas crossbred and local breeds of cattle ownership of the interviewed farmers in Gora Sillingo kebele of Tiyo district ranged from 07 to 32 and 0 to 2 per household respectively.

Agricultural development agents provide extension services such as periodical supervision and training. Provision of credit in the study areas was limited. Credit services were offered by Walqo credit Association in Girar Jarso district.

The major service providers are government institutions such as the district office of livestock development and health agency. They provide planting materials, vaccines, medicines, training, market information, AI services, crossbred cows and bulls, and other services related to livestock production. NGOs such as Land O’Lakes, SNV, and FAO has also been involved in provision of fodder seeds/planting materials for farmers in Girar Jarso and Tiyo districts (The list of NGOs is not exhaustive, only as
listed by experts and interviewed farmers). The team observed that in the district the role of the private sector to be very limited, despite its potential in service provision.

**Improved fodder production Impacts**

Farmers reported that the improved forage used in feeding dairy and fattening animals increased their income, reduced their feed cost due to the decrease in concentrate cost and ensured the year round feed availability. The good animal management practice reduced the disease problem. According to the interviewed farmer, milk production increased by about 20% while feed cost reduced by about 40%.

**Available good practices related to fodder production and utilization**

- The existence of market oriented fodder development practices linked to commercial dairy production

- The practice of forage production in integration with food crops like barley as multiple cropping or in rotation, which has also an advantage of soil fertility improvement practice of early sowing of oats to make two harvests (main and regrowth) made farmers to use as a cut and carry system (first harvest) and as conserved hay (regrowth) and encouraged practice of green fodder oats marketing.

- The practice of applying farmyard manure and or inorganic fertilizer for improved fodder production like elephant grass

- The practice of improving natural pasture through oversowing forage legumes such as vetch species on poor quality grazing pasture lands

- The practice of animal centered cropping system: planting maize and vetch either as a sole crop, or mixed crop (intercropped) targeting feed production for livestock.

- The practice of small scale silage making for dairy

- Promotion of keeping manageable and few but productive animals
The practice of processing of oats and vetch grains to feed for lactating and fattening animals

The practice of zero grazing system for lactating dairy cows and fattening animals.

References


Fodder Production, Utilization and Marketing in High Potential Areas of Uganda

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Introduction

Despite being dominated by smallholder farmers who own about 98% of the cattle herd and about 100% of the small ruminant and non-ruminant stock, livestock production has continued to grow at a rate of about 3% per annum in Uganda. This is mainly because of the increasing demand for animal protein in terms eggs, milk and meat at national, regional and international markets.

After many years of marginalization in prioritization and budget allocations, there is a new recognition across Uganda of the role of Livestock as an integral component of agricultural systems, a major source of protein and a source of income too. Indeed according to UBOS analysis of poverty trends using the UNHS 2005/06 time series data, it is apparent that households that include livestock in their enterprise mix tend to overcome poverty.

In Uganda, agriculture contributes 22.9% to National Gross Domestic Product (NGDP), livestock sub-sector contributes 7-9% to NGDP (MFPED, 2011/12) and 17-19% to agricultural GDP where dairy contributes 50% of Livestock GDP. Livestock is the major source of income for nearly 30% of the farming households.

According to the 2008 National Livestock census, 1.7 million households keep cattle. Cattle owned by pastoralists and communal grazers (majorly in the cattle corridor) produce 85% of all the milk in the country and 95% of the meat. The remaining 15% and 5% respectively; is produced by small scale and medium sized farms.

Productivity of the livestock industry is still very low. One of the major factors for this is poor quality of feeds exacerbated by lack of a properly
organized policy and regulatory framework to guide feed/fodder production, utilization and marketing.

**Animal feeds and fodder**

The national livestock herd and flock has continuously performed below potential due to inadequacies in feeding, poor genetics and vulnerability to diseases. Though, the later highly hinges on failures in the former.

Drought together with associated catastrophic disasters like floods have seriously undermined the per capita availability of forage and animal feed for the large livestock population in Uganda resulting in serious economic losses which may occur directly or indirectly. Conflict emanating from competition for resources including forage, water and replacement stock has resulted in serious loss of the active human labour force, cattle herds, property and incomes. Food insecurity, hunger and poverty is common among the affected communities and has been highly associated to failures of a number of development interventions implemented by government and developing partners.

In order to reverse the trend and provide a baseline for meaningful investment in the livestock sub-sector, strategic planning for long term massive forage and feed production in a sustainable manner is very important.

**Problems of feeds and fodder**

Studies show that Uganda is rich in feed resources that can profitably support the national flock/herd but limitations lie in:

1. Failure to apply sustainable natural resource use technologies.
2. Failure to have organized groups for easy management, supervision and monitoring of natural resources and the feed industry.
3. Failure to apply appropriate harnessing technologies; and specifically for dry season feeding.
4. Lack of appropriate infrastructure for production, storage, distribution and marketing of feeds:
Feed manufacturers lack appropriate infrastructure, machinery and expertise that can reliably bolster development of commercial feed production to meet market demands. Yet alternative technological development packages to facilitate household feed production are also lacking because of scarcity of professionals to provide relevant services. As a result, products on the market are limited, substandard and seasonal and this has frustrated many farmers who incur losses due to high costs of production, reduced productivity and stiltedness of stock/flock and death. This is further compounded by the fact that up to now there is no legal instrument to operationalise the Animal Feeds Policy, Standards or Guidelines to guide. Farmers’ frustration accrues into failure to appreciate the benefits of rearing highly productive livestock because they require high-grade feed, which is costly.

5. Lack of strategically established feed systems aimed at market orientation and profit realisation to trigger investment in the feed industry and livestock farming as a whole.

6. Currently, there is very low interest of “formal” private sector e.g. seed companies, in forage crops. This has lead to lack of forage seed, where it is available it is expensive and often it is not packed appropriately for small scale farmers.

7. Uganda also lacks feeding systems that promote integrated use of natural pastures, commercial feeds and crop residues/industrial by-products to facilitate supplementation, which would ensure:

   - Increased availability and supply of feed
   - Improved nutrition of livestock at low costs
   - Contribution of livestock to integrated farming

However, forages, conventional feed stuffs, industrial by-products and crop residues value chain in Uganda are poorly developed leading to qualitative and quantitative feed inadequacy and seasonality. These shortages are reflected in the below potential livestock outputs, surging animal productivity during dry seasons and the low incomes of the pastoral communities. Inadequate feed resources, especially the seasonal
variation in quality and quantity, are a key constraint to livestock production.

8. Napier grass (Pennisetum purpureum) provides over 80% of the fodder in intensive smallholder dairy farming systems in Uganda. However, Napier grass production is threatened by the emergence of Napier stunt disease causing serious economic loss in the smallholder dairy industry. Napier stunt disease (NSD) was first observed on farmers’ fields in central Uganda in 2001. It has now spread to over 75% of the districts in Uganda. Disease incidence is higher in lowlands than highlands.

**Fodder Production in high rain fed smallholder production systems**

**Characteristics of high rain fed areas**

In the high rain potential rain fed areas of Uganda (central, western and parts of eastern Uganda) rainfall distribution generally falls in two categories; high: Over 1 750 mm per annum - 4% of Uganda land area and moderate: 1 000 - 1 750 mm per annum 70% of Uganda land area. Rainfall distribution in Southern Uganda is bimodal, allowing two crops annually, and adequate grazing for livestock throughout the year. Around Lake Victoria the annual rainfall averages 1,200 – 1,500 mm, and is well distributed.

There are three main types of indigenous cattle in these areas, i.e. the Small East African short horned Zebu, Ankole longhorn and Karamajong. The main improved dairy breed types are purebred Friesian, Jersey, Guernsey, Ayrshire and their crosses mainly with the indigenous breeds. They are basically kept in either

- small-holder intensive systems where typical zero grazing farmers keep 1 to 3 dairy cows and a total herd of around 2 to 10 cattle at any one time on land holdings of less than 5 acres (2ha),
- medium-scale semi-intensive systems where farmers keep 10-50 cattle grazing on fenced paddocked land of 5-50 ha or
• Large-scale extensive operators where agro-pastoralists own more than 50 ha of land and keep more than 50 cattle.

The production systems are very different in many respects but share similar feed challenges at different scales. Whereas farmers in intensive systems use grade animals and invest heavily into feeding, buildings and equipment, farmers in extensive systems use local breeds and invest minimally.

The small holder livestock production systems majorly practice stall feeding. They sometimes plant pasture in plots or in rows integrated with other garden crops. Rarely they irrigate the pasture. Sometimes manure is spread on pasture/legume plots but they use inorganic manure rarely because it is expensive. Crop residues, weeds etc are collected and fed and/or conserved for feeding. On average, these households own about 2 ha each, and together account for up to 90% of the population.

In these systems, a wide range of unselected genera and species of forages exist but nutrient content and nutrient value of most feeds varies seasonally. In addition, dry matter (DM) intake of basal diets is usually inadequate therefore it is difficult to rationalize feeding based on stipulated standards. As a result feeding becomes very costly. They practice repeated use and recirculation of low-yielding seed varieties and inferior breeds of animals. There is high dependence on family labour which is mostly provided by woman. Often land tenure systems are insecure which have led to a contradictory situation in which acute land fragmentation exists side by side with large tracts of unutilized cultivable land.

There is a tendency of farmers to keep large herds of livestock, leading to overstocking and associated land degradation. Poor animal husbandry and high post harvest losses are also a common occurrence.

Most of the small commercial farmers keep cattle as the major livestock type and is majorly raised for milk production. Dairy production provides a unique development strategy as a source of livelihood for most small commercial farmers not only providing income through milk sales but also, milk for home consumption. Other important benefits include manure as an input to arable production and livestock as a reserve for cash for investment. Dairy production is mainly constrained by limited availability and access to high quality feeds especially during the dry
season. Cattle feeding is generally not well done with most farmers offering feed less than the minimum nutritional requirement of the animals and as a result milk production and off take is low.

**Fodder commonly produced in the high rain fed areas**

a) Fodder grasses: Napier, Guatemala, Giant setaria, Guinea grass, Rhodes grass, Kikuyu grass, Congo signal grass, Makarikari (Bambatsi) grass, Nandi setaria

b) Crop residues: Maize stover, stripped maize leaves, sorghum, barley, rice and wheat straws, bean and groundnut haulms, pigeon pea husks, banana leaves, peelings and pseudostems, sweet potato vines, vegetable wastes, sugarcane tops

c) Legumes: Lablab, Lucerne, Desmodium, Centro, Siratro

d) Industrial by-products: Maize germ, cotton seed and sunflower cakes, wheat and rice brans, molasses, brewer’s grain, pineapple waste, pyrethrum marc

e) Fodder trees and shrubs: Calliandra, Leucaena, Mulberry, Sesbania, Gliricidia, Flemingia, Trema

f) Conserved fodder: Hay, Silage

g) Weeds Black jack, Gallant soldier, Wandering Jew, Couch grass, Amaranthus

h) Other crops: Edible Canna, Russian Comfrey, Sugarcane.

**Fodder Utilization**

**Feed utilization for a stall fed animal in the rainy season**

Zero grazed animals are confined in stalls and fed mainly on Elephant grass as basal feed. Elephant grass has been the most promising and high yielding fodder giving dry matter yields that surpass most grasses. Dry
matter yield of elephant grass from different regions of the country ranges from 5 – 15 tonnes/ha/year with little or no fertilizer (dry matter yield depends on soil fertility, climate and management factors).

At farm level, a combination of DM yield from elephant grass and conserved DM intake (in the form of hay) can form the basis for extending the number of livestock that can be supported by available forage.

A cow of an average live weight of 470 kg and eats 2% to 5% of its body weight in dry matter. Translating that into as fed, it can eat 34 to 45kg of feed per day (this can be got from 100 kg of fresh elephant grass). Lactating dairy cows typically eat 50% more than a dry dairy cow. The fodder DM yields from a pure stand of elephant grass on 0.5 ha (1.25 acres) is 4,059.7 kg/ha/yr. This quantity of fodder would support one mature cow for about 131 days. Elephant grass intercropped with a legume on same area of 0.5 ha (1.25 acres) will give a yield of 4,945 kg/ha/yr to support one mature animal for 160 days.

The quantity of fodder available from 0.5 ha is not sufficient to support a mature lactating dairy cow throughout the year (a year is 365 days). The minimum acreage required to support a mature cow for a year is about 0.9 ha of intercropped elephant grass or 1.1 ha (about 3 acres) pure stand of well managed elephant grass.

Herbaceous legumes that can be intercropped with elephant grass to increases the dry matter yield and crude protein of the feed:

- Centro (*Centrosema pubescens*)
- Silverleaf Desmodium (*Desmodium uncinatum*)
- Greenleaf Desmodium (*Desmodium intortum*) and
- Stylo (*Stylosanthes guianensis*).

Fodder legumes that can be grown in alleys:

- Leucaena, (*Leucaena leucocephala*)
- Calliandra (*Calliandra calothyrsus*)
- Sesbania (*Sesbania sesban*) and
- Gliricidia (*Gliricidia sepium*).

The first harvest of Napier grass should be when it attains a height of 1-1.2 meters, which is usually 3 to 4 months after planting. At this stage
Napier grass has high quality and sufficient dry matter. Thereafter the grass should be harvested at intervals of six to eight weeks, when it attains the same height. Optimum feed production is reached 6 months after planting, when the grass reaches about 120 to 130 cm. It should be cut at 10-15 cm from the ground level. The cutting interval should be about 3 months.

A healthy one acre of elephant grass when properly supplemented with commercial concentrates could boost milk yield by about 50 percent (their widespread use is limited by the high cost) and should provide feed to sustain one productive cow for about 5 months.

Other possible sources of feed:

- 0.4 ha of maize crop-lablab mixture in addition to 0.5 ha of Napier grass fodder. The quantity (about 2,194.3 kg dry matter) of maize stover-lablab residues produced from 0.4 ha/yr could support a mature cow of about 450 kg and producing about 13 litres/day for about 247 days (about 8 months). A farmer with about 0.4 ha/yr of maize crop-lablab mixture in addition to either 0.5 ha of Napier grass-forage legume mixture or 0.5 ha of well managed pure stand of Napier grass fodder, will have sufficient fodder to feed a lactating dairy cow for about 412 and 382 days, respectively. For best possible stover and grain yield, lablab seed is introduced into existing maize field 21-35 days after the germination of maize seed or after the first weeding of the maize crop. The lablab seed is sown between maize rows.

- Rice straw is increasingly becoming an important crop by-product in Uganda. About 3.5 million tons of rice straw and 0.5 million tons of rice hulls are produced every year from the rice fields and rice milling process respectively. There is no practical use for these by-products, up till now, except for fuel. Rice straw has low crude protein content of about 5%.

- Lablab (*Dolichos purpureus*) could be grown in a pure stand and harvested to supplement the rice straw or elephant grass. The crude protein content of lablab is 14-19%. The dry matter yield/unit area is about 6,000 kg/ha. Cross bred cows weighing about 450 kg live weight on a basal diet of elephant grass fodder could be supplemented with 2-3 kg/cow/day of lablab hay.
• Calliandra (*Calliandra calothyrosus*). This is a fodder multi-purpose shrub with which reasonable animal production can be achieved if Calliandra is adopted as a supplement to poor quality basal diets or as a partial replacement of commercial concentrate feeds. The leaves are a good source of the vitamin carotene. Calliandra is generally used to improve the utilisation of low quality grasses or as a replacement for concentrate feeds. Three kg of calliandra leaf hay is equal to 1 kg/day of commercial concentrate feed and will provided a similar response in milk yield and butterfat. Five hundred plants of calliandra managed in a hedgerow, will provide enough leaf hay to supplement the diet of one dairy cow throughout the year.

• Nutrient feed blocks: This is an innovative approach for providing the necessary nutrients (protein, energy, vitamins and micro and macro minerals) to ruminants to supplement what is missing in poor quality forages and crop residues. The blocks consist of locally available agro-industrial by-products (maize, rice or wheat bran, cottonseed cake, mineral powder, molasses); conserved forages (grass and fodder tree/forage legume leaf hay) and farm waste (poultry litter and crop by-products). This is a convenient and inexpensive method of providing a range of supplementary nutrients, especially suitable for the commercial and peasantry animal husbandry. This strategy also reduces methane gas and clearly enhances environmental protection.

**Feed utilization in the dry season**

Farmers in the smallholder settings apply different methods of feed utilization in the dry season which are summarized in Table 1.

**Water utilization**

The ratio of drinking water to milk production is estimated at 3 - 5 litres of water per litre of milk. One kilogram of dry matter intake utilizes up to five litres of water. This means that high yielding cows need more than 150 litres of fresh water every day. This is dependent on feed intake, weather conditions, milk production, and stage of lactation. In hot or dry climates, this amount can even be higher. Water scarcity reduces milk production. A 40% reduction in water intake can cut milk production by
25%. However, even in urban and peri-urban settings where water may not be a big problem, water is not given ad-libitum to the livestock.

Table 1. Farmers coping strategies and their limitations during the dry season

<table>
<thead>
<tr>
<th>Farmers coping strategies</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commonly used strategies</td>
<td></td>
</tr>
<tr>
<td>Feeding of crop residues</td>
<td>Poor quality-low crude protein metabolisable energy and digestibility</td>
</tr>
<tr>
<td>Search for pasture e.g. harvesting grass or grazing along the road public lands</td>
<td>• Risk of picking up ticks from grazing public areas hence tickborne diseases &lt;br&gt; • Cattle use valuable energy walking at the expense of milk production</td>
</tr>
<tr>
<td>Purchase feed off-farm (natural grass, napier grass, hay, silage etc.)</td>
<td>• Feeds tend to be costly during the dry seasons &lt;br&gt; • May lack cash to purchase feeds</td>
</tr>
<tr>
<td>Rationing of feed depending on animal category and state</td>
<td>May lead to underfeeding hence reduced milk production</td>
</tr>
<tr>
<td>Frequent watering of cattle</td>
<td>Does not replace dry matter requirement</td>
</tr>
<tr>
<td>Rarely used strategies</td>
<td></td>
</tr>
<tr>
<td>Hiring grazing land</td>
<td>It involves additional production costs of hiring land</td>
</tr>
<tr>
<td>Feed more concentrates</td>
<td>Increases costs of production</td>
</tr>
<tr>
<td>Maintain local breeds</td>
<td>Low milk yields from local breeds</td>
</tr>
<tr>
<td>Feed mineral block before early morning graze</td>
<td>Increases costs of production</td>
</tr>
<tr>
<td>Selling off excess stock</td>
<td>• Low return on livestock sales i.e. cattle prices are usually low during this time</td>
</tr>
</tbody>
</table>

**Fodder Marketing**

There are poor and unreliable marketing systems for both agricultural inputs and outputs which demoralises farmers from investing in costly feeding. Very few farmers feed compounded dairy concentrate, feed ingredients or feed supplements to dairy cattle regularly. Farmers attribute low usage to the high cost of commercial feeds. As a result farmers say that use of concentrates increase their production cost. However, they usually invest in concentrate use during the dry season.
only when feeds are scarce. Wheat/maize bran and compounded dairy meal are available.

Trading of fodder (selling and buying) occurs and is evolving; with Napier grass offered in two forms where farmers either offer cash or barter fodder for milk. Banana peels are often offered for sale to zero grazers as a supplement to Napier grass. Fodder is traded informally at village level i.e. market access is limited to buyers in immediate locality. There is lack of exposure of local markets/small holders to other markets/production systems.

There is growth of peri-urban livestock production that may create demand for feed/fodder. Due to land scarcity, demand for fodder is likely to increase. Farmers are likely to turn to marketing of fodder and residues for income generation. In fact, some farmers lease land for growing fodder.

There are hardly any dealers who produce silage for sale. A few farmers produce hay for sale, however, this is usually bought by large scale farmers who can afford it.

**Potential ‘best bet’ options for improving high quality feeds/fodder**

The foregoing sections highlight problems facing farmers and opportunities that require sustainable solutions that would lead to access to and/or increased production of high quality feeds/fodder. Feed demands are higher in intensive mixed crop-livestock farming systems than extensive grazing systems. The sustainability of livestock production is mainly a result of local resource availability and prevailing policies and institutions.

The options identified to address feed constraints include strategies to widen the feed resource base and increase acreages of fodder, promote feed conservation and utilize low quality crop residues. Other important non-technological options such as organizational/institutional and policy-level interventions are also highlighted. These include promoting and strengthening feed markets and forage seed systems, creating an enabling
policy environment and introducing the innovation systems approach to foster change.

**Technological interventions to address feed constraints**

Table 2 summarizes the possible technological interventions to address the identified problems facing farmers in feeding their livestock.

**Table 2. Possible technological interventions to address feed constraints**

<table>
<thead>
<tr>
<th>Description of ‘best bet’ intervention</th>
<th>Attributes of intervention</th>
</tr>
</thead>
</table>
| 1. Strategies to widen the feed resource base and increase fodder acreages on farms | A few fodder like Napier grass have been widely adopted but most have had very little adoption due to scarcity and cost of planting material. Other high yielding forage e.g. Bracharia spp. is being promoted to offset effect of Napier Stunt disease. This intervention requires
  - Increased forage seed production and market linkages to increase chances of adoption
  - Micro-sizing forage seed packages to enhance access by small scale farmers
  - Government policy explicitly promoting forage seed production and marketing |
| Fodder trees and shrubs such as Calliandra calothyrsus and Sesbania sesban also have potential | Have seen considerable adoption but with limited utilization
  - They are less affected by seasonal dry conditions due to their extensive root system, have long life spans, are rich in protein, are easy and cheap to harvest. They take up little land as they can be planted along boundaries. |
| There is scope for developing use of food-feed crops like sweet potato vines, maize sorghum, finger millet, cassava and barley. | Dual purpose crops have high adoption probability in intensifying systems |
| 2. Promote suitable small scale simple, practical and low cost forage conservation strategies: | |
| a. Box baling of maize stover | Reduces transport cost where crop residues
and other crop residues have to be moved over relatively long distances
- Helps in feed budgeting
- Requires labour of at least two people to bale hay

b. Silage making: tube, pile or pit silage.
Napier grass, green maize, sorghum, and sugarcane tops have shown considerable potential for wider application and adoption of ensilage methods

3. Strategies for utilizing low quality crop residues on farms

a. Storage and utilization
- Rapid removal of stover from the field after grain harvest
- Storage under cover, with some movement of air will allow completion of the drying process
- Chopping stover before feeding using a power driven chopper, a hand operated chaff cutter, a panga or a guillotine blade, There is scope for utilizing the large amounts of crop residues currently available and greatly under-utilized on farms in terms of livestock feeding, This strategy has potential to:
  - Reduce leaf loss and senescence hence maintaining quality.
  - Reduce the absorption of moisture during damp weather thus preventing or reducing the formation of mycotoxins
  - Increase digestibility and intake of fibrous residues.

b. Supplementation with nitrogen
Supplementing low quality cereal stovers/straws could provide maintenance requirements to the dairy cattle, especially during the dry season, when only low quality forages are available
The utilization of poor roughages can be increased by nitrogen supplement.

b. Mixing crop residues based on 'home made' rations
An opportunity exists for on-farm feed formulation using locally available feed ingredients
Farmers mix feed rations using locally available feed ingredients in any proportions and are often not aware of their quality and cost.

d. Urea treatment
Treatment procedure may vary according to circumstances
- Has potential for increasing digestibility and intake of fibrous residues
- Has been widely researched however, its uptake at farm level has been slow. Cost is often cited as the reason for this.
Non-technological options to address feed constraints

Strategies to promote fodder and feed markets

- Promoting cultivation of fodder for sale by individual fodder farmers
- Forming common interest groups of interested dairy and non-dairy farmers and leasing land from big farmers for growing fodder
- Facilitation of direct marketing arrangements where rural fodder producers are linked to urban dairy producers.
- Sourcing of feeds through hubs (and information about it) that could provide regular, consistent supply to allow transformation from subsistence to use of more external feed inputs
- Expansion of retail fodder market chains. In order to achieve this, identifying and supporting fodder farmers with technical knowledge and linking them to markets is important. With a reduced extension work force it will be necessary to focus efforts on farmers or groups of farmers who are receptive to change and willing to participate in the extension process.

Development of sustainable seed systems for forage

- Identify local seed vendors and provide them with training and support. Train fodder shrub seed vendors in seed collection, storage, packaging, and business skills and help link to buyers.
- Development of farmer-led seed multiplication systems at village and community levels.
Addressing policy issues

Livestock policy issue

- Sensitize relevant government agencies about need to regulate movement of vegetative planting material to control spread of fodder diseases e.g. *Napier Stunt disease*.

- Link farmers to feeds and feed services at milk marketing centre (hubs). Farmers should be able to acquire feeds on a check off system so that their feed costs are subtracted from their milk revenue.

- Advise policy makers to promote the use of new methods and approaches.

- Advise policy makers on the need for farmers to have secure land tenure in order that they invest in land improvements and on effective approaches’ for improving land tenure security.

- Urgently need to enhance high yielding fodder production programs to sustain the feeding systems; and introduce pasture improvement programs such as fencing and putting up farm structures to house livestock.

- Encourage formation of feed manufacturers associations who will be mandated to lobby and help governments in feed quality control.

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   *Dr. Jolly M.C. Kabirizi*
Fodder Production, Utilization and Marketing in High Potential Areas of Kenya

David Miano Mwangi

Kenya

Background

Agriculture is the mainstay of Kenya’s national economy; it provides the basis for the development of the other sectors. Its direct contribution to GDP is 26% while a further 27% contribution is indirect through linkages with agro-based and associated industries.

Overall, the agricultural sector employs over 80% of the total labour force, generates 60% of foreign exchange earnings, and provides 75% of industrial raw materials and 57% of the national income. About 80% of Kenya’s population lives in the rural areas where three quarters engage in agricultural activities. The sector is dominated by smallholders who account for approximately 75% of the total output absorbing over 50% of the labour force. Growth in the agricultural sector is closely linked to the overall economic growth in Kenya and a growth of 1% in the sector results in a 1.6% growth in the Gross Domestic Product (GDP). The livestock sub-sector contributes over 30% of the farm gate value of agricultural commodities, about 10% of the national GDP, and at least 50% of the agricultural GDP. The sector employs about 50% of the agricultural labour force. Domestic livestock also supply the local requirements of meat, milk, dairy products and other livestock products while accounting for about 30% of the total marketed agricultural products.

The estimated livestock population consists of 13.5 million cattle (10m zebu and 3.5m exotic and crosses), 10 million sheep, 14.5 million goats, 1.1 million camels, 800,000 donkeys, 29.6 million chicken (24.3 m indigenous, 4.5 m exotic, 800,000 others), 330,000 pigs and 454,000 rabbits (MoLD, 2008). Others include bees, ostrich (19000) and crocodiles.
Livestock farming is practiced in both high rainfall areas and in the arid and semi-arid lands (ASALs). Kenyan pastoralists and agro-pastoralists own 50% of the national cattle and small ruminant herd and 100% of the camel population. The high rainfall areas constitute about 15% of the land mass while the ASALs form at least 80% of Kenya. However, only 30% of the high and medium rainfall areas of Kenya are used for livestock production, whereas, the bulk of the ASALs are devoted to livestock farming. ASALs support over 30% of the total human population.

**Objective of the study**

The main objective of this case study is to document best practices followed in fodder and pasture production and utilization in the highland areas in Kenya.

**Methodology of the study**

The following approach and tools were used in the study:

- A detailed review of the key documents relevant to this work in possession of FAO, Kenya Agricultural Research Institute (KARI) and the Ministry of Livestock Development (MoLD) whose primary objective is the promotion of pasture and fodder production and utilization. Policy documents that are related to the production of pasture and fodder seeds are also reviewed.

- Meetings for consultation with key staff in FAO, KARI and MoLD.

- Meetings with key informants (practicing farmers) representing smallholder intensive crop/livestock farmers, large scale hay producers and medium scale mixed farms.

**Characteristics of highlands in Kenya**

**Characteristics of the Livestock Production in Kenya**

Cattle production is a major component of the livestock production system and it is estimated that about 3.5 million improved dairy cattle are
kept in the highland areas. The five cattle production systems in Kenya are:

- Large scale dairy cattle production system
- Smallholder dairy cattle production system
- Small scale dairy-meat production system
- Pastoralism dairy – meat system
- Large scale commercial ranching

Large scale dairy production system: Approximately 500,000 dairy cattle mainly Friesian and Ayrshire are kept in the humid and sub-humid highlands. This production system emphasis high production per milking animal and lactation yields are at least 5000 kg/cow/year and a calving rate of at least 90%. This system is mainly found in the Rift Valley and Coast provinces and to a lesser extent in central Kenya.

Smallholder dairy cattle production system: Small-scale dairy farming activity is mostly found in ago-climatic zone (ACZ) 1-4 in the Central and Rift Valley provinces and the Coastal lowlands. The system is the major enterprise in the highlands in Kenya. Small-scale dairy farmers typically keep 2 or 3 dairy cows, with their followers, on approximately one hectare of land, whilst they also engage in arable agriculture. There is a higher concentration of smallholder dairy farms in peri-urban areas with easy access to milk marketing channels. These areas have high urban populations or are near major milk consumption centers and therefore, the price of milk is usually higher than other areas.

In Nairobi, farm gate price of milk is KES 40-45 (USD 0.47- 0.52) per litre compared to KES 30-35 (USD 0.35 – 0.41) in Naivahsa area. The herd size is between 2 – 10 animals and the land holdings are between 0.9ha – 2 ha per household (Gitau et al, 1994). It is estimated that 80% of all the marketed milk in Kenya is from smallholder dairy farms (DANIDA/MoLD, 1991; Mbogoh, 1984) and approximately 80% of the dairy.

The smallholder dairy system is mainly constrained by the lack of year round feeds in terms of quantity and quality. This is more pronounced in
urban and peri-urban dairy farms in Nairobi, Kiambu, Thika, Murang’a, Nyeri, Nyandarua, Nakuru, Uashi Gishu, Kitale and Machakos districts.

Characteristics of the highlands

The study was conducted in Central, Eastern Kenya and the Rift Valley provinces in Kenya. Although many areas were visited, the case studies presented in this report are from Kiambu, Murang’a, Mwea East, Naivasha, Nyandarua West, and Nakuru areas. The characteristics of these areas are given below:

Characteristics of Mwea East

The area is classified as Lower midland 4 (LM4) or a marginal cotton zone with a short to very short cropping season (Jaetzold and Schmidt 1983). Mwea East has a bi-modal rainfall pattern with the long rains between March – June and the short rains between October– December. Annual rainfall is 800-850 mm and the altitude is 1,220 – 1,340 with an annual temperature of 22.0-21.2°C.

Soils and topography

The soils are heavy and poorly drained Vertisols (black cotton) soils of moderate to high fertility.

Social economic characteristics and or farming systems

The long rains have fair yield potential for short season lowland maize (Katunani composite), beans and chick peas. The short rains are suitable for sorghum, sunflower and pigeon peas. The pasture is mixed medium grass savanna grass dominated by *Themenda triandra* (red oats). Carrying capacity is 1 Livestock unit on 1.2-3 ha.

This area was mainly a dry season grazing area until Mwea irrigation was established and paddy rice production introduced. Currently apart from rice, tomatoes, water melons, baby and sweet corn are produced. Zebu cattle are the main livestock found in the area but improved dairy animals have been introduced to address the high demand for milk in the area. The animals are confined in zero-grazing units and fodder crops including Napier grass and maize are feed. Rice straw is fast becoming an
important feed resource and entrepreneurs are starting to bail and sell the
material which was previously burnt or ploughed back into the paddy
fields.

Characteristics of Nyandarua West

Climate

The area is classified as upper midland 2 (UM2) or the Pyrethrum -
Wheat zone (Jaetzold and Schmidt 1983). Has a bi-modal rainfall pattern
with the long rains between March – June and the short rains between
October – December with a long growing season. Annual rainfall is
1,000 – 1,200 mm and the altitude is 2,400 – 3,000 m Asal with an
annual temperature of 14.7 -10.0°C.

Soils and topography

The soils well drained very deep, dark reddish brown to very dark grayish
brown, friable and slightly smeary clay with humic topsoil (ando-luvic
Phaeozems). The soils are highly fertile subject to local variations.

Fodder Production on Smallholder Dairy
Farms in Kenya

Due to the small land holdings smallholder farmers have moved to more
intensive production systems especially in Central Kenya, parts of
Eastern Rift Valley and Western Kenya. These systems include zero-
grazing where the dairy animal is confined and high yielding fodder
crops are cut and carried to the animal. The main fodder crop grown in
this production system in Napier grass (*Pennisetum purpureum*) or
elephant grass, maize, oats and vetch among others.

CASE1: Napier Grass (*Pennisetum purpureum*)
Based fodder systems

Sole Napier grass production and utilization

Napier grass supplies more than 50% of the roughage requirement on
these small scale farms. In central Kenya, Napier grass is grown by over
80% of the farmers. Approximately 240,000 ha or 4% of total arable land
on smallholder farms is under fodder crops mainly Napier grass. Napier grass is grown in pure stands and on average at least 0.2 ha is planted with Napier grass. Napier grass has a high yield potential and yields of 80 t DM per ha per year have been reported with high levels of fertilizer application and supplementary irrigation. In Kenya yield of between 10-27 t DM per ha per year has been reported.

**Napier grass establishment**

Napier grass is usually propagated using stem cuttings or root splits as true seed is difficult to produce and difficult to propagate. Cuttings with at least 3 nodes are usually planted at the onset of rains. The cuttings are planted and an angle of 45° with at least 2 nodes under the soil and 1 node above the soil. Canes are preferred as they are easy to prepare and plant but take longer than root splits to establish. If establishing from root splits (root and shoot), the splits are dug up from an existing Napier grass stand and planted at the onset of rains.

Napier grass is produced mainly under rain fed conditions and therefore, the spacing depends on the amount of rainfall in the area. In areas receiving more 1,000 mm of rainfall per year an intra-row and inter-row spacing of 1 m and 0.5 m respectively is recommended, this spacing gives approximately 15,000 stools per ha. In areas receiving between 600–1,000 mm the recommended spacing is 1 m by 1 m giving approximately 10,000 stool per ha. Whereas, in areas with more than 1,200 mm of rainfall a spacing of 0.5m x 0.5 m is used giving approximately 20,000 stools per ha.

The Napier grass stand needs to be kept weed free during the establishment period of about 6 months after which it will cover the ground and smoother any weeds. After every cutting/harvesting the Napier grass plot is weeded and manure or chemical fertilizer applied.

**Napier grass planting methods**

Two methods are used by farmers to plant Napier grass i.e. conventional method and the “Tumbikiza method”

i.) Conventional planting method:

- Dig holes 15-20 cm wide and 15-20 cm deep
- Add 2-3 handfuls of farm yard manure or about 10 tonnes per ha
- Plant a cane with 3 nodes – 2 under the soil and 1 above the soil
- Plant the cane at an angle of $45^\circ$ or root splits are planted

ii.) “Tumbukiza” method:
- Dig pits $60\text{cm} \times 60 \text{cm} \times 60 \text{cm}$ – the pits can be round or rectangular
- Put the top soil on one side and the subsoil on another
- Add at least $10 - 20 \text{ kg of farm yard manure per pit}$ and mix with top soil
- Plant 5-10 canes leaving the top $15 \text{ cm}$ of the pit to collect water

The “Tumbukiza” system produces 20% more DM than the conventional method and the difference in yield is higher in areas with low rainfall. The amount of labour required during planting is much more with “Tumbikiza” but considering the plot could be used for 5-10 years compared to the conventional method where the yield decline to the extent that after 3-4 years the farmer has to replant, “Tumbukiza” is therefore a more attractive method.

Farmers rarely use chemical fertilizer when planting Napier grass but most will apply manure. Manure is usually applied in the planting hole at a rate of 10-15kg of manure in the planting hole giving approximately 10 tonnes of manure per ha. A few farmers use ammonium phosphate (DAP) fertilizer to give $100\text{Kg N per ha}$ and 60 kg $P_2O_5$.

**Harvesting and feeding Napier grass**

After planting the stand is not harvested for at least 3 months after which the harvesting frequency is determined by moisture availability. To maximize on the quality and quantity, Napier is harvested every 6-8 weeks or when it is a meter tall. At this stage the crude protein content will be about 12% but much higher if harvested earlier. After harvesting Napier grass is usually chopped and feed as green chop to dairy cattle. After every harvest the plot is weeded and manure or slurry added in furrows between the Napier grass rows. The manure is applied at a rate of 5-10 tonnes per ha and CAN can be used at a rate of 60-90 kg N per ha or 5-8 bags of CAN per ha.
Napier grass / legume intercrops

Napier grass is intercropped with herbaceous legumes like *Desmodium intortum* or *D. uncinatum*. As Napier grass is aggressive and smothers the legume especially during the establishment stage, the spacing for Napier grass is increased from 1 to 2 m inter-row and the legume is then drilled in shallow furrows between the Napier grass rows at a rate of 5 Kg of seed per ha. The legume seed has to be inoculated with the appropriate rhizobia at planting otherwise it might not fix nitrogen. A phosphatic fertilizer like triple or single super phosphate is applied when planting the legumes as phosphorus is essential in biological nitrogen fixation. Farm yard manure is applied where chemical fertilizer is not available or farmers cannot afford it.

In Nyandarua, farmers are intercropping Napier grass with vetch and some with sweet lupin (Figure 2). As this area is prone to severe frost in the months of January to April, farmers tend to have only about 20% of their DM requirement from Napier grass and oat/vetch intercrops are grown. The other source of feed is fodder maize.

Legumes benefit the intercrop through biological nitrogen fixation and increase the amount of nitrogen harvested per unit area of land. In a Napier/*Desmodium intortum* in central Kenya the legume fixed up to 72 kg N per ha per year and produced over 3 tonnes DM per year in addition to the 24.5 tonnes produced by the grass.

![Figure 1. Napier grass intercropped with *Desmosium intortum* in Mwea, Kenya](image-url)
Figure 2. Napier intercropped with purple vetch in Nyandarua, Kenya

Figure 3. Manure application on Napier grass in Mwea, Kenya

Figure 4. Slurry collection in Mwea, Kenya
Small scale irrigated fodder (Napier grass) in Kenya

Irrigation of fodder crops on smallholder dairy farmers is not a common practice but in situations where the farmers want to grow Napier grass in areas receiving less than 600 mm per year and with a long dry season then supplemental irrigation is necessary. While under rain fed conditions the farmer will be able to harvest Napier grass 3-4 times in a year, this can be increased to up to 7 times with supplemental irrigation.

Overhead and flood/basin are the two systems used to irrigate fodder crops in Kenya. Flood/basin irrigation was the method considered in this case study. The farm is found in Mwea East and belongs to Geoffrey Wanderi.

Establishment and Management of Napier grass

This is a 1.25 acre (0.51 Ha) but on this land the farmer has built a zero grazing unit and accommodation for his workers. Leaving only about 1 acre (0.4 ha) for fodder production. Yet from this area of land he produces more than 50% of the roughage required for his 9 dairy cows! This is made possible through irrigation of the pasture and a very elaborate soil fertility management.

Napier grass (*Pennisetum purpureum*) is the main fodder crop on the farm but a small portion is planted with giant Sateria (*Sateria specilata*) and *Desmodium intortum* (Greenleaf desmodium). The Napier grass is planted at a spacing of 1 m between rows and 0.5m between stools. Irrigation furrows are prepared between the rows through which the fodder crop is irrigated once a week by flooding. The Napier grass is harvested every 6 weeks at a height of 1m. The Napier is cut so as to leave a stable of about 2 cm. After harvesting, manure and slurry is applied to the Napier grass.

Napier planting material

Napier grass is established from vegetative material (root splits or canes). Planting material for improved varieties is available from research stations and Agricultural Training centres (former Farmer training centres). KARI centres are selling Napier grass planting canes at a price of KSh. 1,500 (USD 17.9) for a stack of 1 m x 1 m x 1 m. This material is enough to plant an area of approximately ½ ha.
The Kakamega 1 and Kakamega 2 varieties are resistant to Napier headsmut disease which is a major challenge in Central Kenya and parts of the Rift Valley in Kenya.

**Push-pull fodder production system**

The Push-pull is a habit management system developed by ICIPE (International Center of Insect Physiology and Ecology) to control stem borer, moth in maize. In the push-pull system, *Desmodium intortum* (Greenleaf) or *D. unicinatum* is planted between maize rows and Napier grass is planted around the perimeter of the maize plot (see Figure 5). Desmodium produces chemicals that repel the stem borer moth out of the maize plot (push) and the Napier grass (pull) attracts the moths to lay eggs in it. In Napier grass only about 2% of all the eggs develop into the larval stage of the moth hence reducing the damage caused by this maize pest. In Githunguri and Murang’a areas in central Kenya this system has became a very important source of fodder for dairy animals while protecting the maize crop from the stem borer.

![Figure 5: Push-pull system in Central Kenya](image-url)
Mr. James Mungai, a dairy farmer in Murang'a area, says this about the push-pull system. "In our area milk production is very important as the price of milk is good and most farmers therefore keep dairy cattle but one major problem that we face is the lack of adequate feed for our cows. I therefore, value the push pull system a lot because apart from protecting my maize crop from pests, it provides me with very good quality fodder for my dairy animals in terms of Napier grass and desmodium."

**Components of the smallholder Napier production system**

- The lucrative smallholder dairy production coupled with small land holdings are the key drivers for the adoption of fodder.

- High yielding fodder crop – elephant (Napier) grass is high yielding and is therefore suitable for the smallholder dairy farmers.

- Nutrient cycling is a major component of the system. Manure and slurry are applied to Napier grass at planting and after every harvest.

- Biogas – a few of the farmers also produce biogas from the manure. Manure from 2 dairy cows can produce enough biogas for the energy needs of a family of 6 members. This reduces the need to cut trees for firewood. Kenya has embarked on the promotion of biogas systems including low cost polythene tube digester.

- Legume intercropping – legume seed is a major component of this system.

**Adoption of Napier grass based fodder systems**

The adoption of Napier grass and the other technologies that go with it has been phenomenal in Kenya. It is estimated that over 4% or 240,000 ha of the land in central Kenya is planted to Napier grass. The adoption of Napier grass is also growing in Western Kenya mainly as part of the
push-pull system. The high adoption rate can be attributed to the following factors;

1. It is easy to plant Napier grass from root splits or cane
2. Planting material can be acquired from a neighbor or bought from research centres
3. A lucrative dairy enterprise that depends on fodder

**Crop-Livestock Integrated Fodder Systems**

Several systems that integrate crop and livestock systems have developed in central Kenya. These systems are based on maize production systems. Maize is a staple crop in Kenya and food security is synonymous to having enough maize grain. Therefore, even on smallholder dairy farms, the farmer will always grow some maize. In the main smallholder dairy areas in central Kenya, parts of the Rift Valley and Embu in Eastern Kenya, the maize crop supplies about 26% of the DM requirement of dairy cattle. This is in the form of poor quality maize stover, which can not support maintenance of the dairy cow, let alone milk production. A number of maize production systems have been developed to enhance the quality of livestock feed coming from the maize crop;

**Case 2: Maize for food and fodder**

In this system, though the farmer is interested in good quality fodder for the dairy cattle, it is also interested in harvesting maize grain. However, in some cases green maize is grown for the fresh produce especially in Nairobi. The systems include leave stripping and/or topping, dense planting followed by thinning.

In leave stripping, a farmer plants maize at 75cm x 30 cm with two plants per hill or 75 cm x 15cm with one plant per hill. The recommended fertilizer rate is used and all the agronomic practices are followed. The crop is allowed to grow until silking. After silking, a leave is stripped from each plant per day leaving the leave that suspends the cob and the one above it. After fertilization the maize part above the cob can be cut (topping) the resulting forage is feed to the dairy cows or calves. Striping will give approximately 1 tone of green leave material for feed and topping will increase the yield to about 1.5 tones per ha.
Case 3: High Density Maize Planting and Fodder Harvesting;

In this system the recommended planting of a maize crop is followed but more than two seeds are planted per hill. The number of seeds planted range from 3 to 4. The farmer then thins the maize (1 plant per hill) when it reaches knee height and the second just after the maize tassels. The remain two maize plants are then allowed to go to maturity and then can be harvested as dry maize grain or green maize for the fresh produce market. This system produces 3 – 4 tones DM per ha per season that can be feed to cows. The aim is to manage the maize crop in a way that will not compromise grain yield but get an extra benefit of forage maize that can be fed to cattle.

Case 4: Fodder Maize on Intensive Dairy Farms

In the Upper Midland 3 (UM3) in Nyandarua Napier grass does not do very well due to the low temperatures in these areas. Therefore, farmers around Ol Joro Orok in Nyandarua have adopted the maize crop as a fodder crop. The maize is planted at a spacing of 75 cm x 30 cm and maize varieties like the high altitude composite (HAC), which produces more forage than the other varieties, is preferred. The maize is harvested when the maize grain is at the soft dough stage and either feed as green chop or conserved as silage for use during periods of fodder shortage, which is mainly during the cold period between January and July. Farmers in other areas like Nakuru and Kitale where milk prices are high have also adopted this fodder production system.

Figure 6. Fodder Maize/ sweet lupin intercrop in Nyahururu, Kenya. The lupin is harvested as grain and feed
Case 5: Commercial Baby Corn and Fodder Production

In Mwea East district, irrigation is a major component of the production system. Although initially irrigation was meant for the production of paddy rice, horticulture production is taking root in the area. In addition
to paddy rice the area of Mwea is now producing tomatoes, green maize, French beans and baby corn. Livestock production especially milk production is now being initiated as the area is a milk deficit zone and milk is currently brought into the area from Embu, Meru and even Nyandarua. In an effort to tap into the good prices of KSh. 40 per litre of raw milk farmers are starting intensive dairy units. The feed for these animals is mainly by-products from horticultural production in the area. In this regard green maize and baby corn production are a major source of feed for the dairy cattle. Farmers producing these commodities also keep dairy cattle or sell the green maize stover to livestock owners. As this material is available in large quantities at once, the material is conserved as silage in polythene tubes (see fodder conservation section below).

Meet Mama Munene a baby com farmer in Mwea East – “I grow baby corn and since I have irrigation facilities in my 4 acre farm I have baby corn at different stages. Now I am harvesting from a ½ plot and have another plot that will be ready for harvesting in a month time and I have just prepared another ½ acre where I will be harvesting next week. This gives me an income throughout the year like today I will earn about KSh. 3,000 (USD 35.7) but also green stover for my cows. The manure I get is applied to the baby corn plots so the two systems depend on each other. I harvest the baby corn every week and get green material for my cows but when I have surplus I conserve it as silage in polythene tubes but sometimes I sell the material to other livestock keepers. Many farmers in this area are starting to keep dairy animals as the price of milk is good and there is plenty of feed from farmers growing green maize, sweet corn and baby corn. Currently the price of milk is between Ksh. 35 – 40 per litre and I am milking 3 animals giving me a total of 30 litres so in a day I earn about KSh. 1,000 (USD 12) in addition to the amount I get from baby corn. The animal manure help use maintain soil fertility in the baby corn plots so we do not have to use a lot of chemical fertilizers. I therefore, feel this is a good system and it is benefiting me and my family. My husband is not employed and therefore we depend on the farm to pay school fees, buy food and other items so we have to use the little land efficiently.”

Figure 9. Mama Munene in her baby corn field (insert baby corn ready for the market and tube silage)
Feed Conservation on Smallholder Dairy Farms in Kenya

Majority of the smallholder farmers in Kenya, produce their fodder under rain fed conditions. Therefore, feed is available during the growing season and hence the supply of milk follows a similar pattern. The country gets into milk gluts during the wet season when good quality fodder is available and milk deficits during the dry season. There have been major efforts by research institutions including KARI to develop and disseminate fodder conservation methods suitable for smallholder farmers. These technologies were geared towards making sure the farmer can conserve even small amounts of fodder when a surplus occurs. The main methods developed and being used by farmers during this study included tube/polythene bag silage, above ground silage, grass hay making and the drying and preservation of high value fodder crops like Lucerne and Desmodium.

Tube/polythene bag silage (Figure 10)

Tube/polythene bag silage allows a farmer to conserve small amounts of surplus feed available on smallholder farms. A farmer can conserve about 350 kg of Napier grass or maize forage in a bag 1 m wide x 1 m tall. The main advantage of tube silage is the farmer can conserve small amounts of surplus fodder available at different times of the year. This method uses a heavy duty polythene tube (1000 gauge) that can be easily procured from agro-vet shops or hardware shops around the country. The tube can be as long as the farmer wants but for ease of compacting the material and storage a height of not more than 1.5 m is recommended.

Figure 10: Tube silage on a smallholder farm in Kenya
Aboveground silo (Figure 11)

In this conservation method, a trench or pit is not dug but the material is conserved above ground. The main advantages of this method are:

1. The silo can be made in different parts of the farm
2. Labour for digging a trench or pit is avoided

![Figure 11: Above ground silage on a farm in Nakuru, Kenya](image)

Farmers also dry and store Lucerne and maize stover. The Lucerne is harvested at 50% flowering stage and chopped to a length of about 2cm and spread on polythene sheets and dried under shed for 2 to 3 days. Chopping reduces the time required for drying (Snijders et al 1992). The dry material is then stored in gunny bags and used when required especially in the dry season.

Large scale fodder production in the Highlands

In areas where land holdings are large especially in the Rift Valley and parts of Nyandarua and Laikipia farmers produce fodder. Some of these farms specialize in dairy production or just produce fodder for sale. In the recent past a fodder market has developed targeting mainly smallholder peri-urban and urban dairy producers who cannot produce enough fodder for their dairy animals and relays on forage bought in from off-farm.

The forage includes waste from horticultural crops, horticultural produce rejected during grading and sorting, Napier grass, Rhodes grass and
Lucerne hay. Large scale hay producers have therefore, emerged and are growing and selling Rhodes grass and Lucerne hay. The hay is produced in large scale farms around Naivasha, Nakuru, Eldoret, Kitale in the Rift Valley and Nyandarua in central Kenya and transported to consumption areas like Kiambu, Embu, Murang’a and Machakos.

Two of these large scale fodder production systems are detailed below:

**Case 6: Large-scale irrigated commercial lucerne hay production**

Lucerne is a high value legume crop that is preferred due to its high crude protein level and digestibility. It grows at an altitude of 1,000 – 3,000 m above sea level. Seeds of Hunter river, Hairy Peruvian and Cuf 101 Lucerne varieties are available in Kenya from Kenya Seed company and East African Seed company at a price of KSh. 3,000 (USD 35.7) per kilogramme of seed.

A number of large scale farms around Naivasha have specialised in the production and marketing of Lucerne hay. Marula Estates Limited and Dalemere Estates in Naivasha are good examples. Naivasha is a semi-arid area in the Rift Valley and Lucerne is thus grown under irrigation.

Marula Estates grows Lucerne using pivot irrigation. Currently the farm has 25 pivot irrigation units and is growing about 1,000 acres of Lucerne for hay production. Lucerne variety Cuf 101 is grown on the farm.

**Land Preparation, planting and weed control**

Lucerne is small seeded and requires a fine seed bed for planting, but before land preparation starts a non-selective herbicide is applied to kill all weeds. Then the land is ploughed and harrowed until a fine tilth is attained. Lucerne seeds are then drilled in rows 30 cm wide and at a rate of 5 Kg per hectare. At planting, 50 Kg TSP is applied per acre giving approximately (60 Kgs P₂O₅). After planting, a pre-emergency herbicide is applied to kill any weeds especially grasses that can be a major problem in Lucerne fields. In soils with a pH of 4.9 and below agricultural lime must be applied as Lucerne is sensitive to low soil pH. After germination the Lucerne is allowed to grow to a height of about 30 cm then the plot is cut with the aim of killing the annual weeds.
This is repeated for the first 2-3 months of growth until the Lucerne crop covers the ground and smoothens the weeds. Lucerne is harvested at 50% flowering, which translates to 5-6 weeks, using a side mower and dried in the field for 2-3 days, raked and then haled. The farm has realized that bailing the Lucerne during the hot part of the day results in the leaf shattering and is now bailing in the evening when it is cool to avoid this problem. The hay is sold to smallholder dairy farmers in Kiambu, Nakuru and Machakos at KSh. 350 per 18 kg bale compared to KSh. 200 per bale of grass hay of the same weight. Approximately 40-50 tonnes of Lucerne DM are produced per ha per year (approx 2500 bales) valued at KSh. 875,000. With about 200ha under Lucerne, Marula Estates is producing Lucerne valued at KSh. 175 million in a year.

Factors influencing adoption

Lucerne is a preferred fodder crop especially due to its high nutritive value and the growing demand of Lucerne hay by smallholder peri-urban and urban farmers is driving the production of Lucerne.

Constraint/ challenges of the system

The production of Lucerne requires not only irrigation infrastructure but also other heavy machinery and equipments. Large scale farms have invested heavily in equipment and irrigation infrastructure. Seed is expensive and is not always available as it is imported from South Africa and USA. Therefore, a farmer will not always get the variety of choice when they need it. Seed production in Kenya has been very poor as pollination is poor.

Potential for upscaling (include research)

The varieties available can only grow in a narrow ecological range and research work is currently on going to introduce varieties with a wider ecological adaptability. Four new varieties that will extend the agro-ecological adaptability are in the national performance trials and might be released for seed bulking in the next 1 year. Research work to improve local seed production from Lucerne is on-going.

Lucerne production on large scale has a limited scope in many high rainfall areas of Kenya mainly due to scarcity of land. However, many small-scale farmers have started growing Lucerne on their farms. The
potential of upscaling this is high but proper agronomic practices are necessary for successful Lucerne production. Liming is necessary in many areas of Kenya but manure application can also reduce the effects of soil pH not only with Lucerne but also with other legume crops (Mwangi, 1999).

Case 7: Large scale rain-fed oat/vetch production system in the cold highlands, Kenya

In the high altitude areas of Nyandarua (above 2,000 m asl, the choice of fodder crops to grow is limited as the area is prone to frost. Therefore, fodder crops like Napier grass, Rhodes grass and others are not suitable. In these areas temperate forage crops like oats and vetch are preferred. The area is classified as upper midland 3 (UM3) or the wheat-barley zone (Jaetzold and Schmidt 1983).

The area has good potential yield potential for wheat, barley and high altitude maize. Other crops grown include Irish potatoes, cabbage, rapeseed, oats and pyrethrum. Most of the area is owned by large to medium scale farms with smallholder farms in settlement schemes. The area is suitable for dairy, beef, wool and meat sheep production and the main breeds kept are Friesians, Ayrshire (cattle), Dorper, Merino, Hampshire down and Boran. Carrying capacity is 1 ha/LU. The pasture is dominated by rye grass, cocksfoot and tall fescue and can be improved by intercropping with subterranean and Kenya white clover for dairy cows.

Factors favouring adoption

This production system is favoured by the high demand for milk in Kenya and this enterprise is ranked high in the Nyandarua area. The demand for forage in other dairy areas is a major driver of adoption.

Constraint/challenges of the system

The narrow range of fodder crops that can grow in these high altitude areas and the impact of frost on the productivity of the available fodder crops are major constraints in this system. The system is highly mechanized and the high cost of machinery and fuel are major challenges to this system.
Potential for up scaling

The practice can be up-scaled in areas with similar agro-ecological and economic characteristics not only in Kenya but in other countries in the region. The production and marketing of seed needs to be improved to enable up-scaling of this system.

Seed production, distribution and marketing

Farmers can access fodder seed through several systems in Kenya. These include seed companies/agro-vet shops, farmer to farmer seed, research centres and agricultural training centre.

Formal seed distribution and marketing

Kenya has an elaborate seed production, distribution and marketing system. At least 10 seed companies are involved in the production and marketing of seeds in the country. Some of the companies have distribution systems not only in the country but also in the region (Figure 12). This distribution system is linked to agro-vet shops which improve the access to seeds as they are present in the local markets.

Out of the 10 companies only 3 deal with forage/fodder seed. The Kenya Seed Company, East African Seed Company and Agro-tech limited deal with the following fodder seeds; Lucerne (Medicago sativa), Rhodes grass (Chloris gayana), Sudan grass (Sorghum bicolour), Kikuyu grass (Pennisetum clandestinum) and Kow kandy (a hybrid between Sudan grass and sorghum). Therefore, the production of fodder seeds especially legume seeds, which are in short supply, needs to be improved. Several efforts have been going on in the area.

Farmer seed production and marketing

Several farmer groups have been trained to produce seed of different legumes and sell it among themselves. ICIPE and KARI have trained farmers to produce desmodium seeds for use in the push-pull system. These farmer groups then sell any surplus seeds to other groups. This system has made the seed available and enabled scaling up of the push-pull system.
Njabini vetch seed producers is producing vetch seeds and selling them throughout the country. This group has adopted the use of ICT technology to market their seed (see dissemination section)

![Map of seed distribution](image)

**Figure 12. Distribution of seed by Kenya Seed Company in the region**

**Research and Agricultural Training Centres**

The KARI research centres are major sources of seed and planting materials of a number of fodder crops. These include desmodium, forage sorghum and planting materials of Napier grass & sweet potato vines. The centres are major sources of improved Napier grass varieties like Kakamega 1 and Kakamega 2. The Agricultural training centres distributed all over the country are also sources of Napier grass planting
material. The Kenya Forestry Research Institute (KEFRI) is a major source of Callindra and Lueacena seeds.

**Dissemination of fodder technologies**

The adoption of the best fodder practices depends on the dissemination of information and the availability of other support structures including favorable policies that will facilitate the uptake of the technologies. Many dissemination efforts have been tried in Kenya by both public and private extension agents. These includes common interest group training, Farmers Field Schools and information communication technology (ICT) based dissemination.

**Acknowledgements**

The author acknowledges all the farmers who were ready to discuss their fodder practices. The Ministry of Livestock Development (MoLD) staff in Kiambu, Embu, Mwea West, Naivasha, Nyandarua West and Kitale gave information on the districts and assisted in identifying possible fodder best practices. The Kenya Agricultural Research Institute (KARI) staff in Embu, Muguga, Naivasha, Ol Joro Orrok and Kitale shared their research work on fodder work and assisted in identifying possible fodder best practices.

**References**


Fodder Production, Utilization and Marketing in High Potential Areas of Rwanda

Ntegeyibizaza Samson¹, Twine Dacien²

¹RAB Western Zone
²IAKIB Cooperative / Gicumbi District, Rwanda

Case of Pennisetum purpureum - French Cameroon variety

Macroeconomic consideration

Rwanda is a land-locked country situated between DRC (West), Burundi (South), Tanzania (East) and Uganda (North). The surface area is 26,338 sq. km with an estimated population of 11 million equivalents to 418 inhab/sq km. In some areas, this density can reach 1000 inhabitants.

National GDP is approximately 3 277 RWF billions. The annual per capita income is 540 U.S. dollars (2011). Agriculture is still the main source of foreign currency and livelihoods of people. The secondary sector consists essentially in manufacturing and building and contributes 15% of GDP, the tertiary sector is 47% of GDP.

Rwanda is classified among "low developed countries". But policies have been put in place to step up and alleviate poverty in the country. These are mainly: Vision 2020, MDG's (Millennium development goals) and EDPRS (Economic Development for Poverty Reduction Strategies). Subsequent strategies are also defined. In this context livestock occupies a good place for contributing to the development of the population welfare.

Physical characteristics

Rwanda can be divided in 10 agricultural regions with distinct ecological features (climate, fertility, acidity and slope). The climate is tropical with average temperature of 19 °C and rainfall annually ranges between 900 and 1600 mm. The country has a small rainy season from September to November and a long rainy season from February to May. The short dry
season is between December and January and the long dry season from June to mid September. Some parts of eastern country may suffer from prolonged drought affecting agricultural production and weakening the food security of population

Table 1. Description and weather conditions of regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Slope (%)</th>
<th>Altitude (m)</th>
<th>Rainfall (mm/year)</th>
<th>Temperature (°C)</th>
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<td>24</td>
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<td>1200-2000</td>
<td>19-22</td>
<td>West</td>
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<td>1150-1300</td>
<td>19-22</td>
<td>West</td>
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<td>1300-1600</td>
<td>12-18</td>
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<td>1900-2500</td>
<td>1300-2000</td>
<td>12-18</td>
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</tr>
<tr>
<td>Eastern savannas</td>
<td>2-50</td>
<td>1250-1600</td>
<td>&lt;900</td>
<td>21</td>
<td>East</td>
</tr>
</tbody>
</table>

Overview of Livestock production

Population

Rwanda has different animal species: cattle, goats, ovine, pigs, rabbits and poultry as shown on table 2

Table 2. Livestock population in the different regions of Rwanda

<table>
<thead>
<tr>
<th>Province</th>
<th>Cattle</th>
<th>Goats</th>
<th>Sheep</th>
<th>Swine</th>
<th>Chicken</th>
<th>Rabbit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOUTH</td>
<td>338,536</td>
<td>805,333</td>
<td>158,926</td>
<td>243,975</td>
<td>996,856</td>
<td>236,472</td>
</tr>
<tr>
<td>WEST</td>
<td>184,996</td>
<td>511,821</td>
<td>205,107</td>
<td>214,287</td>
<td>876,376</td>
<td>168,109</td>
</tr>
<tr>
<td>NORTH</td>
<td>215,306</td>
<td>408,899</td>
<td>194,369</td>
<td>142,416</td>
<td>732,137</td>
<td>275,270</td>
</tr>
<tr>
<td>KIGALI</td>
<td>46,418</td>
<td>130,211</td>
<td>8,252</td>
<td>13,153</td>
<td>454,231</td>
<td>20,239</td>
</tr>
<tr>
<td>EAST</td>
<td>358,297</td>
<td>676,013</td>
<td>64,206</td>
<td>102,798</td>
<td>830,674</td>
<td>128,712</td>
</tr>
<tr>
<td>Grand Total</td>
<td>1,143,553</td>
<td>2,532,277</td>
<td>630,860</td>
<td>716,629</td>
<td>3,890,274</td>
<td>828,802</td>
</tr>
</tbody>
</table>
Types of farming systems in Rwanda

Farms in dry area

The system is observed in the Eastern zone of the country bordering Uganda and Tanzania where dry season is sometimes prolonged. Average farm is 25 Ha/household. Forage is mainly Hyparenia, Chloris, Andropogon. Originally, the area is the land for local breed (Ankole) but with artificial insemination changes are being done with results of increased number of cross breeds.

Farms in wet farm

This system is used in Gishwati highlands area (North-western zone). It is a cold zone with pasture made of Kikuyu grass (Pennisetum clandestinum). Average farm is 5Ha/household. Composition of breed is pure or cross breed of Fresian, Jersey and Brown Swiss.

![Dairy cows in household farming](image)

Figure 1. Dairy cows in household farming

This is the main farming system of the country. Animals are kept at home in zero grazing or in a fenced small land near the house of the family.

Livestock policy related to animal production

By 2020, livestock would be able to provide nutrients required by FAO/WHO standard of 6 gr of proteins/person/day. Animal products needed will be therefore about 483.693 t of milk, 83.291 t of meat, 38.546 t of eggs, 17.362 t of fish and 11.063 t of honey.

To achieve these goals animal population will be 505,816 cattle, 1,872,346 caprine, 759,347 ovine, 433,644 porcine, 3,790,258...
poultry and 586,357 rabbit. Also, lakes will be well managed and 4,600 fish ponds operational. Modern beehives will be estimated at 150,000 additionally to traditional beehives. We note that cattle population will decrease in number but increased in milk productivity by transforming local breeds by Artificial insemination.

To operationalize this vision, some optional strategies have been defined. We mention the following examples:

- Cattle is strategically oriented to milk production, other species (monogatrics, small ruminants, poultry) are oriented to meat production.
- All animals have to be enclosed at the household. Therefore, zero grazing is mandatory, unless if animal are grazing in fenced farm.
- Milk production have been identified as the best tool to speed malnutrition and poverty reduction. Therefore a policy of having at least a dairy cow in every family has been designed. For these purpose, the Government started in 2006 a special program called “Girinka”/ one cow per poor family, to support poor families. Up today about 200,000 cows have been freely given to poor farmers.
- Development of livestock infrastructure: Milk Collection Centers (MCC’s) have been built across the country. More than 100 MCC’s are operational. These MCC’s supply dairy plants constructed in different milk basins.
- Four (4) pillars have been identified as key elements to promote animal production development:
  - Genetically improved breed
  - Good plan for diseases control
  - Good plan for animal nutrition
  - Promotion of farmers cooperatives

Although all these pillars are very important, nutrition comes at the top of requirements for improving production, particularly for milk. Fodder availability is therefore a key element for dairy cattle.
Combining all these strategies, milk production and consumption significantly increased (2.7 times) from 2006 as shown in the Table 3.

### Table 3: Milk production from 2006 to 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>Milk (tons)</th>
<th>Per capita consumption (Liters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>152511</td>
<td>20.7</td>
</tr>
<tr>
<td>2007</td>
<td>189827</td>
<td>23</td>
</tr>
<tr>
<td>2008</td>
<td>257480</td>
<td>25.7</td>
</tr>
<tr>
<td>2009</td>
<td>334727</td>
<td>33.5</td>
</tr>
<tr>
<td>2010</td>
<td>372619</td>
<td>37.3</td>
</tr>
<tr>
<td>2011</td>
<td>404704</td>
<td>39.6</td>
</tr>
</tbody>
</table>

**Fodder production, utilization and marketing**

**Challenges for fodder availability**

As mentioned above, Rwanda is a highly populated country. The average land for household is 0.5 Ha. In addition, animal are enclosed and every family is encouraged to rear a dairy cattle.

**Fodder production**

There are 2 types of fodder: grasses as source of energy and leguminous plants for proteins.

Several agrostological trials of plants species and their clones have been conducted for observing their behavior. In this regard, productivity, nutritional value, resistance to diseases, palatability, adaptability to different agroecological regions and the option of haymaking and/or silage have been tested. Main grasses found suitable in Rwanda are: *Pennisetum purpureum var French Cameroon* all over the country, *Setaria sphacelata Kazungula variety* in wet high lands, *Trypsacum laxum* in wet low lands, *Andropogon gayanus* in dry zones and *Chloris gayana* in dry zones. For leguminous plants, we have *Desmodium spp*, *Mucuna, Medicago sativa, Calliandra and Leucaena leucocephala*
Pennisetum purpureum French Cameroon variety

Advantages

*Pennisetum purpureum French Cameroon variety* is considered as the best grass used in Rwanda. It is used by more than 95% of farmers. Nobody can plan to rear cows without knowing where he/she will get French Cameroon.

This plant becomes very popular because of the advantages:

- Planting material (cuttings) are available anywhere
- It grows well and quickly
- It gives a very high biomass: 40 tons of dry matter per ha representing a production of 200 tons of green matter in 9 cuttings per year
- It has adaptability in all ecological zones
- It is very appreciated by animals
- It can be planted on erosion control bands (ditches) and terraces, protecting then the soil
- It is well preserved as silage

Plantation techniques

Soil is prepared and fertilized with organic manure or mineral. Plant cuttings are spaced of 80cm one from another. Cutting is planted in oblique orientation. Plantation is regularly cleaned removing other grasses until the harvest. It can be planted on a special plot or on the terraces or anti-erosion bands depending on availability of land for the farmer.

Harvesting, use and conservation

*Pennisetum purpureum* is cut near the soil level with a very sharp material (machete). It can be served to animal fresh or conserved. If fresh, the grass is chopped in very small pieces with a chopper machine or with a machete. If conserved, silage technique is suitable when the production becomes high and then avoids wastage of the fodder.
Marketing

The use of Pennisetum is very common for farmer owning cows. However, there are people who don’t have cow who are specializing now in fodder production and sell it. This is observed in per-urban zones (Kigali City) and Gicumbi district. This kind of business shows that Pennisetum is available, affordable and adopted by farmers.

Limiting factors for Pennisetum use observed in Rwanda

Pennisetum is well appreciated by farmers, but some errors are often observed:

- No use of fertilizers: many people don’t use fertilizers when planting. The result is that biomass becomes very low and the plantation disappears easily. Solution is the intensification of farmers training and avail fertilizers
- Degradation of biomass during the dry season. To avoid this loss, farmers must know the good period of planting and harvesting. Ideally, it is recommended to harvest before the beginning of dry season and preserve fodder in silage to be used during the draught.

- Use of unchopped grass with consequence of wastage of the material. This is the result of lack of chopper machines affordable for small farmers.

- Many farmers think that *Pennisetum* is a complete feed for animal. Training is necessary to show people the role of supplementation (use of legumes, concentrates, mineral and water)

**Conclusion**

In the context of milk production promotion on small lands where special programs like "One cow per poor family" have been developed, the main issue to be solved was the fodder availability. The situation was complicated by the new policy of enclosed farming vs divagation of animals. Through constant education, mindset change of farmers is actually evident on use of various plants tested. By the moment, *Pennisetum purpureum* /French cameroon variety has been adopted by all farmers in Rwanda. Strategies to promote the use of leguminous plants and concentrates have also been taken. We are confident that milk production will grow up more and more.
**Fodder Production, Utilization and Marketing Practices in Mixed Crop-Livestock Production Systems in the Mid Altitude Areas of Ethiopia**

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**Introduction**

Natural pasture and crop residues are the dominant feed resources for livestock in tropics and sub-tropics especially during the dry season. The major feed sources of livestock holders in the rural sedentary areas of the country is grazing (about 38.71 %) followed by crops residues (33.09 %) and hay (12.03 %), which are the typical diet resources for ruminant animals. These are often the only feed resources during the extended dry seasons. The contributions of agro-industrial by-products and other types of feed resources are generally insignificant accounting only about 3.11% and 12.46 % respectively (CSA, 2012). The increasing population pressure and climate variabilities are the main causes of the current increasing conditions of feed scarcity, which in turn affects livestock productivity (Alemayehu, 2002). Feed availability from natural pasture, crop residues and others is highly fluctuating due to various factors mainly with the availability of rainfall and production practices and hardly support even the maintenance requirements of livestock. Generally inadequate nutrition and feeding are the main constraints that resulted in low milk and meat yields, high mortality of young stock, longer calving intervals, and low animal weights (McIntire, *et al.*, 1992) and reduced animal performances through body weight and body condition loss as well as reduced carcass composition in sub Saharan Africa (SSA).

Several feed production and utilization technologies and strategies to address the problems of inadequate supply and poor quality of feeds has been developed during the last few decades. Development projects have also introduced fodder banks and alternative cropping patterns to help
introduce new fodder varieties and feeding systems. Improved nutrition through adoption of cultivated forage and better crop residue management could substantially increase livestock productivity. But for a wide range of reasons, many researchers and development practitioners have found that limited progress has been made in resolving fodder scarcity. Quite a number of useful forages have been selected for different agroecologies and production systems, although the adoption rate is very low. Currently, the use of improved cultivated fodders as animal feed in Ethiopia is very limited due to various factors. On the other hand, there are many available good practices related to improved fodder production and utilization that can be practical to promote its application in many similar areas in the sub region. However, the available best practices remain isolated in pockets and adopted by few farmers in mid altitude areas of Ethiopia. This requires proper analysis and understanding of success factors and challenges of these best practices of fodder production and utilization.

In this study it is tried to assess the available best/good practices related to improved cultivated fodder production, utilization, marketing, challenges & opportunities by smallholder farmers in the mid altitude areas of crop-livestock production system of Ethiopia. It also aimed to identify possible appropriate approaches to scale up/out this practices and skills and share the information for key partners in similar agroecologies and production systems in the sub region.

Methodology

Selection of study areas

The study was conducted in mid altitude areas of Ethiopia at Chiro and Kewot districts. The districts were selected using purposive sampling technique and identified in consultation with resource persons (actors), key informants from ministry of agriculture (MoA) and regional bureau of agriculture (BoA) and from available secondary sources related to the available best practices on improved fodder cultivation, utilization and marketing. Purposive sampling technique was also employed to select the specific farmers associations (FAs) or kebeles within the district and farmers within each kebeles in consultation with key informants.
Description of the study areas

Chiro district is found in West Harerghe zone, Oromiya regional state, and located about 326 km East of the capital, Addis Ababa while Kewot district is located in North Shewa zone, Amhara regional state, about 220 km northeast of the capital, Addis Ababa, Ethiopia. In Kewot district, the production system is a mixed crop livestock production system where farmers grow crops and keep livestock and they give priority to crop production. The role of livestock in this area is mainly to provide draught power for crop production. However, in Hararghe in general and Chiro district in particular, the system is livestock-crop mixed production where farmers give priority to livestock, and crop farming is geared towards maintaining animal feed (Table 1).

Size of land holdings per household has been continuously declining due to population growth. In addition, the grazing lands are also shrinking due to the expansion of crop lands. This condition forced farmers in Chiro districts to keep smaller livestock herds and intensify their cropping and grazing systems. The major feed resources of livestock are grazing, natural pasture hay, crop residues and agro industrial by products. Moreover, non-conventional feed resources such as fenugreek and sweet potato are also used as supplement feeds in Chiro district. Feed shortage is critical during the dry season.

Data collection and analysis

Data was collected using rapid appraisal techniques including key informant interviews (producers, consumers, agricultural experts and development agents) and analysis of secondary data collected from the records/documents of governmental and non-governmental organizations. The first set of data was collected from purposively selected farmers associations (kebeles) and farmers (fodder producers) and/or traders, consumers, key informants and development agents in the study area using rapid rural appraisal techniques. Pre-prepared checklists of questions were used to query farmers on their fodder production/cultivation, conservation, utilization, and marketing practices, and fodder adoption decisions, seed supply issues, and other relevant topics. In addition, data generated through personal observations in field visits was also considered. Results were based on qualitative analysis of key informant interviews, and quantitative analysis of secondary and primary data.
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Chiro*</th>
<th>Kewot*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production system</td>
<td>Mixed crop-livestock with high priority for livestock production</td>
<td>Mixed crop-livestock, with high priority for crop production</td>
</tr>
<tr>
<td>Altitude (m.a.s.l.)</td>
<td>1300 to 3170 at hilly areas</td>
<td>1300 to 2500 at hilly areas</td>
</tr>
<tr>
<td>Agro-ecological zones</td>
<td>Lowland (49.4%), mid altitude areas (32.8%) and Highland (17.8%)</td>
<td>Lowland (44%), mid altitude area (29%) and highland (27%)</td>
</tr>
<tr>
<td>Rainfall (mm)</td>
<td>600mm to 900mm (rainfall is usually erratic, intense and short in duration.)</td>
<td>300mm to 900mm (Rainfall is usually erratic, intense and short in duration.)</td>
</tr>
<tr>
<td>Major crops grown</td>
<td>-sorghum, maize, haricot bean, sweet potato, potato, wheat, barley, peas, Chat and vegetables (onion and pepper) -Chat is the main cash crop followed by vegetables.</td>
<td>Teff, mung bean, sorghum and vegetables (mainly onion) -Vegetables are the main cash crops</td>
</tr>
<tr>
<td>Livestock population during 2010/11</td>
<td>116, 978 cattle, 17, 090 sheep, 48, 793 goats, 599 horses, 212 mules and 11, 186 asses, 382 camels and 107491 chickens</td>
<td>49085 cattle, 55873 sheep and goats, 9847 donkeys, 22 horses, 207 mules and 38366 chickens</td>
</tr>
<tr>
<td>Livestock potential</td>
<td>Good in fattening</td>
<td>Fair in fattening</td>
</tr>
<tr>
<td>Market access</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Available best practice</td>
<td>-Strip planting and production of Elephant grass in farm lands using irrigation -Zero or Semi-zero grazing system</td>
<td>Elephant grass production planted along the edge of irrigation canal</td>
</tr>
</tbody>
</table>

Fodder production, conservation and utilization practices

Fodder types and production practices

The major feed resources in Chiro district are sorghum and maize stover and/or green fodder, straw, thinned maize and sorghum seedlings, defoliated leaves and sterile plants, maize tassels, sweet potato leaves/vines and tubers, haricot bean leaves/vines, natural pasture hay/green grass, grazing, improved fodder grass like elephant grass (locally known as 'Shenkora Hori or Yelimat Sar') and weeds grown in crop fields. Some farmers in Chiro district intentionally grow elephant grass and/or maize for fodder in their farm lands using irrigation. Sorghum, maize and elephant grass are selected for their high biomass as animal feed. Farmers grow perennial crops like chat, which prevents animals from grazing stubble and crop aftermath. This favors the growth of grasses and leaves, which are later weeded and fed to animals. On the other hand, the major feed resources in Kewot district are natural pasture (grazing lands) and crop residues. In addition, elephant grass production along the edges of irrigation canals and on farm borders as hedgerows was introduced and promoted in Gimdrie village of Kewot district in 2006 by Debre Birhan Agricultural Research Center as a means of reducing the critical feed shortage prevailed especially during the dry season (Likawent, et al., 2007). According to a study report (Alemu, 1987), within the mixed crop livestock production system there are two subsystems, where one focuses on crops while the other prioritize livestock production. During an interview and discussion made at different stages in Chiro district, it was indicated that farmers in the study areas (Ifahas and Fugnan Dimo villages) give priority to their livestock followed by crop production. Farmers intentionally grow sorghum, maize (Figure 1), haricot bean and sweet potato for fodder mainly targeting animal fattening followed by dairy. Growing elephant grass in strips (Figure 1) for fodder in irrigated farm lands also practiced by farmers.

According to respondents of Chiro district, the land size allocated for maize production for fodder ranged from 625 to 800m² per household while the land size allocated for haricot been (white) and sweet potato production for fodder ranged from 500 to 600m² per household. Some farmers of Chiro district responded that they allocate up to 400 m² of land for elephant grass production planted as a strip in their farm lands. According to production experts of Kewot district office of agriculture,
there is about 3 km length of elephant grass production planted in strips along the edges of irrigation canal and its production also widely practiced by farmers in farm boundaries (Figure 2). Elephant grass planted along the boundaries of the farmlands is done in double rows spaced at 75cm between rows and 50cm between plants.

Figure 1. Elephant grass planted in strips for fodder (left), Maize planted for fodder in between elephant grass strips (middle) and Maize planted for fodder (right) in irrigated crop fields during the dry season in Chiro district.

Application of manure/inorganic fertilizers, crop rotation and intercropping methods are employed to maintain soil fertility in Chiro district. In order to improve organic matter of the soil, sometimes burning of elephant grass was practiced by some farmers in Kewot district. However, farmers in Kewot district did not apply inorganic fertilizer/compost and cow dung on elephant grass fields. Intercropping is a common practice in the study areas of Chiro district. Farmers grow maize and/or sorghum as a sole crop or intercropped with chat, sweat potato, or beans depending on the agro-ecology. In the mid to highlands, the intercropping is maize or sorghum with haricot bean while in the lowlands maize or sorghum are intercropped with ground nut. Farmers also grow haricot bean or ground nut as a sole crop.
Feed conservation and utilization practices

In the study areas supply of feed is highly fluctuating over the different seasons of the year, and the scarcity is high during the dry season. Due to these conditions farmers conserve available feed in different forms. Hararghe in general and Chiro district in particular are well known in cattle fattening practices in the country. According to FLDP (1989), in the Hararghe fattening system, livestock depend mainly on thinning from annual crops during the growing season as the case of cut and carry feeding system; and conserved stover and stubble grazing during the dry season. Moreover, in most areas of Hararghe, animals are fattened successfully on farm products alone. For instance, farmers use high seed rate to enhance maize and sorghum biomass growth and then thin excess seedlings and feed to animals as cut and carry system. The thinning is done day to day, not at once. Farmers partly defoliate sorghum and maize leaves after maturity and detassel maize plants after maturity and feed to animals as cut and carry system. After grain maturity, maize and
sorghum stovers are finally harvested and stored either in the shade or in the field for later use (Figure 3). Elephant grass is harvested at about 1m height for animal feeding. When elephant grass reached to 1m height, framers cut the forage and fed to the animal as a cut and carry system either on farmland (i.e. tethered feeding) or indoor feeding. Farmers preferred to feed elephant grass for fattening animal, oxen used for plowing and lactating cows. Sweet potato leaves/vines and tubers, haricot bean leaves/vines and fenugreek are also fed to fattening animals. However, the amount and type of feed utilized varied from farm to farm and even within the individual farm from time to time or season (Table 2).

Figure 3. Sorghum stover conserved for dry season feeding in Chiro district (Left) and elephant grass utilization in Kewot district (middle) and Chiro district (Right) during the dry season

Figure 4. Chopped stover for feeding cattle in Chiro district, 2012.
Table 2. Fodder utilization/feeding practices for fattening and dairy cattle in Chiro and Kewot districts

<table>
<thead>
<tr>
<th>Chiro district</th>
<th>Kewot district</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Most of the farmers practicing indoor as well as tethered feeding. There is no free grazing system.</strong></td>
<td>- Practicing free grazing system</td>
</tr>
<tr>
<td>- Fodder production linked to market oriented livestock production</td>
<td>- Fodder production weekly linked to market oriented livestock production</td>
</tr>
<tr>
<td>- During the dry season, some farmers in Ifabas village feed their fattening animals':</td>
<td>- In Gimdrie village</td>
</tr>
<tr>
<td>▪ hay and crop residues such as chopped sorghum stover (Figure 4), chopped sweet potato tubers and vines supplementing with moistened wheat bran and salt.</td>
<td>▪ oxen and cows are grazed on crop aftermath and along road sides particularly during the months of December to January (early dry season)</td>
</tr>
<tr>
<td>▪ farmers also feed ground and moist fenugreek mixed with table salt and wheat bran to their fattening animals by mixing it with chopped hay and sweet potato tuber.</td>
<td>▪ Elephant grass in the form of cut and carry system is fed to fattening oxen and lactating cows during the months of September to November.</td>
</tr>
<tr>
<td>- During the dry season, farmers in Fugnan Dimo village, feed their fattening animal and/or local cows:</td>
<td>▪ During September to December, where most of fattening activities practiced, farmers use elephant grass and crop residues such as teff straw as a basal diet supplementing with wheat bran for fattening.</td>
</tr>
<tr>
<td>▪ natural pasture hay and/or crop residues, elephant grass, maize fodder harvested at milking (locally called Chorka) stage as cut and carry and supplementing with moist wheat bran and salt.</td>
<td></td>
</tr>
<tr>
<td>- Some farmers use maize grain for goat fattening but not for cattle fattening.</td>
<td></td>
</tr>
<tr>
<td>- During the wet season, farmers in Fugnan Dimo village feed their animals:</td>
<td></td>
</tr>
<tr>
<td>▪ green grass, maize and sorghum thinning (defoliated leaves), elephant grass, haricot bean fodder harvested at flowering stage and weeds as cut and carry system supplementing with salt or salt blocks (locally called Amole Chew).</td>
<td></td>
</tr>
<tr>
<td>- Water is available freely once in a day while a mineral supplement (common salt blocks) locally called &quot;Amole chew&quot; is always available offered to animals.</td>
<td></td>
</tr>
<tr>
<td>- In general, priority in feeding animals is given to fattening followed by milking cows. Dairy production is based on keeping a few numbers of local cows kept by farmers.</td>
<td>75</td>
</tr>
</tbody>
</table>
In contrast to Kewot district, the fattening practice in Chiro district is market oriented and it is commonly practiced by farmers in many places of the district. Before the commencement of the fattening practice farmers in Chiro district treat fattening animals with albendazole against internal parasites. Farmers train and use un-castrated bull for traction for one or two years and then fatten for sale. Some farmers castrate the bulls followed by fattening and sell in order to fetch good price (Figure 5).

![Figure 5. Finished steers ready for market in Chiro district, 2012.](image)

In Ifabas village of Chiro district, it was observed that water harvesting structure constructed by farmer intentionally to harvest water for drinking of fattening and dairy animals. To avoid infiltration of water some farmers used plastic sheet lined under the surface and wall of the ground (Figure 6). Cattle, sheep and goats are also observed tied with rope near crop fields or *khat* (*Chat*) fields in Chiro district (Figure 7). In Hararghe area in general and Chiro district in particular, tethering animals near crop land and house is a common practice experienced by most farmers since long time ago. All feeds are taken to the animals. Cattle fattening practiced by most of the farmers is completely under indoor condition while goat fattening is practiced indoor as well as tethering in some browsing sites.
Most of the farmers in Chiro district practice two fattening cycles per year targeting holiday markets such as Ethiopian New year (September) and Easter. Farmers in Chiro district reported that fattening activities during the rest of the season depend on the availability of feed reserve and the purchase price of animals to be fattened. Farmers that kept enough feed reserve are the ones fattening during the dry season. The number of animals fattened during the dry season is 2 per household, while during the wet season the number ranges from 2 to 6 animals per cycle. The number of animals in the wet season varies based on the available feed. The length of fattening period also based on the availability of feed and the condition and age of the animals. When there is feed shortage farmers do not keep fattened animals long to prevent the animal from losing weight. Cattle fatten during the dry season do not used as a draught power for crop cultivation while cattle fatten during the wet season were engaged in plowing for one season only. The major crops of Hararghe areas are sorghum and maize and well compatible with
the fattening practices. However, because of the marketing problem (especially market for finished cattle) prevailed in Gimdrie village of Kewot district, farmers were sometimes discouraged for this type of business (fattening) activity.

**Marketing of fodder/fodder seed, livestock and livestock products**

Marketing of fodder such as standing fodder for hay production and crop residues are becoming a common practice in the study area. Communities in Fugnan Dimo and Ifabas village reported that, they purchase standing natural pasture (fodder) from the government owned closed areas or from other private farmers. They also purchase wheat bran, fenugreek flour and salt/lick block from local market. Very few farmers sold cuttings of elephant grass for district office of agriculture as source of planting materials. However, most of the farmers in both districts do not practicing sale of forage seeds/planting materials instead they give free of charge especially elephant grass root splits to their friends or neighboring farmers.

The livestock production system in the study area of Chiro district is market oriented. Farmers keep few numbers of oxen (steers), which are mainly purchased from market then serve as traction animal for smallholders. After a few years of service farmers fattened and sold for beef. Small ruminants are mainly kept for fattening and sale. In the study area a number of young bulls, fattened oxen, sheep and goat are available and are in most cases in good body condition. Availability of young bulls in the local market could be associated with the practice of farmers to buy draught oxen every year and fatten at early age unlike other areas of the highlands. According to FLDP (1989), the Hararghe farmers are close to extensive rangeland areas and the male animals in Hararghe areas come mainly from the rangelands. Typically smallholders purchase oxen from the rangelands (through traders), use them as draught animals for few years and then fatten them prior to sale. The regional success of this strategy is reflected in the price premium offered to fat stock from Hararghe area on the Addis Ababa market, which is the most important domestic meat market in the country. Farmers prefer and use young animals for fattening. The relative close proximity of the study districts to pastoralists in the rangelands enables farmers to keep relatively more
efficient and young animals (in terms of rates of conversion of animal feed into draught power and other livestock products) than is the case in the central highlands.

The purchase price of animals is dependent on body weight, condition and season. Heavier and good conditioned animals fetch higher price. The selection criteria's of farmers that favored by farmers for fattening are good body condition/frame, long in length and height, red or white color, young or middle age and big hump. However black color, old age, small hump, short and poor body frame are the disfavored criteria's by farmers. Selling price of animals is also higher during holidays and religious festivals mainly in Ethiopian Easter and Ethiopian New Year. Farmers in the study areas prefer to sell their animals during these periods. Nevertheless, even during the other time of the year, the price of Hararghe finished steers/oxen, locally called Sanga in general and Chiro Sanga in particular have the highest demand in the area, Adama and Addis Ababa markets throughout the year.

Milk marketing is not a common practice compared to fattened animals in most of the rural communities of the district, except those located near towns. In Chiro district farmers have the tradition of drinking milk as Hoja (the traditional drink in the study area prepared from milk). Some of the reasons for not selling milk were low milk yield of local breeds and poor access to market. But those communities located nearby towns are increasing their milk production for sale as the marketing is attractive due to the increasing milk demand. Milk marketing is characterized by the high demand during non-fasting seasons and low demand during fasting seasons of the Orthodox Christians. Milk selling is not a taboo but it is because of the low milk yields of the local cows kept by farmers and almost all milk produced is used for home consumption. However, in Ifahas village of Chiro district, households experience a traditional milk marketing system where 20 households form a milk producers group for milk marketing. In this system, milk from all member households is collected daily and taken to local (Chiro town or the then Asebe-Teferi town) market for sale by one of the group members, and the money is used by the household who took the milk to the market. Other members of the milk group will wait their turn for milk collection and selling. This is done by the group members turn by turn. Each day each member contributes an equal amount of milk to the group based on the initial agreement made among members. Farmers reported that they get market information informally from colleagues and neighbors who visited the
market some time before them, asking traders coming from towns, discussions during social gatherings in the community/village to which farmers have better trust. Such information has been assisting them to set the price.

**Inputs, stakeholder participation and support services**

Institutional support services of extension, research, input supply, rural finance and marketing are key areas of intervention that can play a central role in the transformation of subsistence production into market orientation (Azage Tegegne *et al.*, 2010). So far introduction inputs such as improved forage seeds/planting materials, has been facilitated through government institutions such as the Bureau of Agriculture and research institutes. Farmers in Chiro district reported that animal health and vaccination services are available at an affordable price and provided solely by government organizations but not artificial insemination services. However, there is a critical shortage of service providers (technicians) for effective medication and vaccination services for livestock. Most of the trainings offered to farmers are orientation on livestock packages, health and feed aspects. However, during discussion with farmers in Kewot district, it was mentioned that farmers did not get any training on elephant grass production, management and utilization. The number of extension workers per village in Chiro district ranges from 1 to 3. Provision of credit in the study areas was limited. It was provided by food security programs and some NGOs (for instance CARE Ethiopia) operating in Chiro district.

The major input and service providers are government institutions such as the Bureau of Agriculture which provides planting materials, vaccines, medicines, training, market information and other services related to livestock production. The participation and assistance of NGOs were also underlined. The role of CARE Ethiopia and others are of paramount importance (The list of NGOs is not exhaustive, only as listed by experts and interviewed farmers). The team observed that in the district the role of the private sector was very minimal, despite its potential in service provision.
Benefits obtained due to the improved fodder production and utilization practices

In the irrigated sites, farmers in Chiro district have been able to harvest elephant grass forage year round, usually at monthly or bimonthly intervals. Farmers also reported that the improved forage used for fattening and dairy improved their income, reduced their feed cost and ensured the year round feed availability. Cut-and-carry systems of animal feeding also freed children from looking after grazing animals and give the opportunity to attend schools. Cattle do not travel to long distance in search of feed and water due to the zero-grazing system practiced by farmers. Milk yield increased from 1 to 3 liters/cow/day in local cows. Due to the year round fodder availability, farmers are able to fatten cattle and/or small ruminants 2 to 3 cycles per year.

![Image](image_url)

Figure 8. Elephant grass production and management challenges during the dry season under free grazing systems, in Kewot district,

Farmers in the irrigated sites of Chiro district reported that, the feed availability improved particularly during the dry season. Moreover, elephant grass planted along the edges of irrigation canals has also helped in stabilizing the canal and reduced water loss through evaporation. Additional income obtained from the sale of planting materials of elephant grass was another benefit, even though such benefit are rarely obtained but its future potential market looks promising. On the other hand, in Kewot district, due to the marketing problem of livestock and
livestock products and the available free grazing system in the area particularly during the dry season, elephant grass production and utilization practices are very challenging (Figure 8). In line with this farmers also reported that “the recent activity launched by the government nationally on integrated watershed management may restrict free grazing in the area”.

Available good practices related to fodder production and utilization

The fattening package in the area practiced is either unique to Hararghe farmers in general or are commonly practiced in Chiro district since long time ago. The available good practices in cattle fattening package include:

- Using high seed rate for maize and sorghum and then thin weak and sterile plants and feed to fattening animals. Thinning will be done in a way that supports feeding of fattening animals for a longer period of time.
- Defoliation of the lower old leaves of sorghum and maize plants and feed fattening animals.
- Detasling maize after grain setting, and feeding it to animals
- The practice of animal centered cropping system: planting sorghum/maize and haricot bean as a sole crop or intercropped maize with haricot bean, which targets animal feed production.
- Fodder harvested at appropriate stage of maturity
- Strip planting of elephant grass in irrigated crop fields and use it as fodder harvested at appropriate stage of maturity
- Tethering fattening and other animals near crop field and implementation of zero-grazing systems
- The practice of market oriented fattening practice
- Common practice of keeping manageable number of animals during fattening
- Oxen are in most cases bought during the cropping season and used for plowing, then fattened and sold for beef.

- Practice of feeding fenugreek and sweet potato to fattening cattle intended for the good response, is suggested by Chiro farmers.

- Construction of water harvesting structure as a source of water for livestock

- Traditional milk marketing system of farmers at Chiro district is a culture of forming milk producers group up to 20 members whereby each day a member of the group will collect milk from all members and sell it, and use the money for its own. Other members will wait their turn.

- Elephant grass production along the edges of irrigation canals and on farm boundaries, which have multidimensional benefits as feed and natural resource conservation.

References


Introduction

Livestock are important component of the farming systems of Kenya and contributes about 42% of the agricultural gross domestic product (GDP) and 12% of total GDP. About 60% of the livestock are found in the arid and semi-arid land (ASAL) and contributes 95% of the family income and livelihood security thus is important for poverty reduction. Most of the ASAL is fall within the lowland area of Kenya. The social economic characteristics and farming system prevalent in the lowland areas is very diverse and ranges from pastoral to agro-pastoral. In the pastoral systems livestock are kept as a symbol of wealth and they are used in festivals, rituals and cementing relationships as source of milk, meat and income. In the agro-pastoral systems, livestock provide milk, meat, manure and draft power for crop production and act as security against crop failure.

A number of on-farm surveys e.g. Njarui et al. (2011) and, Ndathi et al (2012) indicate that the most important constraint to livestock productivity is inadequate quantity and quality of feeds. Climate change is expected to result in reduced rainfall and increase the frequency of drought events thus worsening the feed situation. In the semi-arid region, 90% of smallholder farmers experience regular feed shortages and seasonal variation in feed availability (Njarui et al., 2011). In the agro-pastoral systems, animals depend on both natural pastures or cultivated pastures and crop residues after the crops are harvested. In the pastoralist areas animals subsist largely on natural pastures. Feed deficit in both production system is mainly be attributed to limitations in increasing the area under pastures and fodder crops, limited availability of good fodder varieties, lack of quality seeds, poor quality of dry fodders, poor management and lack of conservation.
There have been efforts by the government and partners to improve the livelihood of the communities living in the lowland areas mainly by targeting livestock productivity. One of the strategies of achieving this is by strengthening the livestock feed base in order to increase meat and milk production. Several initiatives have been undertaken including introduction of high yielding and more nutritious pastures and fodders and developing management options for sustainable production. As a result, through joint effort between researchers, extension, farmers and development partners successful fodder and pasture production practices have been developed and promoted and adopted, some of which have shown increased feed availability under different production systems. Identifying these and understanding the management leading to their success will contribute to efforts to upscale the best practices in other areas with similar conditions in the lowland areas of Kenya and elsewhere in East Africa.

This report describes selected best practices on fodder and pasture production and management that have been developed in different parts of lowland areas of Kenya as a strategy to improve livestock feed availability. The author came across several practices under different management but in this report only three are described under pastoral and agro-pastoral production system.

Characteristics of the lowlands

The lowland region of Kenya is very diverse and has many landscape, a range of agro-ecological zones (AEZ) and different farming system. It stresses from the coastal belt bordering Indian Ocean to the south east, Taita-Taveta county, Ukambani region and extend to Garissa region in the eastern corridor of Kenya (Figure 1). Tana River which has its source from the central highlands of Kenya is an important physical feature supporting irrigation for the pastoralist communities living along its bank. Generally the relief is low lying, from sea level to <1200 m above sea level although there are isolated hills that exceed 2000 m above sea level. Most of the region is described as ASAL and rainfall is generally low (annual rainfall 250 -700 mm) and erratic except in the coastal belt which extend up to 30 km towards the hinterland that is regarded as wet (800-1200 mm annual rainfall). The region is important for livestock production because of low rainfall. Most of the land falls in agro-ecological zone (AEZ) V and VI.
Case studies on the best fodder practices

The study covered three fodders and pasture best practices in different AEz and farming systems within the lowland areas of Kenya. These are:

(i) rangeland rehabilitation in agro-pastoral systems,
(ii) fodder production under trees crops in the coastal belt and
(iii) irrigated fodders for pastoral communities

Each of this practice targets a specific niche for livestock production and because of the diversity and difference in management applied; each practice will be described separately.

Rangeland rehabilitation in agro-pastoral systems

The study focused on pasture production based on re-seeding of indigenous range grass species in the semi-arid lands of eastern Kenya. The main aim of re-seeding is to rehabilitate degraded natural pastures for increased herbage production for livestock. The practice is being
practiced by the smallholder agro-pastoral system in Makueni County who account for over 80% of farmers in the region.

**Climate**

The region is located in agro-ecological zones (AEZ) IV, V and VI according to classification of Pratt and Gwynne (1977). It is characterized by low and erratic precipitation, which is insufficient for production of crops. The long term average annual rainfall ranges from 350 - 700 mm while mean temperatures ranges from 14 - 29°C. There are two distinct rainfall season, the long rains (LR) season, occurring from March to May and the short rains (SR) season which occur from October to December. Between the SR and the LR seasons (January and February) there is a short dry season while the long dry season occur from June to September. Inter-seasonal rainfall variation in semi-arid is large with coefficient of variation between 45 and 58% (Keating et al., 1992). Annual evaporation exceeds the amount of rainfall and ranges from 1600 – 2400 mm (KARI, 2001)

**Topography, vegetation and soils**

The altitude ranges from 600 m above sea level near Athi River to 1100 m above sea level along the Chyulu hills (GOK, 2002). The vegetation has been altered greatly through settlement and cultivation for food crops (Keya, 2002), resulting in severe soil erosion in many places. However, perennial range grasses are still common with the acacia trees and shrubs dominating the over-story. Umbrella thorn (*Acacia tortilis* [Forssk] Hayne.), black thorn (*A. mellifera* [Vahl] Benth.) are the most abundant. Others woody trees species include *Balanites glabra* (Mildr & Schlecht) and *Commiphora campestris* (Engl.).

Further south in AEZ VI, baobab (*Adansonia digitata* L.) is the most dominant. The forbs layer is mainly composed of grasses. The most common grasses include buffel grass (*Cenchrus ciliaris* L.), maasai love grass (*Eragrostis superba* Peyr.), guinea grass (*Panicum maximum* Jacq.), horse tail grass (*Chloris roxburgiana* Schult.) and wild rye grass (*Enteropogon macrostachyus* [A. Rich] Benth.). Other grasses are red oat grass (*Themeda triandra* Forssk.), aristida (*Aristida kenyensis* Henr.), sweet pitted grass (*Bothriochloa insculpta* [A. Rich] A. Camus) and spear grass (*Heteropogon contortus* [L.] Roem. & Schult.). Different types of soils are common including the Ferrasols, Nitisols, Vertisols,
Acrisols, Cambisols, Andasols and Fluvisols but Acrisols and Vertisols are most common. They are generally poor in nitrogen and phosphorus due to long period of weathering.

**Social economic characteristics and farming systems**

Population density is highly influenced by rainfall with the dry areas of Kibwezi being less dense (62 persons per km²) compared with the wetter highlands of Mbooni (199 persons per km²). Poverty level is widespread with over 64% living below the poverty index. Both men and women carry out farming activities but there are special tasks allocated to different gender as high-lightened in the section below. The Kamba tribe who inhabit the region are pre-dominantly agro-pastoralist at subsistence level. To the west, they border Kajiado County, inhabited by the legendary Maasai, who are semi-nomadic pastoralist.

Livestock are the most important source of income and livelihoods as maize the principal staple crop is successful in 3 seasons out of every 10 wet seasons. The dominant cattle are the indigenous zebu (*Bos indicus*). The number of farmers adopting exotic European breeds (*Bos taurus*) is increasing due to existence of market for milk. The small East African goat is the most popular small ruminant. A few farmers keep sheep and over 95% of the households keep poultry. Bee keeping is increasing becoming an important activity. Despite research and extension advice, farmers tend to keep more animals than the carrying capacity leading to overgrazing and land degradation. However, survey by Manyeki *et al.* (2011) showed a decline in livestock numbers between 2008 and 2010 due to recurrent drought. Farmers normally keep more goats than cattle as they are more adaptable to prevalent dry conditions. Inadequate pastures, water and diseases are regarded as the major constraints to livestock production.

On the cultivated land, the major subsistence crops grown are maize (*Zea mays* L.), beans (*Phaseolus vulgaris* L.), pigeon peas (*Cajanus cajan* [L] Millsp.), cowpeas (*Vigna unguiculata* [L] Walp.) and sorghums (*Sorghum bicolor* (L) Moench.). Intercropping is the norm, with maize intercropped with the grain legumes. Horticultural fruit trees such as citrus (*Citrus* sp. L.), mango (*Mangifera indica* L.) and pawpaw (*Carica papaya* L.) are increasing becoming important source of cash.
Pasture production practice

The pasture improvement practice promoted by both extension and research is based on mainly four indigenous range grasses; buffel grass, maasai love grass, horse tail grass and wild rye grass. These grasses are preferred because they are drought tolerant and are persistence to grazing. Their major limitation is the low germination rate (<20%) (Keya and Hornetz, 1999). In AEZ IV, where the soil is sandy, buffel grass and maasai love grass are the most preferred species by farmers.

However, wild rye grass is not popular because it is not very productive and grows well under Commiphora bushes. These grasses are used to rehabilitate degraded land with remarkable success. Bermuda grass (Cynodon plectostachyus K.Schum.] Pilg.), although has never been promoted is common along the riverline. A study by Ndathi et al. (2012) indicated that it is the more preferred by farmers than the other grasses. Due to high temperature, these grasses grow fast and attain peak growth in 4 - 6 weeks after on-set of wet season (Njarui, 2007) an advantage for the region due to short period of rainfall. Unfortunately, the fast growth and development is normally accompanied by rapid deposition of fibrous component making them less digestible.

Pasture establishment and management

Farmers normally plant seeds harvested from their farms or acquired from neighbours and friends as there is no formal production and marketing of these grass seeds. Three planting methods are recommended by research for successful establishment; sowing in pits, sowing in furrows and broadcasting the seed. The former two are important for providing micro-environment for quick establishment since they capture little rainfall experienced in ASALs. Pits are highly recommended where the ground is sloppy to reduce run-off. The pits have been described by Gichangi et al. (1992). These are circular or semi-circular loops where soil is excavated to a shallow depth (upto 30 cm) to create a semi-circular bank of 15-30 cm high on lower side of pit using soil removed from the trench immediately above it. The pits are interlocked with each other to form a mosaic to trap water in the pit immediately below it. In some instance surface of the soil is disturbed on the surface to avoid seeds from being washed off by torrential rains, usually experienced during the first days of the rainy season. Although they have shown to be extremely
effective in rehabilitating the denuded land the cost of digging is appreciable.

Generally farmers rarely make elaborate land preparation in their pasture development but carry out limited bush clearing. They prefer planting in furrows and broadcasting rather than pits because it is cheaper. The furrows are made using a pair of oxen. Normally land preparation is the domain of men but women are also involved at times. This is followed by drilling the seed by hand into existing vegetation and covering by lightly pulling tree branches along the furrows. Broadcasting of seed is not highly recommended as ants carry away the seeds to their nest. Where the slope is relatively steep, usually a cut-off drain referred to as “fanya chini” terrace is dug to prevent run-off water from above land washing the soil. Establishment is more successful if planting is carried out during the SR season as the rains are more reliable. Apart from limited bush clearing other inputs such as manure or inorganic fertilizers are not applied. There is no farmer who reported application of manure or inorganic fertilizer to replenish what the grass mines from the soil. The social economic characteristics dictates that manure be applied to the staple food crops principally, maize, pigeon peas and cowpeas.

**Productivity and uses**

Herbage production under farmers’ management has been poorly quantified. However, reports indicate that under controlled condition, yield of over 6 t/ha are obtained (Keya and Hornetz, 1999). Practically, establishment and productivity is variable between seasons and is dictated by amount of precipitation and management. This is exemplified by a study to assess the performance of pastures in 12 farms during the LR 2009 seasons by Kirwa et al. (2010). They found that mean plant population was variable between farms and ranged from 0.0 - 126, 0.0 - 11.0 and 0.0 - 22.5 plants per m² for wild rye grass, buffel grass and maasai love grass, respectively. Ground cover after one year was low and averaged 45.8%.

In most instance the grasses is grazed *in situ*, continuously without rest period to allow regeneration from seeds. Due to the large numbers of animals kept there is overgrazing and degradation after a few seasons. Nevertheless, some farmers harvest the seeds and also bale hay using the handmade hay boxes for sale and for feeding their livestock during the dry season. Different form of storage are used including hay barn,
granary and on trees. Ndathi et al. (2012b) reported that the most effective method of storage is granary. Where the grass is left as standing hay in the field, the quality is poor and is susceptible to weather and termite destruction. Both men and women are involved in the management of livestock. During school holidays children are also involved in herding of the livestock. Labourers are also involved where the household can afford to source externally.

Figure 2. Grass growing under Commiphora bushes in rehabilitated grazing lands in SE Rangeland of Kenya and hay stored in hay barn

**Seed production and marketing**

Farmers normally preserve some of their pastures for seed, either to use for planting in subsequent seasons or for sale. Seed harvesting is the prerogative of all the gender. However, women and children are key players particularly at harvesting, cleaning and sorting of the seeds. Generally the seed yields are low because of uneven establishment, low rainfall and inefficient methods of seed harvesting and timing. Estimates of 112, 72 and 66 kg/ha from buffel grass, maasai love grass and wild rye grass, respectively have been reported in literature (Manyeki et al., 2011)

Seed is harvested manually and the process is slow and time consuming. Research recommend that during harvest the grass culms are cut at least 30 cm below the inflorescence and then tied in bundles and stoked in order to dry slowly to avoid shock before the seeds are threshed. Some farmers feel that this is labour intensive and prefer stripping the seed directly from the inflorescence. For the false rye grass, the seeds have
awns which prick the hand and some farmers tend to avoid planting this grass.

Price of seed varies between seasons and is high preceding drought. In 2011, the price ranged from Kshs. 800-1000 per kg of buffel grass and Kshs. 600-800 per kg of maasai love grass for external markets. The difference in price between grass species is based on the amount of seed per kg with buffel grass having more seeds per kg than maasai love grass. However, the price at local market is the same for all species (Kshs. 100-300 per kg). Hay is sold for Kshs. 250-300 for a bale of 14-18 kg depending on the severity of feed scarcity. Most of the hay is sold locally within the region and around in Wote town.

Farmers have formed group for collective marketing of their seeds. They reported that marketing in a group guaranteed better price for their seeds. However, there are also individual farmers who are not member of the group and market seeds and hay on their own. The major market outlets are Non-Government Organisation (NGO) which includes Germany Agro-Action (GAA), World Vision, Government ministries, African World life Foundation and FAO- Somalia. The district livestock office in Makueni County and KARI Kiboko links farmers to buyers. Within each farmer group, there is a lead person who is trained to source for market outlets. No labelling of seed is done as it is illegal according to Kenya Plant Health Inspectorate Services (KEPHIS) since these grasses are not registered varieties. Normally the seeds are sold in gunny bags or in nylon papers.

**Dissemination efforts**

Before the government started active promotion of grass farming most farmers regarded grasses as weeds. A few farmers with dairy cattle reported that they had tried to establish the grasses using splits but failed.

**Alice Ndumi Mbithi**, a 60 year old lady of Iviani Youth Group narrates, "I thought grasses were just weeds and I did not imagine I could plough, plant, even weed for grasses and harvest seeds and bale hay for sale. I have seen some benefits and this has improved my income by practising what I am taught by government officers.” She continued to say, “my land is no longer degraded like in the past.”
Promoting rehabilitation of eroded grazing land commenced in 1996 under Makueni Agricultural Project (MAP), a Kenya government programme funded by Danish International Development Agency (DANIDA). The aim was to help farmers improve feed production for their livestock. Seeds of Rhodes grass (*Chloris gayana* L.) cv. Boma were supplied to farmers for free but the grass failed due to low rainfall. The project later switched to buffel grass and maasai love grass. To reach many farmers, the project established focal development areas (FDA) at sub-location level where farmers would meet for training. Only interested farmers who had livestock were recruited. A Focal Area Development Committee was democratically elected for each focal area to coordinate the activities of the group. After exit of MAP, the Decentralised Agricultural Support Service (DASS) took over support from 2004 to 2007 under the same funding. In addition to pasture management, farmers were empowered on conservation using hay boxes for baling. During DASS, farmer extension research linkages were established to facilitate flow of information from research to farmers through the office of Research-Extension Liaison Officer (RELO). The role of RELO was to gather technologies from research and package them for application by the farmers.

The National Agricultural and Livestock Extension Program (NALEP) is the current participatory extension system being implemented by the Ministry of Livestock Development (MoLD) to promote rehabilitation of grazing lands. The main focus of NALEP is on poverty reduction and empowerment of small-scale farmers by strengthening the capacity of extension staff to meet farmers’ needs. Farmers are encouraged to form Common Interest Groups (CIG) as the focal areas for learning at location level. Regular training on different topics on pasture establishment, management, hay making are conducted on selected days in a participatory manner. Individual farmers donate part of his land for demonstrations and training of the groups. In return, farmers are expected to replicate what they learn from the group in their own farms. In 2011, 370 kg of seeds of buffel grass and maasai love grass were distributed to farmers in Makueni district. In addition 57 households (26 males and 31 females) were trained on land preparation, and planting of ranges grasses seeds. During the same year, the MoLD planted 7 ha of grass seed for bulking for future distribution.
While the MoLD was promoting pasture development, KARI-Kiboko research centre was concurrently conducting on-farm trials and demonstration in lower Makueni County on best methods of rehabilitating natural pastures. To address pastures seed scarcity, the research centre initiated activities on community based seed system around 1998 under Agricultural Research Support Programme (ARSP) II funding by European Union. Several clusters were established across the region with each cluster comprising 3-4 groups each consisting of 10-15 farmers. Under this system, KARI-Kiboko provided technical training on pasture husbandry and seed production and on post-harvest handling of seed such as germination testing and purity determination. Thereafter they embarked on training of trainers (TOT) who were then used to train other farmers in their groups. The role of KARI shifted to backstopping the TOT and provision of seeds. These efforts continued during the Kenya Arid and Semi-Arid Land programme between 2008 and 2011.

The promotion efforts have also benefited from some of the successful groups who not only multiply seed for sale but also its members are used to train other groups. The government has also linked with other development partners to accelerate the dissemination of the technology. Some of this included; GTZ, GAA and World Vision. The GTZ normally purchase seeds from individual farmers or groups and re-distribute to other farmers based on their requirements. These partners also provide additional funding for field operations and facilitate training of farmers.

**Adoption and impact**

During the project implementation a large number of farmers were enlightened on the need to rehabilitate their grazing lands either through demonstrations, field days and training. Literature reports that over 53 CIGs made of 525 farmers have been trained and over 90% of the members had established their own plots by 2008. Between 16-43% of farmers had harvested seeds but only 11% sold seeds. Study by Kimitei *et al.* (2011) in various part of Makueni County revealed that between 57-84% of farmers have knowledge on natural pasture improvement technologies including re-seeding. One farmer reported that he used to buy livestock feed resources for 5 months in a year but has now become self sufficient in feed production.

In one of the successful farmers group, Kavatini Pasture and Livestock Improvement Group each member has least 1 ha of improved pastures.
The group was registered in 2000 with initial members of 15 and membership has now grown to 32. Some members of the group have over 10 ha of rehabilitated pastures and sell hay and seeds. The group is able to sell over 1000 kg of seed annually. The groups operating in the region have considerable contribution to local seed availability and helped to promote pasture development by mentoring other farmers. Another group, Ivaini Youth Group produced over 300 kg during the LR 2012 season.

There has also been increased land under pasture in the region between 2008 and 2010. Estimate indicates a considerable proportion of farmers conserve feed mainly as standing hay in the field and the number carrying baling using hay boxes is increasing. It is estimated that during 2009, about 4200 bales of hay were sold from Makueni in addition to 8500 ha of standing hay (MoLD, 2010). In addition, 11500 kg of grass seeds was produced in the same region.

**Factor contributing to success of the practice**

There are various factors that have favoured the adoption of the practices in the region and are described below.

**Market for seeds:** There is demand for grass seeds both locally and regionally particularly for buffel grass at favourable prices. The farmers realized that they needed to manage their pasture well in order to produce good seed and consequently this motivated them establish pastures. The MoLD and KARI links the farmers to the market.

**Technical backup by extension services and research:** The government through the MoLD established various programme to focus on improvement of livestock feed resources in the rangelands and building capacity of farmers. Regular visits and training by extension agents encouraged the farmers to put more effort to improve their pastures. NALEP for example enhanced the capacity of farmers and staffs. KARI also provided the technical expertise and knowledge required in pasture husbandly and post-harvest handling. The project has also benefited from other development agents who supplied seed to farmers for free and provided platform for training.

**Group training:** At initial stages of project implementation, the MoLD encouraged the local communities to form groups. This made it easier to reach a large audience and the fact that farmers were able to try their own
technologies. This participatory approach adopted by extension allowed farmers interests to be catered for and enhanced their awareness and benefits of pasture improvement. It became easier to market seed though groups than individually.

**Challenges to the systems**

*Unfavorable seed policy:* There is no sustainable seed supply system for the ranges grasses and farmers depend on their own saved seeds and from friends. The formal or private sector involvement in bulking or marketing of these grasses does not exist. The KEPHIS sets standards for seed production, quality, distribution and marketing and registration of varieties. The parastatal does not allow production and sale of seed for varieties that are not registered and does not permit the right of farmers to register their own seed thus commercialisation of indigenous grass seed for increased availability is limited.

*Drought:* Low rainfall, frequent and prolonged drought period results in unproductive pastures and poor regeneration. Despite the use of pits for improving the micro-environment for sowing of the seeds sometimes the amount of rainfall is too low to sustain good growth and production of pastures.

*Inadequate labour:* Seed harvesting is done manually and is labour demanding. Further seeds of wild rye grass have awns that prick the hand. Several surveys have shown that the average age of farming community is over 50 years (e.g. Njariui *et al.*, 2009, Omiti *et al.*, 1999) as the youth prefer to seek better paying jobs in urban centres.

**Research gap**

The project has assisted farmers to improve their feed reserves, earn income from their improved livestock productivity, seed sales and consequently improve their livelihoods. However, there are areas that need to be researched on for enhanced productivity.

*Seed Regulation:* Seed regulation by KEPHIS only allows registered varieties for commercialization. The parastatal should make laws that consider seed production at local level by developing linkages with the institutions working with farmers. Thus they should develop guidelines that stimulate and encourage smallholder farmers to produce seed for sale.
Proper Seed storage: Research should identify optimum conditions for storage since pasture seeds are sensitive to moisture and temperature fluctuation. This will include developing structure for storage at household level to increase longevity.

Limited grass species: The pasture production depends on only one single ecotype for each grass species. There is need to collect other ecotypes and screen for high yielding and quality and develop varieties that are distinct, uniform and stable for registration by KEPHIS to allow commercial seed production. This will improve accessibility of seeds that is in short supply.

Opportunities for up-scaling

There is evidence that the practice if adopted it has enormous benefits in term of restoration of grazing land, generating income from seed sales and alleviating feed shortage for livestock. However, there is need to upscale the practice to reach more households and increase land under pastures. There are several areas with similar characteristics and farming system in the lowland areas where the practice can be assimilated for improved gains. The up-scaling should be carried out at individual households and community level.

To accelerate adoption, there is need to build capacity of farmer on proper land management which entails keeping the right stocking rates in order to minimize overgrazing for sustainable pasture production. Farmers should also be trained on the best planting methods and made aware on the proper timing during harvesting of grass in order to have high quality hay. Also proper methods of feed conservation to increase availability during the dry season should be paid special attention. Grass if left in the field as standing hay losses quality rapidly due to effects of weather and most is destroyed by termites and this practice should be discouraged. Production of seed through community based systems should also be encouraged.

Fodder production under trees crops in coastal belt

The study examined fodder production, integrated with tree crops in small holder agro-pastoral system along the coastal belt of Kenya. The coastal belt lies in the coastal lowland (CL) AEZ and extends inland from
the coast bordering the Indian Ocean to the east for about 30 km where production of crop is practical under rain-fed condition.

**Climate**

Based on the amount of rainfall the CL is divided into five agro-ecological zones, namely CL2, CL3, CL4, CL5 and CL6 (Jaetzold and Schmidt, 1983). Rainfall is bimodal with LR season from April to June and the SR from October to December. The LR are more reliable for crop production while the SR do not support a good crop. Rainfall is highest (1200 mm) in the south-west in the CL 3 zone. Further in the Kilifi-Malindi area (CL 4), annual rainfall decreases to 1000 mm and in Lamu (CL4) it further drops to 900 mm (Jaetzold and Schmidt, 1983). Similarly, rainfall decreases from the coast to hinterland. Potential evapotranspiration is high (annual evaporation 1900 – 2300 mm), and exceeds annual precipitation in most months, thus resulting in water deficit. Mean annual temperatures ranges from 22 to 35°C. Relative humidity is also high and ranges from 70 to 90%.

**Topography, vegetation and soils**

The land topography is low lying, from the sea level and rising to 300 m above sea level toward the hinterland. Most of the natural flora has been cleared and replaced by tree crops. Coconuts (*Cocos nucifera* L.) and cashew nuts (*Anacardium occidentale* L.) are the major trees dominating the vegetation. Major soil include Ferrasols which are sandy clay, strongly weathered and red brown in colour, and Cambisols, which are shallow to moderately deep (Njarui and Mureithi, 2004). They are deficient in nitrogen; phosphorus and potassium with soil P being below the critical level of 20 ppm (Njarui and Mureithi, 2004). Low soil fertility in the region is attributed to soil erosion, burning of crop residues, overgrazing and continuous cultivation without the replenishment of soil nutrients.

**Social economic characteristics and farming system**

The region is populated by the The Mijikenda ethnic groups who accounts for about two-thirds of the population in Kwale and Kilifi counties and one thirds are migrants from up-country. Family size is relatively large and on average each household has 8-9 persons (Ali *et*
Majority of people live in absolute poverty with 72% in Kilifi County living below poverty index. In the south coast the scenario is similar with 65% in Msambweni and 75% in Lungalunga living below the poverty index. Land sizes average 3.2 ha per household (Ali et al., 2008). Over 75% of the household own less than 6 ha of land with majority owning 2 ha on average (Njunie et al., 2006). Due to high population, the farm sizes have continued to decline thus constraining the level at which land can sustain food production.

Rural households engage in diverse agricultural and non-agricultural activities. Maize and cassava (*Manihot esculenta* Crantz.) are the main staple foods followed by cowpeas. They are almost always cultivated as intercrops under trees crops of coconuts and cashew nuts. The coconuts, cashew nuts, and horticultural crops such as mangoes and citrus are the major cash crops usually scattered in the farm without any distinct pattern. Crop yields are generally low due to low soil fertility and poor crop husbandry. Typically maize yield is less than 1 t/ha (Mwamachi et al., 2005) compared with over 3 t/ha achieved from research (KARI-Mtwapa, 2005). Use of inorganic and organic fertilizer is low due to limited income by the farmers thus leading to continuous soil fertility decline.

Livestock includes cattle, goats, sheep and poultry. Most of the cattle are the local zebus which are mainly kept as a source of cash and security against crop failure. About 65% of household keep livestock with less than 20% owning some cattle (Thorpe et al., 1993). Information from MoLD indicates that the number of dairy cows at the coast is low due to high challenges of tsetse flies and east coast fever (ECF) with about 23000 in Kilifi (MoLD, 2012) and about 3000 in Kwale County. Over 30% of the herds in Kwale are owned by large scale farms. While the zebus’ cattle are normally grazed on natural pastures, the dairy cattle are fed in zero grazing units enclosed in nets to keep off tsetse flies particularly in Kwale district. Natural pastures account for the largest feed and there is a severe feed shortage usually from January to March.
Fodder production practices

The fodder practice is centered on Napier grass (*Pennisetum purpureum* K. Schum) and tree legumes; leucaena (*Leucaena leucocephala* [Lam] de Wit) and gliricidia (*Gliricidia sepium* [Jacq] Walp.). Napier grass is mainly grown to supply the basal diet for the livestock and the trees as sources of protein. Leucaena and gliricidia have added benefits of soil conservation and provide firewood and building materials. The practice is common in CL2, CL3 and CL4 where dairy farming is most suitable. Researchers recommend alley farming where the fodders are planted under trees crops of cashew nuts and coconuts. In this arrangement the tree legumes are planted in hedgerows at 5 m apart and intra-row spacing of 25 cm and the Napier is planted between the legume trees hedgerows at spacing of 1 m between rows and 0.5 m within the rows giving 4 rows of Napier grass between the tree legume hedgerows. Some farmers tend to modify these recommendations and planted the leucaena and gliricidia along farm boundaries and bench terrace. Napier grass is also planted using a wider spacing that the 1 x 1 m recommended spacing. However planting along the terrace has added benefit of stabilizing the soil and reduces erosion. The tree legumes are deep rooted and tap moisture deep in soil profile thus making them drought tolerant.
Fodder establishment and management

*Leucaena* is more successful if established through seedlings while *gliricidia* it is through stem cuttings. The seedlings are raised in nurseries for about 8 - 10 weeks and transplanted following onset of rains but for *gliricidia*, the cuttings are planted directly in the field. *Napier grass* can be established by cuttings or root splits. Where cuttings are used it is recommended that they have at least three nodes. For *leucaena*, most farmers plant the seed directly because raising seedling in nursery is expensive and they take longer to establish.

Application of 75 kg N per ha for *Napier grass* or 55 t per ha of slurry is recommended to to maintain high yield. Hardly do farmers apply this amount as preference is given to food crops. Although farmers are advised to harvest the leaves for livestock by cutting the tree legumes at 50 cm stump height, majority of farmers instead strip off the leaves. Their experience is that stripping makes plant to initiate more leaves as opposed to cutting. This factor needs to be investigated. Stripping of leaves is not regular but is done on piece meal according to animal requirement and mainly during the dry period when natural pastures are scarce and weeds from crop land is inadequate. However, cutting the stem has added benefits in that it provides firewood. For the farmers who cut the stems, the height was variable and in almost all the farms visited the height was above 0.5 cm above the ground. For *Napier*, it is recommended to be harvest when it is about 50-100 cm high but in most farms it was over-grown and this result in poor quality.

![Figure 4. Napier planted under coconut trees in coastal belt, Kenya](image-url)
Figure 5. Gliricidia fodder at the coastal belt. The leaves have been hand stripped for livestock

Productivity and uses

The tree legumes take at least 1 year to establish while Napier grass takes about one season. Studies conducted at KARI-Mtwapa have shown that under careful management the fodders can maintain high yield over several years. Total dry matter yield are generally high when Napier is intercropped with tree legumes (>20 t per ha) than when planted alone (<15 t per ha) (Mureithi et al., 1998). The productivity of the fodders at farmers' field has not been thoroughly documented in literature (Njarui and Mureithi, 2004). However productivity is low at farm level because of poor management. Lack of application of right quantity of fertilizer or manure and late weeding are some of the factors contributing to low yields. Reports from MoLD indicate that there has been a downward trend in fodder production in Kilifi district in 2011 (MoLD, 2012).

All farmers appreciate that leucaena is very palatable and results in increased milk yield when fed as supplement to animals fed on grass. Gliricidia was not popular among farmers because it is not readily eaten by livestock. Feed conservation is rare with less than 1% conserve who feed for their livestock. The cultivated fodders were meant for dairy farmers practising mainly zero grazing and semi-zero grazing system. In this regard Napier is cut and transported and chopped before presented to animals.
Dissemination strategies

There was a well-coordinated and sustained effort in promotion of the fodders practice in CL2, CL3 and CL4 AEZ. The chronological events on dissemination is clearly documented by Mureithi et al. (1998) and Njarui and Mureithi (2004). The search for fodders for the region commenced in 1974 under FAO supported project. Napier grass was identified as basal diet for the livestock while leucaena and gliricidia as source of protein.

From 1988-1994 a joint collaborative project between KARI/ILCA (International Livestock Centre for Africa) now ILRI (International Livestock Research Institute) and Ministry of Agriculture with National Dairy Development Program (NDDP) was established to strengthen dairy farming among smallholders. The focus was to promote utilization of fodders based on Napier grass and tree legumes species (leucaena and gliricidia). The project targeted farmers practicing zero-grazing system and semi-zero system (Njarui and Mureithi, 2004). The project fostered strong linkages between research-extension and farmers. Farmers were advised to plant 0.4 ha of Napier and 500 trees per cow. Joint on-farm trials and demonstrations were conducted to expose the farmers on different fodder production systems based on intercropping and pure stands to stimulate them to develop interest. Field days were held in some of the successful farms to expose more farmers to the technologies. This participatory approach enabled the farmers to make informed decision on where to plant the fodders.

During this tenure, farmers were linked to financial institutions mainly Agricultural Finance Corporation (AFC) and could borrow money to purchase dairy cows. There was also organized milk marketing and Kilifi Plantations Limited and Bahari Dairy Club were absorbing most of the farmers milk. On the other front, Heifer Project International (HPI) operating in Kwale district was giving free dairy cows to vulnerable and female headed households and assisted them to construct a zero grazing unit. In return they were expected to establish sufficient fodders for one dairy cow (0.4 ha Napier grass and 500 legume trees). KARI-Mwapa and Ministry of Agriculture were bulking and supplying Napier splits, while the Agroforestry centre at Mtwapa produced seedling of leucaena for free.
Adoption and Impact

Due to aggressive promotion of the technologies in the initial phases farmers were very enthusiastic and large numbers adopted the practice (Mureithi et al., 1998). However, in spite of the efforts and enthusiasm, information from literature indicates that adoption of cultivated fodders has regrettably continued to decline. In early 1990s, Nicholson et al., (1993) recorded adoption of only 30% and about 15 years later Ali et al. (2008) reported that adoption had declined further to 12% and the area under production had declined. It is important to note that the decline of leucaena in the 1990s was due to arrival of leucaena psyllid (Heteropsylla cubana Crawford) in the region which severely devastated the plants but later stabilized. On average, the acreage of Napier had declined in CL3 by 45% from 0.77 ha to 0.42 ha per household and was much less in CL4. The area planted with legumes had similarly declined and although farmers indicated this was mainly due to seeds or planting material; Napier cuttings and splits could easily be obtained from their neighbours or from their plots.

As a result of decline, the contribution of these fodders to livestock feed has been low. Literature indicates that 78% of small holder dairy farms rely on natural pastures (Ali et al., 2008) implying the contribution of planted fodder to total feed is low. The source of natural pastures is under trees crops; along the river banks and low lying areas, from their neighbours and weeds from the crop land. However during the dry season, the natural pastures dries and leucaena along the roadside particularly in Kwale provide useful feeds.

Rachel one of the progressive farmers and beneficiary of the project has a vivid memory of how the project had improved their livelihoods. By then she had 11 dairy cows but now has only one. She still maintains what remained of the fodders and the zero grazing units. Most of her leucaena and Napier is overgrown since she does not use it for feeding her dairy cows. Asked where she took her animals, she replied, “I sold all my dairy cows to educate my children. Now I have one cow remaining and it produce very little milk.” She continues to say, “I am still looking at the period when the dairy industry will be vibrant as before at the coastal region”.
Success factors

Technical expertise

Strong expertise from NDDP, KARI and ILCA during the implementation of the project helped develop linkages and partnership with farmers and build their capacity. This provided extensive technical advice and access of knowledge and skills. Further establishment of on farm trials and participatory monitoring provide information and management of the fodders species and dairy cattle.

Availability of credit

Initially some farmers received up to 50% financial (grant) assistance to adopt zero grazing. Later they could easily access credit at concession rates from Agricultural Finance Corporation (AFC) to finance purchase better dairy cows and construct a zero grazing unit. This made it easy for them to develop their fodder plots. This facility collapsed in 1990s but although it has been revived, the interest are high and prohibitive hence inability to expand development in dairy farming.
Free cow

Vulnerable households were given cows for free and helped to construct a zero grazing unit. In return, they were expected to establish 0.4 ha of Napier grass and plant 500 trees of leucaena per dairy cow. This facility is no longer in existence since the project ended.

Challenges to the system

Collapse of milk markets

Kilifi Plantations Limited and Bahari Dairy Club which were the major market outlets for milk and stopped processing milk leaving farmers at the mercy of milk hawkers. The hawkers were sometimes unable to pay for the milk and during the glut period most of the milk was wasted.

Attack by *leucaena psyllid*

The devastating leucaena psyllid attack in the 1990s resulted in severe decline in productivity of leucaena and this made farmers to abandon cultivating it.

Poor management and drought

Napier grass lack persistence, if poorly managed. In the coastal region, the lower soil horizon is sandy and is prone to high leaching of nutrients and without regular fertilizer application production declines. Compounded with frequency and long drought most farmers lost interest in re-planting the Napier grass. There are farmers who were able to maintain Napier for over 10 years by regular addition of manure.

Potential weed

In the south coast, farmers reported that leucaena had become a weed and they uprooted it. Leucaena is a prolific seeder and if stems are not pruned regularly before flowering it has potential of becoming a weed. Evidence of this was noted along the roadside (Plate).
Low palatability of fodders

Gliricidia is generally not palatable and it has either to be wilted before presented to animal or the animals are starved without feeds before they become accustomed to it.

Dependency on government and development partners

The community looked to the extension and development partners to provide additional benefits such as inputs and marketing of milk. Thus they had not developed mechanism of self-sustaining and failed to function when the project ended.

Diseases

Tse tse flies particularly in Kwale and east coast fever (ECF) have progressively led to the decline in number of high performing dairy cattle. The cost of acaricides and other drugs to treat diseases increased after abolition of price control of agricultural inputs in 1989 and farmers were unable to afford the prices. Conversely this led to decline in fodder production.

Liberisation of artificial insemination services

Forage development was based on ownership of grade cows. Liberisation of artificial insemination removed government subsidies and made them expensive and unavailable to most farmers. This constrained sustainable improvement of dairy farming and had a direct negative effect on pasture improvement.

Potential for up-scaling the fodder practices

There is high potential for dairy development at the coastal region as over 70% of milk requirement is imported from the other parts of the country; principally Rift Valley region and central highlands of Kenya. This potential can be realised by up-scaling the fodder practices to improve feed availability. Leucaena and gliricidia are drought tolerant while Napier grass needs improved management to be productive. The efforts in promoting the fodders in the region need a long term commitment from extension officer and other key stakeholders to enhance the capacity of the local people in order to make them more independent.
Nevertheless due to several challenges experienced in the region, for successful adoption, these fodder practices will depend entirely on addressing other constraints along the dairy value chain. Consequently, there is need to develop a package that will include the following:

(i) Development of sustainable infrastructure on milk marketing. This will also incorporate value addition of milk to generate other milk products to extend the shelf life during period of milk glut.

(ii) It will be necessary to improve the dairy composition and herd structure. This will involve working closely with private sector to improve access and affordable AI services and link farmers to financial institution to secure loans to purchase better dairy animals and develop their farms and,

(iii) Develop strategies to control diseases particularly ECF and tsetse flies which cause trypanosomiasis and death of animals.

**Irrigated fodders for pastoral communities**

This case study examined fodder production under irrigation by the predominantly pastoral communities in the arid rangeland along the Tana River. The fodders are mainly grown to target livestock supplementation during the dry seasons and drought period when feeds from natural pastures are scarce in order to minimise livestock loss. The study focused in the area north of Garissa town where the land being irrigated stretches up to 3-4 km from the river. As the practices commenced in 2011 there is limited documentation in literature on this fodder practice and the information provided is based on discussion with key stakeholders and observations.

**Climate**

The region is generally arid and rains are very unreliable. The annual rainfall ranges from 250 to 300 mm and is insufficient to support crop production without irrigation. Rainfall is bimodal; with the LR occurring from March to May and the SR from October to December. Between the LR and SR seasons (June - October), there is a long dry season where precipitation is nil. On average the number of rainy days in both seasons average 16 and the SR are regarded as more reliable for pasture growth. Cyclical droughts are common and this affects the pasture growth and consequently livestock productivity severely. According to Howden
(2009), droughts have increased in frequency from once in every 10 years in the 1970’s; once in every 5 years in the 1980s; and once in every 2-3 in the current decade. Potential evapo-transpiration is high (1900 -2400 mm per annum) thus resulting in water deficit. Because of the low altitudes, temperatures are generally high, ranging from 20°C to 38°C. The month of September, January and March are the hottest months and between April and August is relatively cool (PHC, 2005)

**Topography, vegetation and soils**

The landscape is basically low lying with altitude ranging between 70 m to 400 m above sea level. Notable features are the River Tana on the western side of Garissa County which drains its water to Indian Ocean and several seasonal laghas. The vegetation cover is low and consists mainly of bushy acacias. Overgrazing has resulted in disappearance of palatable grass species and invasion by undesirable species and bush encroachment. Notable is the obnoxious and invasive Prosopis (*Prosopis juliflora* [Sw.] Willd.) which has become a common vegetation suppressing growth of other useful acacias and grass significantly. This undermines greatly the capacity of the land to support the livestock and human population.

The soils range from sandstones, dark clays in some patches to alluvial soils. The alluvial soils are very fertile and occur along the River Tana basin and several laghas in the region (PHC, 2005). Except for the sandstones and the clays, the rest of the soils are fertile and are suitable for crop production with adequate rainfall.

**Social economic characteristics and farming system**

The population in the county is concentrated in small pockets surrounding water points and trading centres with basic services. The region is inhabited by the Somalis who are basically pastoralist and families live in portable huts. However, Tana River which is the only permanent source of water in the region has encouraged the pastoralist to become sedentary. There is high level of poverty, with 62% of population in rural areas living below the poverty index (FAO, 2007). The county is a net importer of staple food as about only 1% can be cultivated without irrigation.
Due to low rainfall and frequent drought the inhabitants are largely pastoralist with nomadism being the most common land use activity. Consequently, livestock form the main source of livelihoods and income strategy and supports over 90% of the population (ROK, 2002). The livestock kept are, goats, camels, cattle, sheeps and donkeys. The cattle are kept mainly in area south of Garissa and camels mainly to the north. Women and young children care for sheep and goats while the young men and boys are responsible for herding cattle and the highly valued camel. Women take the responsibility of milking the animals and food preparation for the family. Inadequate water supply, cattle rustling, diseases and poor marketing infrastructure for livestock and its products are the main problems hindering the growth of the sector. Increased livestock population has led to overgrazing and competition over watering grounds. The collapse of traditional range management structures has compromised access to pastures that were traditionally set aside for dry season grazing. Livestock are now often moved into these areas without consulting elders (PHC, 2005). Further, pastures are also threatened by cutting down trees for charcoal burning, firewood and building materials.

Land in the County is primarily trust land or communally owned as no land adjudication has been undertaken in the region. People who have settled along the Tana River have adopted cultivation of crops under irrigation along its banks. The river provides reliable supply of water for irrigation throughout the year. Irrigated agriculture is concentrated along a stretch of up to 3-4 km from the river. A broad range of crops are grown such as maize, beans, cowpea, tomatoes and various vegetables. Fruit trees are also cultivated and include bananas, mangoes, paw paws and lemons. The annual crops are grown during the rainy season and are rotated with fodder during the dry season. Cultivation of these crops is stimulated by high demand from urban centre of Garissa.

**Irrigated fodder practices**

The pastoralists with assistant of government extension services and development partners have focused on cultivation of Sudan grass (Sorghum bicolor subsp. Drummondii) as the main fodder crop for livestock. A few other grasses and legumes were evaluated in the same environment under irrigation but they were unsuccessful. These included Rhodes grass, Napier grass and lucerne (*Medicago sativa* L.). Rhodes grass had poor germination and establishment while Napier grass forms a
dense root system that tends to cover the irrigation furrows thus farmers do not like it. Further, it is difficulty to uproot to give way for rotation with other crops during the wet season when fodders are in low demand. Production of lucerne was low due to the high temperature experienced in the region. The pastoralists prefer Sudan grass because it grows fast and establish very quickly and produce high biomass. Further, the grass is easy to uproot thus is compatible with the farming system. However there is great danger of cultivating only one species of grass as it is not buffered against biotic stresses. Already at harvest stage the farmers mentioned that they observed insects on the grass culms.

**Fodder establishment and management**

Ploughing and harrowing is normally carried out by tractors. This is followed by heaping the soil together manually to create an embankment and furrows for irrigation using a modified shovel-like tool locally known "Kababa". The Kababa require two people to work; one press down in soil and the other pulls in order to heap the soil and create a furrow.

![Somali women demonstrating how they prepare land for planting Sudan grass using "kababa"](image)

Figure 7. Somali women demonstrating how they prepare land for planting Sudan grass using "kababa"

The seeds are drilled along the sloping sides of the soil embankment at about 30-50 cm apart to give two rows locally as "fita". Seeds are acquired from Kenya Seed Company in Nairobi as there are no stockists who market the seeds in Garissa town. However, some farmers multiply their own seeds but birds are major challenge. The water for irrigation is pumped from Tana River and then directed to canals and flow by gravity
to the fields. The canals are made of earth and are raised slightly above the rest of the land.

Women play similar roles as men in management of fodders and managerial capacity of the group. For example, in Wathajir Farmer Group, out of 74 members, 36 are women; some who hold key positions in management committee. Groups have their own operation calendar but in most of them, members work in the communal land twice per week and absconding attracts a fine of Kshs. 100 - 300.

**Fodder productivity and uses**

Harvesting of fodder is carried out using machetes and the grass is cut at about 5 - 10 cm above the ground. No research has been undertaken in the system thus yields have not been scientifically quantified but farmers reported that productivity of Sudan grass if well irrigated is high. The initial harvest after planting is carried after two months and the subsequent harvests are carried once per month as the re-growth is fast due to high temperatures. Normally at the time of harvest, the grass is about 50 - 100 cm high. Several cuts are made before productivity start to decline. Most of the freshly cut grass is fed directly to the livestock as conservation through hay is not popular. However, it was noted that some farmers have erected temporary storage structures in the farm but the quantity stored was low. Sudan grass is not friendly to bale and take long to dry before baling because it relatively stemmy.

![Figure 8. Sudan grass ready for harvesting and a temporary structure for hay storage along the Tana River basin, Garissa County](image-url)
Fodder marketing

Demand for fodders is generally high and escalate during the dry season. There are two levels of fodder marketing; at farm gate where the grass is sold at the farms and in the second scenario the grass is cut and transported to Garissa town using donkey carts. There is fodder market every Wednesday at Garissa town. Most of the regular customers are people in peri-urban areas of Garissa town who keep livestock. There are also traders who buy from the farm and sell to other livestock farmers. The farm price of green fodder ranges from Kshs 150 - 200 for one *fila* and from Kshs. 200 - 300 per bale of about 18-20 kg. Due to high labour requirement to handle grass at drying and baling farmers are opting to sell green fodder. Secondly two ‘filas’ are required to produce one bale thus it is more profitable to sell green fodder than baled hay. The price for group members is normally about half of the market price.

Dissemination strategies

Interest on fodder production was initiated by MoLD located in Garissa town in 2010 under FAO funding. Initially, a baseline survey was conducted to establish the feasibility of fodder cultivation along the Tana River and assess the knowledge of the local community on fodder production. The study revealed that the pastoralists were keen to grow fodder, but they lacked skills and knowledge and information on the type of fodder species to cultivate. Following consultation, the partners agreed on fodder production to enhance livestock feed supply during the dry season when the natural pastures are inadequate. The project started working with pastoralists in 10 sites located along the Tana River. At each sites the extension officer selected existing groups that were involved in crop production. Each group consisted of 25-30 farmers.

Pastoral Field Schools (PFS) were established in four sites to raise the pastoral communities’ awareness on importance of fodder production and train the group on land preparation, planting, management and utilization of the fodders. Conservations through baling using hand made boxes and storage was also emphasized. In the other six sites, the conventional extensions methods were used to build capacity of farmers. Demonstrations and field days were organized and in some instance successful farmers were used to mentor newly recruited farmers. Initially
each group was required to establish 0.10 ha of fodder. The project initially provided diesel for the pump for one year. Each group has a committee composed of men and women who were in-charge of management of group activities and monitor implementation.

Although the pastoralist gained better understanding on best practices in fodder production through PFS than the regular extension methods it had several challenges. In PFS, more resources were required for learning; continuous follow up, a facilitator and regular meeting thus it was time consuming.

The FAO funding lasted towards the end on 2011 after which NALEP together with other key stakeholders took over the support. Some of these stakeholders are CARE (Cooperative for Assistance and Relief Everywhere) International, International Organisation for Migration (IOM) and Kenya Livestock Dryland Project (KLDP) who have been supporting technical training on fodder production, marketing, conservation and provision of seeds to the pastoralists.

**Adoption and impact**

Compared with the two cases studies on fodder practices described above, the period of promoting irrigated fodders has been relatively short (<2 years) and adoption and impact have not been widely documented. However during the visit the author noted that more land had been opened for expansion of fodder cultivation as entirely all pastoralists realized it is more profitable than food crops. It is unmistakable that fodder growing under irrigation is the solution to pasture shortage in the region and has made the community build resilience against effects of drought. This initiative has contributed to reduction in death of livestock during drought, maintain breeding herd during the dry season and also improved availability of milk for the households. Money generated from the sale of hay contributes to welfare of the members. Wathajir Farmer Group, one of the successful group reported that they made a gross of Kshs 260,000 from 1.5 acres of grass in 6 months during 2011. About one quarter of an acre is sold for Kshs 8000 for a single harvest. The groups also buy animals weakened by drought at low price to fatten for sale at profit.
Factors influencing success of the fodder practice

Favourable market for fodders

During the dry season and drought period animals need supplementation as the native pasture is scarce and hence demand for fodder is high. Also, there is a thriving fodder markets in Garissa town and livestock farmers in the peri-urban areas of town are major customers. This provides opportunities for pastoralist to grow fodder for income generation and livelihoods.

Community group

The involvement of the community has also been the key success factor of the project. The communities were involved in the initial stages of the project development and their priorities and interest were well considered.

Capacity building

Pastoralists were effectively equipped with knowledge through PFS on all key stages of land preparation, planting, utilization and conservation. They were also given an opportunity to make informed decision about the practice through hand-on activities training in different topics on pasture husbandry.

Constraints affecting the fodder production

Just like the other practice described above there are major constraints affecting the fodder production under irrigation. These if addressed could improve fodder production cost and result in increased yield.

Unfavorable land policy

Land adjudication has never taken place in the region and therefore the land belongs to government “trust land” or is communally owned. This discourage the pastoralists to invest in permanent structures e.g. construction of brick canals to reduce water loss storage structures to extend feed availability during the dry season.
High taxes and fuel

Farmers are required to pay a significant levy (Kshs 5200 per pump per year) for using the water for irrigation to the boards that manage Tana River. In addition, the escalating fuel prices for the pump increase the production cost and reduce profit. This is compounded by high evaporation rates due to high temperature and seepage as the canals are made of earth.

Lack of seed

The source of seeds for the Sudan grass is presently limited to KSC Ltd in Nairobi. It is in charge of production and marketing and there are no seed stockists who deal with fodders seeds in Garissa town. The distance to source the seed is far (over 350 km) price is high and in some instance the seeds are not available.

Research gap

There is limited research that has been undertaken in the region to support growth of fodder production by the pastoralists. KARI which is in charge of research on livestock feed in the country can play a key leading role in this field. The major areas of research that need to be undertaken to increase productivity of the system include:

Management of the fodder

There is need to develop management options for the Sudan grass in order to maintain high yield after planting. Key agronomic practices to be evaluated include fertilizer application regimes to sustain productivity as the grass mines lots mineral from the soil and determine optimum harvesting intervals.

Source of protein

There is need to carry out research to identify other fodders particularly for source of protein which is a major limiting factor for livestock during the dry season. Selection should initially consider several indigenous fodder species for evaluation and promotion. There is need to conduct a taxonomic survey of the area to compile a list of these species. Other legumes such as forage lablab (*Lablab purpureus* L.), clitoria (*Clitoria*
ternatea L.) and Leucaena spp which have shown promise in similar environment should be considered.

**Genetic diversity**

There are risks of overdependence on one grass species which may not be well buffered against biotic stresses. Farmer already reported that Sudan grass is normally attacked by insect during harvest. Option should be explored to bring in genetic diversity of the fodders.

**Weeds threat**

The land available for irrigation is threatened by the dreaded and invasive Prosopis plant. Although the pastoralist have been empowered on how to exploit its pods for livestock feeds, ways to control it should be investigated to deter it from occupying the prime land suitable for irrigation.

**Opportunities for up-scaling**

As already mentioned above, the long dry season and frequent drought makes the animal weak and unproductive. There is need to maintain animals in good body condition during the dry season and therefore cultivation of fodders will be critical. Further, the area sown is not large to supply the quantity required for supplementation during the dry season. There is need therefore to expand area under fodder production to meet the increasing demand. Several thrust are proposed:

(i) The pastoralists have limited background on fodders cultivation and hence training will build their capacity on production. Training to improve their skills and knowledge will be required on land preparation, planting, management, harvesting hay making and storage.

(ii) Encourage farmers to multiply and maintain their own seeds. This will solve the perennial problem of seed scarcity especially at planting time.

(iii) Explore way in which the several seasonal laghas in the County could also be used to grow more fodders
The pastoralists should also be encouraged to purchase more animals that are weakened by drought and sell after fattening to generate more income.

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Rehabilitation of Degraded Pasture and Mainstreaming Livestock Nutrition into the Agro-Pastoral Field Schools in Karamoja, Uganda

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Background

Karamoja is an isolated and remote region located to the North eastern region of Uganda. It roughly stretches between 1° and 4° North; and 33° and 35° East. The total area is 27,000 Km². It also has two international boundaries, with Kenya to the East and South Sudan to the North, as shown in figure 1.

This region belongs to the greater Karimojong cluster ecosystem, which also extends into south-eastern Southern Sudan, north-western Kenya, and south-western Ethiopia. Basically, the ecosystem is classified as ASAL (Arid and Semiarid Lands) which also covers the rest of the Greater Horn of Africa (GHA). The major socioeconomic and cultural system for Karamoja is agro-pastoralism. This is a livelihood system whereby livestock management is based on extensive grazing on the rangelands, characterized tactically and strategically by high mobility to track the scattered range resources especially water, pasture and mineral licks on the one hand, and seeking for safety nests from epizootics and conflict hotspots on the other hand.

In the Agro-pastoral farming system, livestock and livestock products play a key role in raising incomes of households. According to analysis of poverty trends using the Uganda National Household Survey time series data (UBOS 2007), it is evident that households that include livestock in their enterprise mix tend to be generally less poor. Close to 95% of the cattle are owned by pastoralists and communal grazers.
The region is generally characterized by poor rainfall distribution and reliability, averaging 700mm per annum, manifested through prolonged dry spells and also occasional flash floods. The magnitude, frequency and severity of these hazards have increased over the past decades seriously eroding the productive assets and traditional coping capacities that support livelihoods. From 2001, there have been extended dry spells every second year (2002, 2004 and 2006), leading to repeated crop failures and low livestock productivity. The years 2007 till now have however experienced sporadic heavy torrents which have resulted in flash floods, also to some extent impacting negatively on Agro-pastoral performance.

Despite the distinctive production zones - pastoral, agro-pastoral and agricultural (figure 1) there is empirical evidence clearly showing that livestock-based livelihoods remain the best economic option for households in Karamoja, both for income maximization and for resilience. According to the livestock census carried out in 2008, Karamoja registered 2.3 million cattle accounting for 19.8% of the total national cattle population. Agro-pastoralism to a certain degree is the main farming system that has been adapted to the region as a specific strategy in response to environmental conditions that make it difficult to sustain crop production.

The increasing crop failures in the region have mainly been attributed to the poor rainfall distribution patterns, rather than the lack of it and yet under the same circumstances, the effect on pasture and browse is of a lesser degree compared to the field crops. A household economy analysis (HEA) study conducted in 2010 by FAO showed that even in a year with almost complete crop failure, the majority of agro pastoral and pastoral households in Karamoja were able to cope without external assistance except for the very poor households who relied on the general food distribution.
Most of the efforts on livestock production in the region have been limited to mass vaccinations campaigns in response to the recurrent disease outbreaks and no attention to livestock nutrition. It should be noted that the prolonged dry spells have also had adverse effects on pasture productivity and therefore on livestock production in general. Basic animal husbandry practices including skills on livestock supplementary feed processing and conservation are limited. These underlying factors affecting livestock productivity, only mirror the virtually over stretched agriculture extension services which in the case of the hard to reach and remote Karamoja, are non-existent in some parts, and where existing, their capacity and coverage are still very limited.

The Food and Agriculture Organization of the United Nations (FAO) in collaboration with the Government of Uganda and respective District Local Governments has been supporting communities in Karamoja to build resilience over the past 6 years through a holistic livelihood
program. The program focused on three integrated priority areas of crop production, livestock production and Land and water management from a Disaster Risk Management (DRM) lens.

FAO is implementing Result area 2 (improving agro-pastoral production) of the Karamoja Livelihoods Program for the project code OSRO/UGA/101/EC: “Improving Food Security and Diversification of Livelihood Opportunities for Communities in Karamoja”. This is a Government of Uganda Program in support of the Peace, Recovery & Development Plan (PRDP) and the Karamoja Integrated Development Plan (KIDP) under the direct supervision of the Office of the Prime Minister. It is funded by the European Commission through its 10th European Development Fund. The overall goal of the KALIP program is to enhance peace and development in Karamoja through supporting the livelihoods, including agro-pastoral production and alternative income generation opportunities for the people of Karamoja. In line with the above, the purpose of the program is to support improved incomes and food security of the agro-pastoral communities to build up their productive asset base.

**Project Description**

The Result Area 4 of the FAO project on improving livestock nutrition was developed in close consultation with the National Livestock Resources Research Institute (NaLIRRI) of the National Agricultural Research Organization (NARO). The collaboration between FAO and NaLIRRI is a Public Private Partnership and technical strategy aimed at supporting the pastoral communities in the region to improving and sustaining the pastoral production capacities to strengthen their resilience against shocks through improved livestock nutrition and productivity. Due to the importance attached to livestock in the region, there is a high potential for communities to quickly adopt good practices that lead towards improved livestock productivity. The activities will be anchored around use of locally available feed supplements; forage processing and preservation; and pasture management and rehabilitation of degraded pasture.

Whereas some of the activities will be implemented across the whole region, the bulk of the activities are to be implemented in the pastoral and agro-pastoral zones of Karamoja. With the exception of rehabilitation of
degraded pasture along the dry season belts, all activities will be implemented through selected Agro Pastoral Field Schools (APFS) as part of the broader medium and long term food security and livelihood interventions in the community.

The APFS is a dynamic and systematic farmer empowerment approach through which skills and knowledge are imparted to the farmers to make appropriate crop and livestock management decisions for improved productivity. The approach responds to the farmers’ needs, offers them the opportunity to learn from each other to improve their production systems and respond to new opportunities and threats. Slightly above 600 FFS/APFS have been established in Karamoja and the communities have shown overwhelming demand for technologies and technological innovations for improving and diversifying production.

NaLIRRI is currently, in collaboration with the technical staff of the respective District Local Governments, the Department of Animal Production and Marketing of the Ministry of Animal Industry and Fisheries (MAAIF), Nabuin Zonal Agricultural Research and Development Institute (NabuinZARDI), NGOs implementing KALIP in the targeted communities, the community leaders (including Kraal leaders, Manyatta leaders and Opinion leaders), and other stakeholders supporting the livestock sector to ensure coherence.

In regard to cost benefit-effectiveness, NaLIRRI will use the new and existing APFS for any demonstrations, learning, and other activities as appropriate. Linkages and synergy with other KALIP components, especially public works will be valuable to especially support the pasture improvement activities, where the need for labor is high. Thus is envisaged to ensure effective and efficient programming.

Objectives and best practices

The overall objective is to improve livestock nutrition among the agro-pastoral communities in Karamoja. While the specific objectives are:

1. To rehabilitate and improve the condition of pastures within the dry season mobility belt of Karamoja through introduction of legumes and improved pasture species,
(ii) To make direct contribution in enhancing livestock value chain as driving force for livelihoods resilience in the region

(iii) To build the capacity of stakeholders and pastoral communities to mainstream livestock nutrition practices into the Agro Pastoral Field Schools, and

(iv) To amplify the positive environmental spill over impact of the project through deliberate promotion of multipurpose leguminous fodder trees, which are good for restoring soil fertility, crop cover, bees forage and fuel wood.

(v) To build synergy between the APFS and CAHWS system as most important approaches in ensuring sustainable livestock development, hence livelihoods resilience in the region

**Outputs**

- Result 1: At least 630 acres of degraded pasture along the dry season mobility routes rehabilitated;

- Result 2: At least 15 nuclei validation and training sites established within the pastoral zone and fully engaged in community outreach;

- Result 3: At least 15 fodder tree nurseries established and supplying seedlings to the community;

- Result 4: A simplified and well illustrated module field tested and mainstreamed into the existing APFS curriculum;

- Result 5: At least 100 APFS facilitators trained on livestock nutrition practices appropriate for Karamoja and able to facilitate the same to APFS groups;

- Result 6: Livestock nutrition practices successfully incorporated as an integral component of the cycle long learning process for the APFS groups being supported; and

- Result 7: Availability and access to legume and grass seeds in the pastoral and agro pastoral zones improved
Specific activities

_Rehabilitate at least 630 acres of degraded pasture along the dry season mobility routes_

a) Sensitisation and Participatory Community Planning: To foster the successful implementation of the pasture improvement activities, the full participation of the beneficiary communities has been put in place. Key among which are the Kraal leaders, household/manyatta heads, opinion leaders and the local leaders involved at all times of the process.

These key activities are in progress

- Community facilitation to draw action plans and develop guidelines on access and management by the beneficiary communities to ensure sustainable use of the improved pasture blocks.

- Pastoral/agro-pastoral migratory patterns have been established in Kaabong, Amudat and Moroto districts. This is within the wider context of the regional migratory pattern

- Facilitation of development of guidelines/bylaws at community level by the communities

- Facilitation of formation of management committees to oversee the activities

- Facilitating/foster collaborative arrangements between the different beneficiary communities on management, protection and sustainable use of the pastures

- Facilitating the development of community action plans for the management, protection and sustainable use of the resources,

- Piloting of haymaking, production cost and provision to livestock

- Collection and provision of nutrient rich acacia pods as dry season supplementary feeding, and

- Facilitating the development of conflict resolution measures
b) **Rehabilitation of 630 acres of degraded pastures in the region**

will be effected, taking into account the traditional migration patterns during the wet and dry seasons. The overall aim is to rehabilitate existing pastures through reseeding with appropriate improved pasture grass species and legumes or over sowing with legumes suitable for the region depending on the soil type and viability of the option. To address the stress periods, priority for improvement will be the dry season pastures. To following activities have been undertaken:

- Condition of pasture/soil condition along migratory routes established

- Status of water resources along migratory routes in Moroto, Amudat and Kaabong assessed. Study and mapping of migration patterns of the pastoral communities during the wet and dry seasons including the average number of animals within the respective locations and the nature of dispersion during migration periods.

- Existing pastures mapped out, as well as an assessment on the state of the mapped pastures in the region

- Evaluation and documentation of the potential for improving the existing pastures in the different locations of the pastoral/agro-pastoral belt, with recommendations on the appropriate interventions and pasture species suitable for the specific areas that can be introduced/promoted;

- Two locations per district in Moroto, Kaabong and Amudat districts identified for establishment of nuclei validation sites in (c) below. Kaabong (Kotor and Lolelia grazing areas); Amudat (Amuna and Loroo grazing lands); Moroto (Nakonyeen grazing lands)

- Recommendation of varieties of improved cereal crops with short maturity periods, high grain and stover yielding, that can be introduced among the pastoral communities.

- Assessment, suggestion/recommendation on the nature of additional activities that may be necessary to support the pasture
improvement activities that may inform the overall programme for future funding.

- Assessment and mapping out existing, and or additional infrastructure that can be used, rehabilitated or developed to support the pasture improvement activities, especially the water points.

**Strategic activities:**

**Establish multiplication sites for important legume and grass seeds**

To maintain the over-sowing and re-seeding activities in future and sustainably upscale the pasture improvement efforts in the region, there will be need for a reliable supply of seed. As a follow up to the training on the various techniques for legume and grass seed multiplication, APFS and individual households will be encouraged to establish multiplication sites of important legumes and grass seeds to ensure local supply.

**Set up community nuclei and validation sites**

To raise community awareness and promote the various good livestock nutrition practices, community nuclei and validation sites will be set up in 15 strategically located APFS in the three districts in the pastoral zone including Amudat, Kaabong and Moroto. The identified sites will act as training and demonstration sites as a means to encourage adoption of such good and important practices. NaLIRRI, together with the APFS facilitators and communities, plan for and identify the various integrated livestock nutrition good practices that can be validated. These may include among others, practices on sustainable pasture management; pasture improvement (reseeding and or over sowing with suitable improved varieties of pasture grasses and legumes) harvesting, preparation and preservation of hay and support them to set up the appropriate preservation infrastructure.
Establish fodder tree nurseries

In a bid to ensure availability of seedlings for the appropriate fodder trees adapted to Karamoja region, a total of 15 fodder tree nurseries are to be established in strategic catchments to be identified in at least 2 sub counties in each of the 7 districts of Karamoja. In addition to seedling production, the nurseries will form centers for learning and adoption by the rest of the communities. As much as possible, the selected species should be multipurpose, to provide fodder and also provide other benefits like fuel wood, enhance soil fertility, control erosion etc. The tree nurseries will be managed by an APFS identified from the beneficiary community. The contractor will:

- Conduct a needs analysis and select 15 appropriate sub-counties to establish fodder tree nurseries for raising seedlings.
- Together with the respective FAO field offices and implementing partners, identify the suitable APFS groups to manage the nursery
- Select appropriate species for the different identified localities, based on the needs of the participating APFS and suitability of the conditions for their proper growth.
- Build the skills of the APFS and neighbouring communities in establishing and managing the tree nurseries.
- Support the communities to plan for the valuable use of the seedlings to raise fodder trees within the APFS manyattas, as well as benefit surrounding communities where demanded, and
- Evaluate the potential for raising such nurseries for income generation by interested APFS and provide the necessary technical support.

Develop training module on basic livestock nutrition practices

NaLIRRI will develop a comprehensive but simplified and well illustrated training manual with accompanying visual aids on basic
livestock nutrition practices. The module should be tailored to the agro pastoral system of Karamoja targeting community based facilitators with limited or no formal training on animal husbandry. This module will be integrated into the broader APFS curriculum as a core component covering among others; principles of livestock nutrition, value of supplementary feeding, types and sources of supplementary feeds, their preparation and conservation, pasture improvement/rehabilitation, sustainable pasture management, preparation and preservation of hay, preparation and use of home-made salt mineral licks, promote the use of crop residues of high stover and grain yielding cereals for animals etc.

**Train APFS Facilitators**

Based on the training module developed, three separate 5-day hands-on practical training workshops will conducted for at least 100 APFS facilitators and Extension staff drawn from Amudat, Kaabong and Moroto Districts

**Conclusion**

1. Promote, upscale and sustain best practices related to fodder production and utilization in the Agropastoral system of Karamoja, Uganda is through rangeland rehabilitation (reseeding with grass, legumes, and multipurpose leguminous trees). To enhance and maximise livestock production and productivity intensive hay making is the practice of choice, which is balanced by supplementation of locally made salt blocks.

2. Currently hay production is still a very grey area which is currently only being popularized through FAOs’ flagship program, the APFS in conjunction with CAHWs. In light of the present situation of rapidly augmenting human population, the pressure over the limited range resources is increasingly obvious as well as the shift towards commercialized economy, the need to intensify productions system through improved fodder management and provision is the best option. This sets the ground to work out a cost benefit system for fodder commercialization, still to be conducted by FAO through the current APFS and consequent programs.
3. The pre-requisite and limiting factor for both best practices in Karamoja is:

- Through tripartite regional (Uganda Kenya-S. Sudan) in regard to cross border conflict management and peace building to ensure peaceful trans-boundary coexistence of pastoralists who share natural resources across international border, especially in the more endowed Ugandan side.

- Stakeholder buy-in of the APFS as the major thrust for skills and capacity enhancement in regard to very limited government extension workers in the Karamoja region, and perhaps in the neighboring countries

- The need for up scaling funding of programs as a watershed approach to support rehabilitation of the degraded pastoral ecosystems

- In relating to marketing of fodder, the need to adopt a holistic approach of livestock health and production should be prioritized, to gain from the regional initiatives e.g. CAADP/NEPAD and IGAD, to enhance livestock value chain

Annexes

Figure 3: Practical training session on various forage resources
Figure 2: Livestock migratory routes in the Horn of Africa

Figure 4: Forage harvesting by the beneficiaries in the community
Figure 5: Beneficiaries' / Participants making Hay

Figure 6: Hay storage
Introduction

The livestock sub-sector contributes about 12% of Kenya’s Gross Domestic Product (GDP), 40% to the agricultural GDP and employs 50% of agricultural labor force. About 60% of Kenya’s livestock herd is found in the arid and semi-arid lands (ASALs), which constitute about 80% of the country. It is estimated that 10 million Kenyans living in the ASALs derive their livelihood largely from Livestock. Livestock resource plays a very important role in Kenya’s socio-economic development and contributes towards household food and nutritional security (National Livestock Policy 2008).

Despite the significant contribution to the national economy, the livestock sub-sector has not been fully developed to its optimum potential. Livestock productivity is constrained by a number of factors including ecological, socio-economic, technical and policy related barriers. The most prevalent setbacks at the production level are the chronic disease outbreaks and feed shortage occasioned by frequent droughts. Drought is by far the leading cause of livestock mortality in Kenya.

Livestock nutrition is one of the most important constraints on increased livestock production, especially during dry season when forage quality and quantity is low. In this period, water is also limiting because most springs are seasonal. This affects all livestock feeding systems including cut and carry, tethered or free grazing systems. During the 2009/10 drought, the total livestock losses were estimated at Ksh. 643.2 billion of which Ksh. 554.0 billion accounting for production losses and 42.5
billion on additional costs on animal health, feed and water (OCHA 2010).

Range condition and trend assessments over the years have often pointed at worsening productivity of natural pastures both in the arid and semi-arid areas of East Africa. The possible options for improving forage availability in semi-arid rangelands can be based on reseeding, de-stocking, change of herd composition and bush management.

**Fodder resources in Kenya**

Eastern Africa is renowned as a centre of genetic diversity of tropical grasses and the centre of greatest diversity of cultivated grass species (Boonman, 1993). Species originating from Eastern Africa, are the most widely planted forage grasses, e.g *Brachiaria* pastures are widely grown in Brazil with estimates ranging from 30 to 70 million hectares (Fisher and Kerridge, 1996). During the Kenya/FAO project on Forage Collection and Evaluation (1974 - 1987), a total of 202 grass and 164 legume accessions were collected from various parts of the country. Some of the grass species collected included *Panicum maximum*, *Cenchrus ciliaris*, *Chloris gayana*, *Digitaria milanjiana*, *Enteropogon macrostachyus*, *Cynodon dactylon*, *Eragrostis superba*, *Leptochloa obtusifolia*, and *Setaria sphacelata*. The legume species collected included *Glycine wightii*, *Clitoria ternatea*, *Crotolaria spp.*, *Lablab purpureus*, *Rhynchosia spp.* and *Stylosanthes guianensis* among others.

**Case studies for pasture/fodder marketing**

**Community based forage seed system**

One of the most limiting factors to reseeding and fodder production is inadequate supply of quality grass seeds. In Kenya, grass/fodder seed available in the market comprises the type that do well in the humid and sub-humid areas such as the *Chloris gayana* and *Lucerne*. Kenya Seed Company (KSC) is the market leader in seed production for cereals, pastures and fodder. The target for KSC is the high rainfall areas where agriculture and livestock production systems are commercialized. There has been less effort in producing seeds for the marginal ASAL areas.
Therefore, there is a need to build the capacity of local communities to increase the availability of quality pasture/fodder seeds for semi arid rangeland grasses through participatory community based seed production system (Mnene, 2006).

Through a pilot project by the Kenyan Agricultural Research Institute (KARI), National Range Research Station at Kiboko, capacity building of farmers entailed equipping them with methods, skills, and knowledge to design, facilitate and implement seed multiplication initiatives in their respective areas. It involved participatory approach based on experiential learning techniques and participatory training methods. The topics covered included; land and natural pasture degradation, natural pasture improvement, site selection for natural pasture establishment, types of range forages and desirable grass species, land preparation, planting, sowing, crop management, forage seed harvesting, seed processing, seed quality and seed certification procedures.

The methodology involved the various players in the seed value chain system (Figure 1), which comprises organizations, individuals and institutions involved in different seed system functions, i.e., system development, seed multiplication, processing, storage, distribution and marketing.

The informal sector was composed of individual farm households, each carrying out seed production functions on its own, with little or no specialization. While, the formal sector is composed of public and private organizations with specialized roles in supplying new varieties. Different types of seeds flow from organizations and individuals from one stage of the seed chain to the next through informal and formal seed supply channels. Linkages with Kenya Plant Health Inspectorate services (KEPHIS) was done to give guidance on rules and regulations such as variety release procedures, intellectual property rights, certification programs, seed standards and contract laws which influence the structure, coordination and performance of the seed value chain system.

**Sustainability**

Local farmers are keen in multiplying grass seed for improvement of livestock productivity and income generation through selling of surplus seeds. Increasing the capability of local people and mobilization of
community-based organizations (CBOs) and groups to handle seed-related operations is key in strengthening seed systems. The practice may be institutionalized through a Community Forage Seed Bank (CFSB). More ASAL zones of the country have to be covered for effective local seed supply systems, especially in drought-prone areas. This will in the long term address the deteriorating range condition and trend assessments over the years which has often pointed at worsening productivity of natural pastures both in the arid and semi-arid areas of Kenya, which has led to low livestock productivity in the ASALs.

![Figure 1. Seed production and supply along the value chain (KARI)](image)

**Prosopis Trees as Source for Animal Feed**

*Prosopis juliflora* (Sw.) DC, hereafter referred to as *Prosopis* is an evergreen tree endemic to South America, Central America and the
Caribbean. It was first introduced to Kenya in 1973 for the rehabilitation of quarries in Mombasa. Later it was introduced to the semi-arid districts of Baringo, Tana river and Turkana districts in the early 1980s (Anderson, 2005).

*Prosopis* spp has been reported by the local communities to be aggressive with a superior competitive advantage compared to the native tree species, resulting to loss of the important plant species that were reliable sources of livestock forage. There are also cases of invasion and allelopathic properties in areas where it was introduced. This loss has also led to loss of biodiversity and encroachment of previously dry season’s livestock grazing areas hence, further threatening the livelihoods of the rural poor. Some members of local communities have sued the government seeking compensation for general damages arising from some injuries on their goats which they attribute to consumption of *Prosopis* such as loss of teeth and poisonous thorns that cause injuries to humans and livestock. The Invasive Species Specialist Group of the IUCN, rated it as one of the world’s top 100 least wanted plant species. *Prosopis* invasion in Kenya is widespread especially in Tana River, Garissa, Baringo and Turkana counties.

On a positive note, *Prosopis* spp can alleviate the effects of drought and feed scarcity in the ASAL. However, *Prosopis* spp still remain an underutilized livestock feed resource in areas prone to chronic droughts. *Prosopis* pods are high in sugar and protein content and are rich food source for livestock like sheep, goats, cattle, pigs and poultry. Rations containing *Prosopis* pods have been recommended for lactating animals and have been said to increase milk production with increasing proportion of pod flour (Guliye 2011).

Through a TCP project supported by FAO and implemented by KEFRI in Baringo county, an integrated management of *Prosopis* through development and utilization of various products was piloted. The project objective was to build the capacity of local communities in management of invasive *Prosopis* spp and development of marketable products. The capacity building of the communities was undertaken through Farmer Field Schools (FFS) approach and involved training, workshops, demonstrations, experimentation, equipment, product development and support to small enterprises.
Among the products development by the project, *Prosopis* pods was the most promising product due to high demand from the animal feed industry. The potential of *Prosopis* in providing much needed feed and fodder in dry lands and the forging of links with the private sector has been the most exiting development to the local communities in Baringo. Promoting the use of *Prosopis* pods has progressed so rapidly that an export order to South Africa (as a dietary supplement) was secured while an animal feed industry in Nairobi secured a contract with the farmers to supply 200 tonnes per month.

The farmers are paid Ksh. 3.0 per kilo and the negotiations are still on to improve the price. Participating households include the landless and extremely poor. Environmentally, the removal and milling of each tonne of pods destroys around two million seeds, with a corresponding effect on controlling the spread of *Prosopis* as a weed, in year one almost 50 million seeds destroyed. No biological, chemical or mechanical control programme could consider the destruction of seeds at such a rate, and this innovative approach is not only cost-free once established, it actually puts money into the community.

**Sustainability**

In communities where training has been held, perceptions on the value of *Prosopis* have changed immediately, and where income has been generated, the whole ‘problem’ of *Prosopis* has been turned into a solution. With a demand for 300 t/month or 36,000 t/yr, this would put USD 120,000 into some of the most marginal communities in Kenya every year, and remove at least 70 billion seeds that would have a significant impact on rural livelihoods and on reducing future spread of *Prosopis* as an invasive weed.

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Best Practices in Feed Management and Utilization in the Borena and Somali Rangelands of Ethiopia

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Abstract

Pastoral production remains the dominant land use in Ethiopia's lowlands (i.e. arid and semi-arid land) usually found below 1,500 meters. Most of the available studies in Ethiopia (PFE, 2006; PFE, IIRR, and DF 2010) indicated that pastoralists constitute with an estimated 10–13 million of Ethiopia's 77 million people, occupy some 60% of the country's land mass. Despite of huge resource potential and significant contributions to the livelihoods, national economy and to rangeland health, there are persistent challenges. There are however, best practices related to feed management and utilization in the rangelands that can be up scalable to similar areas. Therefore, the main objective of this study was to share these best experiences and knowledge adopted in areas having similar socioeconomic and environmental situations. For this study two best practices were selected. One on rangeland management and utilization practice in the rangelands- Borana pastoralists experience (Oromiya region) and the other fodder production and utilization practice in the rangeland along permanent rives as dry season feeding strategies- the case of Sudan Grass (Sorghum sudanense) in Somali region. Kallo or grazing reserve was one of good practices in rangeland management and utilization. These good practices are important coping strategies to overcome/escape critical dry season feed shortages in the rangelands.
Introduction

Pastoral and agro-pastoral production systems remains the dominant land use in Ethiopia’s arid and semi-arid lowlands usually found below 1,500 meters. Most of the available studies in Ethiopia (PFE, 2006; PFE, IIRR, and DF 2010) indicated that pastoralists and agro-pastoralists constitutes with an estimated 10–13 million of Ethiopia’s 77 million people, occupy some 60% the country’s land mass. The main pastoral communities are Somali (53%) in the Southeast, Afar (29%) in the Northeastern, Borena (10%) living in the Southern, Bench maji and South Omo (7%) in the SNNP of Southern and Gambella and Benshangul regions (1%) in the West (Fig. 1).

![Location of major pastoral communities](image)

Figure 1 - Location of major pastoral communities (Source: PFE, IIRR, and DF 2010)

Ethiopian pastoralists and agropastoralists raise a large portion of the national herd, estimated at 30 % of the cattle, 75 % of the goats, 25 % of the sheep, 20 % of the equines and all of the camels (CARE-Ethiopia, 2010). Considering the Ethiopian rangelands, the contribution of Somali Regional State is significant, followed by the rangelands of Afar and Oromiya regional state (Table 1).
Livestock are main livelihood base for Ethiopian pastoralists as a key asset, source of food, income, and social asset forming the basis of social relationships through gifts and exchanges. The contribution of pastoral livestock in the agricultural economy of the country remains lower. Pastoral output underpins almost Ethiopia’s entire live animal and meat exports (IGAD, 2011). The Ethiopian growth and transformation (GTP) plan for pastoral development also sets ambitious targets; increasing export earnings from live animals and meat exports from US$125 million in 2009/10 to US$1 billion in 2014/15 (GOE, 2010).

Despite this huge resource potential and significant contributions to the livelihoods, national economy and to rangeland health, there are persistent challenges, such as continued degradation of the rangelands, shrinkage of land available for grazing and reduced opportunities for mobility. Major contributing factors to these persistent challenges are bush encroachment, continued excision of key grazing areas for irrigation, expansion and other uses (i.e. national parks and crop cultivation) and poor rangeland management practices. Moreover, increasing population and the emerging sedentarization, conflict, and frequent drought, aggravated the challenges. There are, however, best practices related to feed management and utilization in the rangelands that can be up-scalable to similar areas. These practices ranged from rangeland management and utilization practices to areas where there are rivers – such as Afar, Somali and South Omo where agro-pastoralists use small-scale irrigation for fodder production in the rangelands. These best practices are important coping strategies to overcome/escape critical dry season feed shortages. Therefore, the main objective of this paper was to
explore these best experiences and knowledge on feed management and utilization practices on the rangelands adopted and share information for scaling up/out these good practices in areas having similar socioeconomic and environmental situations.

**Materials and Methods**

**Study area description**

Two best practices related to feed management and utilization in the rangelands of Ethiopia were selected to share their experiences and knowledge adopted in areas having similar socioeconomic and environmental situations (Fig. 2). These are:

1. Rangeland management and utilization practice in the rangelands-Borana pastoralists experience (Yabelo district, Borana administrative zone of Oromiya region)
2. Fodder production and utilization practice in the rangeland along permanent rives as dry season feeding strategies - Sudan Grass (Sorghum sudanese) in Godey district, Somali region

![Figure 2 - Map of study sites/districts (in circle)](image-url)
Biophysical and socioeconomic description of the study areas

Yabelo district of Oromiya region: Geographically, the district lies between 4°53’N latitude and 38°5’E longitude. The topography of the district is predominantly plain lowlands, having an elevation range of 350 to 1800 meters above sea level. Mean annual minimum to maximum temperature is between 17°C and 30°C, respectively while the mean annual rainfall is ranging between 500 and 750mm. The district has an area of about 5,550 km², of which 11% is arable or cultivable (7.5% was under annual crops), 52.6% pasture, 7% forest (5.5% state forests), 26.5% bush land and the remaining 3% is considered swampy or degraded. About 90% of the total land in the district is classified as arid and 10% is semi-arid agro-ecology. Yabelo district has a total population of 102,165, of which about 13% were urban dwellers. Average farmland holding sizes per farmer household was 1.85 ha. About 70% of the total farmers of the district were pastoralists. According to district’s office of agriculture, about 238,032 cattle, 39,151 sheep, 98,879 goats, 23,340 camels, 2,766 donkeys, 3,774 equine and 39,783 chickens were available in Yabelo district. Maize, teff, haricot bean and wheat are widely cultivated crops in the order of importance and covers an average area of 6564, 4173, 3146 and 2382 hectares respectively, other crops like sorghum, barley and chick pea are also cultivated in the district.

Godey district of Somali regional state: Geographically the district lies between 5°9’N latitude and 44°5’E longitude in an altitude ranging from 250 to 350 meters above sea level. The district has arid agro ecologic zone and its mean annual minimum to maximum temperature is between 19.1°C and 33.8°C, respectively. The annual rainfall is ranging between 220 and 350mm, distributed in two rainy seasons with main rains in April and May and small rains in September and October. The natural vegetation in the district is a mixture of deciduous bush land and shrub land with different species. The farming system is characterized by pastoralism and agro-pastoralism, having an estimated livestock population of 352,000 cattle, 244,350 sheep, 135,000 goats and 45,000 camels and equines together (SCF-UK, 2001). The major crop grown by agro-pastoralists in the district along the Shebelle includes maize, sorghum, sesame and horticultural crops (i.e. peppers,
tomatoes, carrots, mango, papaya, guava, banana and lemon), according to their order of importance.

The total rural population of Godey district is 95,647, of which 25% (i.e. 23,912) mainly depend their livelihood on Shebelle river. Similarly, total urban population estimate is more than 43,134 (Abdi et al., 2011) and increasingly, destitute agro-pastoralists are becoming settled farmers.

Data collection
In order to capture knowledge, concepts and functions of these good practices, information was gathered in three ways;
1. Key informant interviews involving discussion with elders (i.e. knowledgeable pastoralists)
2. Focus group discussion with expertise and researchers working on the area using a check list
3. Secondary data and direct observation during field visits to reinforce the primary data collected during key informant interviews and group discussion

Results and Discussions
Knowledge, concepts and functions of the good practices in relation to feed management and utilization in the rangelands (Yabelo and Godey) were assessed in detailed and summarized as follows.

1. Improved Rangeland Management & Utilization in Yabelo District of Borena Zone

Rangeland management & utilization practices: Like other tropical rangelands, the Borena rangeland is subjected to interaction of strongly fluctuating natural and manmade calamities. Within this uncertain and variable environment, the Borena pastoralists has developed and practiced both indigenous and introduced rangeland management and utilization practices in order to best maintain an optimal balance between feed resources, livestock and people. The pastoralists in the area pointed out that indigenous strategic rangeland management and
utilization practices have evolved over time and are critical for efficient management and sustainable utilization of rangeland resources. Whereas, none indigenous practices are those introduced by different organizations and research institutions and the pastoralists in the district adapted to use these technologies. Moreover, there exist strong customary institutions to safeguard the indigenous strategic rangeland management and utilization practices as indicated by respondents.

Reseeding, bush clearing, prescribed burning, hay making, grazing management (i.e. grazing reserve or Kallo system and mobility/herd splitting) and use of crop residues as dry season feeding are the good practices available in Yabelo districts. Experts from Yabelo pastoral and agro-pastoral office and Yabelo pastoral and dry land research center also agreed with the above mentioned good practices. Prescribed burning was used mainly to remove encroaching species, control external parasites such as ticks and to produce fresh grasses. It was indicated that, ban on this practice by Derg regime (i.e. former government) has hindered transfer of knowledge and skills on prescribed burning to the Borena pastoralists’ successive generation, hence created knowledge and skills gap on this practice. Angassa and Oba (2009), indicated that it is now being slowly re-introduced. Moreover, pastoralists in Yabelo district are reluctant to practice manual bush clearing as it is labor intensive.

All respondents agreed that grazing reserves-kallo system and grazing management (i.e. herd movements or mobility between grazing land units of the rangeland) are best rangeland management and utilization practices. Moreover, the emerging and promising rangeland rehabilitation practice: reseeding: is another practice which can be taken as best bet as far as sound awareness creation and technical support for pastoralists employed. In this case study, grazing reserves-kallo system, grazing management (i.e. movements and herd splitting) and reseeding has been found among the best practice of range management and utilization in the area, that could be scaled up or out to areas having similar socioeconomic and environmental situations. These good rangeland management and utilization practices are briefly discussed as follows:

**Grazing reserve or “Kallo”:**

Grazing reserve or Kallo in Borena is best bet and well known traditional feed management practice, in which special enclosures (kallos)
established for very special feeding purpose. Pastoralists in Borena used kallos as dry season grazing reserves that entirely meant for calves, lactating cows and sick animals. Interviewed elder pastoralist mentioned that Kallo system in Borena started before half a century.

Kallo is established by closing parts of the rangeland areas to access by animals usually by traditional ways of fencing or delineated with natural features. Enclosures close to villages are normally fenced, whereas large enclosures are marked by natural structures. These enclosures are protected and managed by the community through bylaws and community agreements. Pastoralists usually cleared unwanted plants such as woody species found inside the fenced areas and fencing is done by the community as it requires extensive labor. Sometimes there is a practice of prescribed burning following fencing, which reportedly led to abundant post-fire pasture sprout during the long rainy season (Boku Tache, 2010). In relation to drought survival, site selection also considered, like proximity to perennial wells in order to contribute to a smooth transition of the emaciated animals to safe season by reducing physical stress aggravated by long distance mobility. Moreover, NGO initiated Kallos considered site selections as degraded and bush encroached land for the purpose of rehabilitating severely degraded land and clearing bush, respectively.

Pastoral elder respondent stated that the size of Kallo is determined by two main factors. The numbers of livestock (i.e. lactating cow, calves and sick animals) in an olla (i.e. Village); and rainy season anticipated in the coming year as well as current forage conditions are the determinant factors of Kallo size. Therefore, in seasons in which the pastoralists expect drought the size of kallo would be bigger, while in good years the size of the Kallo will be smaller. Moreover, information collected from literatures indicated that average size of a Kallo was 7ha, with a range between 1 and 42 ha (Solomon et al, 2007) while, Menwyelet (1990) in Solomon et al, (2007) estimated the average size to be 12 ha with a range of 1–80 ha. The size of kallo also varies with their types, such as the size of Seera Yabbii (i.e. a kallo type established for grazing calves and relatively small, around 10 ha or less) is smaller than Semi-private/communal enclosures (Fig. 3).
Management and Utilization of Kallo: The reserved pasture is either grazed openly by the target herd classes or cut and carried for indoor feeding or both. The community bylaws also forbid grass cutting for thatching purposes. Decision on opening at appropriate times, management and utilization of Kallos is made by the community bylaws (Boku Tache, 2010). Respondents indicated that decision making on access, utilization and management of Kallos are entirely made at the ollas (village) level by the olla leader and elders of the community. However, the traditional Borena natural resource management system allowed pastoralists from other areas to use Kallos but the host communities of ollas (village) would agree (Alison and Solomon, 2011). In Bule Harsogido (Hallona village) of Arero district, Borena zone enclosure management is a responsibility of the community as a whole while elders coordinate routine activities to ensure that all the user villages equally participate in the fence reinforcement task and use the product equitably. Moreover, in this district an intentional breach of the customary rule governing the resource use and management entails fines amounting to 300 Birr (now raised to 500 Birr) although the latter are rarely collected as offenders are often pardoned upon public apology. If collected, however, the money is used either for an upkeep of the enclosure or for covering periodical contributions expected of the constituent villagers by the the District. On the contrary, at Irressa Tibba (Wacille village) half of the 300 Birr fines collected from the illegal resource users was meant for the guard’s salary while the other half was earmarked for the upkeep of the reserve itself (Boku Tache, 2010). The grazing reserves usually closed around the onset of rainy seasons and
opened in dry season. If Grazing reserves or Kallos well managed and integrated with customary land use, the Borena pastoralists practices could be best bet up scalable range management and utilization tool as they are based on indigenous knowledge in availing feed for critical times and integrating aspects of environmental conservation and resource use.

Figure 4  Hay production from community managed enclosure Simminto village, Borena zone (Source: Boku Tache, 2010)

Grazing management: Movements and herd splitting

Like Kallo system, grazing management practices of the Borena pastoralists are best bet and well known traditional rangeland management and utilization practices. Herd movements within and between rangeland units as well as herd splitting are best grazing management practices. In herd movements practice herders rotated livestock from one landscape to another allowing the grasslands to revegetate after being grazed by livestock. Moreover, this practice allowed pastoralists to have access to all range resources of Borena rangeland.
According to the interviewed elder pastoralists, the whole Borena rangeland have divided into 5 production systems (locally called "dheeda"), each containing minerals, pasture and water. Herd movement or rotational grazing is practiced within and between these 5 dheeda. The distance covered in one day could be more than 10 km, which agrees with the different reports on pastoralists movements indicating up to 18 km per day (Oba, 1998). The Borena pastoralists further divided the grazing land into wet and dry season areas. The dry season areas were found around permanent water sources such as permanent wells and it’s relatively smaller in size than wet season grazing area. As described by pastoralists, livestock spend short grazing time on wet season grazing area to give chance for grass species regenerate after grazing. Grazing land units are protected from overgrazing through bylaws or customary institutions. When grazing period of a given grazing land unit is exhausted, another grazing land unit would be identified by a scout (i.e. usually young pastoralists). According to elder pastoralists, the scout will look at preferred grass species (like Cenchrus ciliaris for example), grass height, water availability and its capacity to identify rangeland unit ready for grazing.
Herd splitting is another best bet and well known traditional grazing management practice in Borena rangelands. According to the respondents, livestock in a given village were divided into two main groups. The first group locally called warra consisted of calves, lactating cows and sick animals on grazing lands close to village and the second group locally called forra consisted of satellite herds. The grazing land around the village would only be used to support animals needed by households on a daily basis or those unable to move long distances or warra herd and this grazing land was established to a radius of 16km (Skinner, 2010). Warra animals would be moved to the forra herd when appropriate in order to prevent unnecessary grazing pressure in village areas. Moreover, villages would be moved every 5 to 8 years, and with it the warra herd would gain access to new pasture (Homewood, 2008).

**Reseeding**

Reseeding in Yabelo district is practiced by collecting seeds of highly preferred local grass species in the area and sowing them on severely degraded rangeland parts after plowing. Researchers from Yabelo pastoral and agro-pastoral office and Yabelo pastoral and dry land research center indicated that reseeding of grasses in the district is started in 2006. Degraded rangeland parts; that could not be rehabilitated using enclosure approach (i.e. due to its low soil seed bank contents) are normally the primary sites for reseeding. Land preparation is made by plowing using oxen and fertilizer (usually manure) is applied after plowing. Following this, seeds of grass species will be sown at the onset of main rainy season by broadcasting. Sown fields will be trampled by animals for better seed and soil contact. Species identified by respondents that are suitable for reseeding practice were Chloris gayanna locally called “Horsira”, Cenchrus ciliaris and Penisetum mezanium. When the reseeded rangelands rehabilitated and reached for use, two types of utilization methods usually applied like that of the Kallo system; grazing by lactating cows, calves and sick animals or cut and carry system locally called “Oka”. The Oka system is usually practiced in inaccessible areas.

A research conducted at Yabelo pastoral and dry land research center revealed that reseeding with manure application showed positive results (Fig. 6). However, several attempts by government and non-government organizations failed to attain anticipated results to scale up/out. Several reasons has been pointed out by respondents, among others lack of
quality seed (viability) and poor technical skills (i.e. poor land preparation and inappropriate time of seeding) are the main once. Generally it was indicated that for scaling up reseeding of degraded rangelands there is a need to do awareness creation and trainings of pastoralists as it requires relatively more intensive management including collection of seeds, land preparation, sowing and over all follow up managements of the field (Skinner, 2010).

Figure 6 - Rehabilitated rangeland using reseeding. (Source: Yabelo Pastoral and Dry land Research Center)

2. Sudan Grass Production and Utilization Practice as dry season feeding strategies in Godey District (Somali region).

Improved forage production practice in Godey district started with establishment of group-based small scale irrigation schemes by Livelihood Support for Somali Agro-Pastoralists program (L-SAP) project of CHF international along the Wabe Shabelle river for the production of food and cash crops to improve the household income and assets of targeted poor households. In 2008, forage production by Barsan cooperative group received further support from CHF international through provision of seeds of grass species together with sesame, onion, tomato and beans seed. The group also cultivated maize for animal feed. Moreover, with the development of improved forage production
technologies by Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI) through introduction and testing forage species for their wide acceptability and superior performance, more forage species has reached to agro-pastoral cooperative groups in the district since 2008. Among the introduced forage species, Sudan grass (*Sorghum sudanense*) is the most common fodder widely accepted and produced by most agro-pastoralists in Barsan and Debafed villages of Godey district (Fig. 7). Sudan grass has been recently reached to the farmers’ research and extension groups (FREGs) at small scale prescling up demonstration level through Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI, 2012). Respondents indicated that Sudan grass has many advantages including its ease of establishment, higher biomass yield and regrowth ability (up to four harvests in one planting) and free from diseases. Other forage species cultivated in the area were *Pennisetum purpureum, Panicum antidotatum, Cinchurus ciliaris, Chloris gayanna, Cajanus cajan, Vigna unguiculata, Medicago sativa* and *Macroptilum atropurpurem*. However, cultivation of these forage species was not common and varied across farms depending on season and farm productivity.

It was also reported that the growing of fodder particularly in Barsan village opened the eyes of pastoralists to non grazing options for feeding livestock and encourage people to cut and carry grass for feed.

Sheik Mehadi Sheik Husen, age 54, Chairman of Dekalberdale cooperative and Cashier of Shebelle union agropastoral cooperative, owing 27 cattle, 25 goats and 3 donkey; having more than 10 ha of farmland of which 3 ha is meant for improved forage production (i.e. Sudan grass mainly), gave us the following history on Sudan grass production practice in the area:

"The Research institutions and NGOs convinced us to plant Sudan grass for livestock feed through training, awareness creation meetings, exchange visits, etc. Initially most of us planted seed of Sudan grass obtained from SoRPARI on very small portion of our farmland. However, we gradually accepted the technology and increased the size of land allocated for Sudan grass production. Availability of fodder during critical feed shortage period usually at long dry season and income generated through the sale of fodder and its seed has contributed to our attitudinal changes toward this technology. Moreover, cultivation Sudan grass requires relatively low inputs, easy to establish and produces high biomass yield from its regrowths"."
Production practices of Sudan grass by agropastorals

Normally establishment of Sudan grass is made on large fields, which are on average about 3 hectares per household. Seedbeds are prepared by clearing weeds and light tillage or simple soil disturbance. The field is also leveled with well designed furrows for efficient irrigation. In the study area farmers use seed rate of 10-15 kg/ha for Sudan grass. This is relatively low compared to the recommended rate of about 12-16 kg/ha,
JEPSGPI, 2008); mainly due to high soil fertility status of the district in general. Sowing is made usually by broadcasting at shallow depths close to the surface. This is because farmers practice of partial or minimum tillage to save labor. In covering surface sown seeds, farmers do either driving animals (usually sheep and/or goats) back and forth or dragging a spiny tree branch devoid of leaves to consolidate the soil and provide better soil/seed contact.

Fertilizer is rarely applied as the soil in the area is adequately fertile and the high cost of chemical fertilizers are not affordable and encouraging the farmers. Farmers use surface irrigation, but the interval varies with plant growth stage. At early growth stage; from planting until the plant reaches to knee height; irrigation interval is from one to two weeks, and then after irrigation is done about every two to three weeks. Moreover, irrigation is applied at relatively narrower interval during the hottest periods.

The sown Sudan grass is harvested at maturity for seed production which took about two months. Then the second harvest after 4 to 5 weeks regrowth will be harvested for forage at the age of flowering/blooming (50% blooming). The forage could be either grazed or conserved as hay. This is the stage in which the forage produced is high in both quality and quantity. Farmers in the study leave average stubble height of 10cm when the grass is cut for hay. This is mainly to facilitate fast recovery and higher tillering capacity. With this management practice, high quality hay is produced during the second and subsequent cuttings as farmers don’t allow the forage to over mature. In the study area, the grass generally may be cut up to four times but, fifth cutting may be possible by few farmers.

Manual harvesting of mature seeds has been considered as the most appropriate practice of forage seed production in study area. Manual harvesting of mature seeds was done by cutting the panicle, putting it in to sack and drying, then followed threshing dried panicles manually on the sack.

**Conservation & utilization practices of Sudan grass:**
Hay is the most common fodder conservation practice in the studied area (Barsen). Sudan grass is harvested at blooming stage while the plant is still green. Harvesting is done manually. The harvested biomass is sun
cured for about five days, followed by collection and pile commonly under shades like big trees. Farmers described that, bleached color hay is an indication of bad quality. Respondents in the study area indicated that Sudan grass is conserved in the form of hay for two main reasons. First, it serves as drought escaping mechanism at the time of critical feed shortage usually during long dry season. Secondly, farmers also benefited as means of generating cash especially during the long dry season when feed shortage is critical. Some farmers have also explained that fodder production has the benefit to escape drought seasons, generate income from both seed and forage selling, and more importantly make their animals productive (milk production) regularly due to the strategic feeding.

Conserved hay is mostly utilized during pick dry season and given to priority animals to cope with feed shortage agro-pastoralists at Godey district commonly divide their livestock into different groups for various reasons. In Barsen village, the purpose is to provide the more productive animals, with more and quality hay particularly at pick dry season of a year. According the interviewed elders, at pick dry season lactating cows and their calves usually given conserved hay three times a day (i.e. in the morning, afternoon and at night). The non-dairy cattle (i.e. heifers, young bulls, dry cows) that graze freely on rangelands, supplemented with hay mostly in the morning and evenings, during the long dry season when feed shortage is critical.

**Fodder and seed marketing practices**

Hay is preferably sold during pick dry season to get better earn. Green fodder is also sold on local market to other pastoralists and agro-pastoralists but the price is low compared to the hay. Price of hay varied with season in which it is sold relatively with higher price during the dry season (i.e. price of one donkey cart hay is between 200-300 birr during this time), at low price during wet season (i.e. one donkey cart hay is between 100-150 birr). There is also a practice of selling standing forage in the study area, according to respondents standing forage is sold between 3000-4000 birr/ha. Although there is problem of seed marketing in the area, respondents reported seed of Sudan grass is sold at 80 birr/kg to district pastoral and agro-pastoral office.
Benefits obtained:
The key reasons identified by respondents for undertaking irrigated farming in general and forage production from Sudan grass in particular were to protect their livestock assets against recurrent drought. The value of fodder production was explained by reference to two trends viz. reduction in forage as rangelands was converted to farmland, and damage being caused to natural grazing lands (i.e. rangelands) due to invasion of *Prosopis juliflora* (Ayele Gebre-Mariam, 2005). Moreover, fodder conserved for dry season feeding and income obtained from the sale of fodder and forage seed was another major benefit the agro-pastoralists obtained.

Associated problems:
The problems associated with irrigated farming in general and fodder production in particular in the study district are mainly related with pump and its spare parts, fuel and access to market for produced items. Fuel shortage is a common phenomenon and major bottleneck for the benefits to be obtained from this activity. Moreover, fuel consumption of the pump is increasing with age of the pump. Similarly farmers complained that there is limited availability of spare parts for their pumps. Moreover, the available spare parts at local markets are poor in quality. Farmers also mentioned that the pumps currently operating on the site are low in capacity to fulfill farmer’s demand. Two main reasons are raised for this by farmers; these are irrigated farming is increasing through time and capacity of available pumps are reducing as they aged. Farmers felt that there is no market opportunity for their products particularly for forage seed. As a result, they usually forced to sell it at local market with very low prices.

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162

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Pastoral and Agro-Pastoral Systems in South Sudan

Daniel Pitia Tongun and Stanley Lado Severino

Introduction

The Republic of South Sudan is located in Eastern Africa, and borders with Sudan, Uganda, Ethiopia, the Central African Republic (CAR), the Democratic Republic of Congo (DRC) and Kenya. It covers an estimated area of 644,329 km². The country has a population of 8.26 million people. It is estimated that 83% of the population lives in the rural areas, and 78% of households rely on agriculture or animal husbandry as their primary source of livelihood.

South Sudan has an estimated livestock population of 13,750,000 heads of cattle, 10,085,801 heads of sheep and 12,387,001 heads of goat. Indigenous breeds of cattle, kept under traditional management are the most important type of livestock in South Sudan. Although cattle dominate livestock sector; small ruminants also play an important socio-economic role in the pastoral and agro-pastoral livelihood. Southern Sudan is culturally, geographically and religiously diverse and well endowed with natural resources, including: water, animals, wildlife, forest, oil and other mineral resources. Despite these enormous economic resources, the economic contribution of the livestock sector to the National Gross Domestic Product (GDP) is negligible due to the presence of endemic livestock diseases and poor management.

Pastoralism, the use of extensive grazing on rangeland for livestock production, is one of the key production systems in the South Sudan. Nonetheless throughout much of its long history, its reputation has been poor and its practitioner marginalized by sedentary cultivators and urban dwellers. Pastoral societies in South Sudan are categorized based on a number of criteria. The most important categorizations are based on species, management system, geography and ecology.

Pastoralism evolved as a response to two factors: medium human population densities and the presence of extensive rangeland, usually in
semi-arid regions. In South Sudan, pastoralism is strongly associated with the presence of grasslands and they tend to exist in complex relationships with hunter-gatherers.

Agro-pastoralists hold land right and use their own or hired labor to cultivate land and grow staples. While livestock is still valued property, agro-pastoralists' herds are usually smaller than those found in other pastoral systems, possibly because they no longer rely solely on livestock and depend on a relatively limited grazing area which can be reached from their villages within day.

In South Sudan, agro-pastoralists invest more in housing and other local infrastructures and if their herds become large, they often send them away with more nomadic pastoralists. Agro-pastoralism is often the key to the interaction between the sedentary and the mobile communities sharing the same ethno-linguistic identity with the pastoralists. Agro-pastoralists often act as brokers in establishing cattle tracks, negotiating the camping of herds in farms (when crop residues can be exchanged for valuable manure) and arranging for the rearing of work animals to add value to overall agricultural production.

**Ecological Zones of South Sudan**

**The Green Belt (Rain Forests):** This included the extreme South-West of Western Equatoria extending approximately to the 1,350 mm isohyets. Besides the Zande Land, the green belt also covers the South West half of Yei River County and in particular, the Aloma plateau area, excluding the Kajo-keji plain. It also covers the Acholi highland in Upper Talanga Eastern Equatoria. The green belt receives the highest amount of rainfall in the region ranging from 1,350 mm to 1,600 mm per annum, which spreads from 8 to 9 months. Soil types were red lateritic and acidic and were subjected to leaching. The vegetation was broad leafed woodland savanna with several species of perennial and annual grasses. The area was highly infested with tsetse flies.

**The Ironstone Plateau:** This area was comprised of Western and South-Western parts of Bahr El Gahazl and Equatoria. It receives rainfall ranging from 900 to 1,300 mm per annum. The Ironstone possesses a soil property of red acidic with high content of iron-oxide, which was predominantly lateritic with low fertility due to leaching and erosion. The vegetation type is broad-leafed woodland with several varieties of tree
species. Along the Fringes of the ironstone plateau, bordering the flood region was a narrow belt of sandy alluvial deposits. The vegetation is mainly composed of poorly developed scattered trees. There are several species of perennial and annual grasses whose herbaceous biomass is low, matures very quickly and quality especially its digestible protein content decrease very rapidly.

**The Central Hills Area:** This area includes the greater parts of Juba, Torit, Yei and Mundri districts. Similar to Ironstone plateau, rainfall varies between 900 and 1,300 mm per annum. Soils were young, shallow, lateritic and acidic with undulating topography leading to considerable sheet of erosion. Vegetation consisted of poorly developed scattered trees due to consistent and uncontrolled dry season burning of the grasses.

**The South- Eastern Hills and Mountains:** This covers Eastern Equatoria and Merges with the flood plains in the north and semi-arid parts of northern border of Kenya. The high altitude areas in the zone, which have higher altitudes more than 1,800 m above sea level, consisted of Didinga, Imatong and Boma mountain and received an annual rainfall ranging from 1,100 mm in Diding hills to 2,200 mm in Imatong lasting for 7 to 9 months. Vegetation consisted of shrubs trees and low grasses.

**The Mountain slopes and Hills:** It is a high altitude area 1,000 m above sea levels, the soil is deeper than that of ironstone plateau and ground water is readily available near the surface of the soil. The land is suitable for rearing livestock, especially dwarfs or hill goats since there are growing of the shrubs at the fringes of the hills.

**The Central Flood Plain:** These comprise parts of Southern Upper Nile, Northern and North-Eastern Bahr El Gahzal, Jongeli, Eastern Equatoria and large parts of Lakes State. These areas constitute about half of the South Sudan and are sub-divided into four main land types with similar rainfall pattern (750-1,000 mm/Annum lasting for 5 to 7 months), which include:

A. **The high ground area (Highland):** The highland areas are widespread patches of ground areas and termite mounts, which can remain un-flooded during the rainy season. The property of soil is sandy and permeable with better drainage alluvial banks of rivers. The vegetation consists of thorny and open-mixed woodland/savanna with abundant types of perennial and annual grasses. This is the area
where there are few human settlement, cultivation and livestock grazing during the rainy season.

B. **Intermediate Land:** This is rain flooded grassland, which covers parts of Southern Upper Nile, Jonglei and parts of Unity State. It lies between the highland and Toich. The intermediate land has cracking alkaline clay soils, which is dominated by open short annual grasses with patches of acacia woodlands. The area constitutes good grazing land for livestock during the rainy season and specially when going towards the dried season as the flood water moved towards the river.

C. **Toich area:** This is a common Nilotic word for the flood plains or river flooded grassland. It lies below the intermediate land and the Sudd. This area with its fertile clay soil supports luxuriant native grasses such as the elephant grasses and the papyrus spp.

D. **The Sudd:** This is a permanent swamp with fertile alluvial clay soils dominated by papyrus grasses. It is a very important ecological zone, which is a seasonal migratory root for birds of different types. Therefore, each of the first three land types is seasonally essential for the maintenance of the rural economy of the inhabitants but the fourth land type is of marginally economic value gained from fishing.

**The Central Rain Lands:** This zone is confined to Northern Upper Nile around Renk. It has four months rainfall of 400 to 600 mm per annum while the southern part receives 670 to 760 mm per annum that spreads over 6 months. In the north, bushy thickets of acacia trees were found, most of which have been cleared for large scale cultivation around Renk, which the Southern part is dominated by grassy open thorny woodland.

**Constraints:** Insecurity, Conflicts (Agriculturalists and Pastoralists), Cattle rustling and Livestock Diseases

**Way-forward:**

- Improve the productivity and conservation of natural pastures and fodder plants, establishment & rehabilitation of ranches and increase demonstration activities to farmers
- Introduction of improve and appropriate technologies to improve supply of water and reduce degradation and deterioration of the quality of natural grazing.
Introduction

Kenya’s agricultural productivity is determined by factors such as climate, hydrology and terrain (Jaetzold et al., 2009). These agro-ecological factors also determine the suitability of an area for a particular land use and ultimately inform the zoning processes. There are seven agro-ecological zones that represent major ecosystems as well as productivity and suitability of land (Pratt and Gwyne, 1977). Land’s agricultural potential can be classified as high, medium or low. The high to medium potential land covers agro-ecological zone 1, 2 and 3. It comprises of about 20 percent of the country’s total receiving average rainfall of more than 800 mm per annum, the minimum required for rain-fed agriculture.

The arid and semi arid lands largely occupy northern and eastern Kenya as well as the southern margins of the central Kenya highlands. The semi-arid area covers about 20 percent of the entire land area and is under agro-ecological zones 4 and 5. The arid area, which is characterized by desert conditions, covers around 60 percent of the total landmass and is under agro ecological zones 6 and 7. The ASALs have an average annual rainfall of 400 mm. Droughts are frequent and crops fail in one out of every three seasons. Therefore, Most of the areas are rangelands which are suitable for ranching and pastoralism.

Land degradation in Kenya

In the year 1997, 64 percent of Kenya’s landmass was subject to moderate land degradation and about 23 percent to very severe degradation problems, the later had increased to nearly 30 percent in the
early 2000s with the cultivated areas and grasslands being particularly affected (Muchena 2008, Bai et al., 2008). This degradation manifests itself as gully erosion with the problem appearing to be most pronounced in the Eastern and North Eastern parts of Kenya where 12.3 percent of land suffers from severe degradation, 52 percent from moderate degradation and 33 percent is vulnerable to land degradation.

Why fodder production?

Fodder production and its use is driven by the following major factors:

- Extreme seasonal experiences with more frequent droughts becoming less predictable and rainfall patterns more erratic. The livestock keepers can no longer rely on predictable pastures and are choosing to settle near the fodder supplies which offer more reliable availability.

- Urban and peri-urban population and associated demand for fodder have created a fodder market that is steadily growing.

- Improved incomes for livelihoods from fodder production and trade encouraging more farmers who have access to land and water to go into fodder production.

- Extension education and increased awareness of the production potential offer greater appreciation of benefits possible from fodder production and trading.

- The rivers that pass through ASALs of Kenya- e.g Tana, and Daua can be used to produce fodder and food crops. Soil along the river bank can be conserved

A. Fodder production in the agropastoral livelihood zones of eastern Kenya Iviani in Kenya

Excessive pressure on the vegetation by livestock is a considerable problem that has adversely affected the production potential and carrying capacity of Kenya’s ASALs. The growth of the pastoralist population and subsequent increase of the livestock population have led to the extension of grazing activity into semi-arid marginal lands causing severe degradation (Figure 1) and reduced livestock yields as shown in figure 1.
The impact of grazing in the drier areas is most evident around watering points and settlement areas, which are grazed until they are bare leading to malnourished animals and even livestock deaths. The cumulative effect of extensive land degradation has reduced the carrying capacity in all the country’s agro-ecological zones leading to soil erosion and depletion of the natural seed banks in the soil. Figure 2 shows initiatives by the Ministry of Livestock development to rehabilitate degraded agro pastoral lands in Makueni. Figure 3 shows targeted community members being trained on fodder production in Makueni.

Figure 2. Constructed semi-circular pans and reseeding in Makueni Ivani using *Eragrostis superba* (masai love grass)
Seed bulking and hay conservation techniques have been a key challenge. In most cases, almost about 40 percent of the fodder and seed harvested goes to waste. Hence, there is need to develop appropriate conservation measures and utilise the seeds before their lifespan expires. Figure 4 shows farmers being trained on seed bulking and hay conservation.

B. Fodder production in the irrigated livelihood zones

There are irrigated agropastoral areas like in Garissa along river Tana, Mandera along river Daua and in Baringo, where fodder is grown along the riverside.
The community members have to come together and identify their needs, share expectations as shown in figure 6. Generally the average farm size ranges from 1.2 to 48.6 hectares. Some of land owners lease idle plots or land left fallow to roaming livestock keepers for their animals to graze on the crop residues.

The fodder is used to feed livestock and the surplus is sold to other livestock users, either directly or through transporters and traders in and around the mentioned towns. Figure 6 shows community members harvesting Sudan grass along river Daua in Mandera and dairy goats feeding on the surplus.

The significant fodder types found in the areas are maize stover, cowpeas vines, sorghum stalks, Napier and fresh Sudan grass as well as weeds harvested from farms by labourers.
C. Hay conservation

Hodder can be used to bridge feed deficits during lean periods. Conservation can also be used to reduce feed losses. Figure 8 below shows conserved hay under a typical pastoral situation and improved hay shed packed with bales of hay.

Figure 8. Open and constructed hay shed in Mandera

Conclusion

The Ministry of livestock development in Kenya (through the District Livestock Production Office) ensures that there is harmonization of
fodder production activities by the various supporting organizations in the pastoral and agropastoral areas. In collaboration with supporting organizations like KARI; FAO GIZ, COOPI among others, the gaps are identified and areas requiring assistance are known. The Ministry also continues to provide extension education as part of its official mandate. Community members are educated on the advantages of the forages being introduced, how to establish them, followed up with advisory visits.

Acknowledgement

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References


Successful Practices in Range Improvement Adopted in the Karamoja Agro-Pastoral System of Uganda

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Introduction

This presentation is based on a study commissioned by FAO in Karamoja region in the result area 2 (improving agro-pastoral production and productivity) of the Karamoja Livelihoods Program under the project “Improving Food Security and Diversification of Livelihood Opportunities for Communities in Karamoja”. This is a Government of Uganda Program in support of the Peace, Recovery & Development Plan (PRDP) and the Karamoja Integrated Development Plan (KIDP) under the direct supervision of the Office of the Prime Minister. It is funded by the European Commission by its 10th European Development Fund. The overall goal of the KALIP program is to enhance peace and development in Karamoja through supporting the livelihoods, including agro-pastoral production and alternative income generation opportunities for the people of Karamoja. In line with this, the purpose of the program is to support improved incomes and food security of the agro-pastoral communities to build up their productive asset base. The broad objective is to improve livestock nutrition among 50% of the agro-pastoralists with the following activities:

- Promote and sensitize communities on conservation and use of locally available feed supplements
- Train on harvesting, preparation and preservation of hay, using manual wooden hay balers
- Facilitate construction of fodder barns in selected APFS
- Establish fodder tree nurseries
- Rehabilitate degraded pasture along the dry season mobility routes
The Conceptual framework

Being an arid and semi-arid region, the most sustainable livelihoods option is premised on extensive livestock production, where the imperative is mobility in search of the scarce range resources; pasture and water. In order to appreciate the importance of adequate animal nutrition in animal production and productivity, the component of improving livestock nutrition under the “Karamoja Livelihood Improvement Programme” seeks to improve the various aspects of animal nutrition so as to enhance the sustainability of livestock production systems in the region.

Specifically, the project seeks to rehabilitate and improve the condition of pastures within the dry season mobility belt of Karamoja. These conditions include the introduction of legumes and improved pasture species as well as to building the capacity of stakeholders and pastoral communities to mainstream livestock nutrition practices into the Agro Pastoral Field Schools. The project on improving livestock nutrition is being implemented by the National Livestock Resources and Research Institute (NaLIRRI) and its sister research institutes MAAIF, in very close collaboration. In order to guide as well as inform future implementation of project activities, a situation analysis was conducted by the project implementation team to:

1. Study and map the migration patterns of the pastoral communities during the wet and dry seasons including the average number of animals within the respective locations and the nature of dispersion during migration periods.

2. Map out existing pastures and provide an assessment on the state of the mapped pastures in the region and the existing utilization practices including the strength and weakness to use as lesson.

3. Evaluate and document the potential for improving the existing pastures in the different locations of the pastoral/agro-pastoral belt, with recommendations on the appropriate interventions and pasture species suitable for the specific areas.

4. Identify 2 locations per district in Moroto, Kaabong and Amudat districts along migratory routes for rehabilitation of degraded pasture.
Promotion of good rangeland practice conducted in four selected districts of Karamoja to see the following situations:

1. Grazing management
2. Dry season migratory routes management
3. Fodder conservation/Bank management
4. Control of invasive species

Pastoral / agro-pastoral migratory routes/patterns and Grazing Management

Seasonal patterns of grazing are a key element in the flexible response of Karimojong agro-pastoralists to uncertain resources. This is indeed a tactical and strategic coping mechanism where the dictum crops are stationery whilst livestock are mobile, the basis for pastoral sustainability. Herders move livestock frequently in order to achieve optimum exploitation of available pasture and water.

While a whole variety of factors influence movement in any given season, it is possible to identify typical seasonal patterns of movement. The productivity of the pastoral system depends on the ability of herders to move frequently to new areas of grazing in response to unpredictable rainfall and epizootics. This mobile exploitation of communally held grazing has proved the most optimal use of arid and semi arid ‘non equilibrium’ environments. It is also essential for the conservation of resources. Seasonal resource use patterns enable the best watered and lush pastures to be left for grazing well into the dry season while the herds roamed far and wide to feed on short term grass available only at the beginning of the wet season.

Recent events in Karamoja have, however, led to significant distortion in the traditional migratory patterns. Such are the high incidences of inter ethnic cattle raids driven by the social-economic gains, which led to emergence of protected kraals in most of the districts. A protected kraal consists of several herds of animals (goats, sheep, camels and cattle) from several closely related communities, kept in one place under the protection of the army.

The presence of the army is intended to protect herds of a given community from raids by other ethnic communities. Structurally, a
protected kraal consists of a strong enclosure/fence made from locally available woody species particularly from Acacia species. Internally, the kraal is sub-divided into several partitions to represent the different herds within the kraal. Each partition is further sub-divided in sub-partitions to separate cattle, goats and sheep. The animals in the kraal are collected by the owners every morning, taken for grazing in the surrounding areas and returned to the kraal in the evening. When the surrounding grazing resources are exhausted or when water is inadequate, the kraal shifts to a new location in search of pasture and water, still under the protection of the army.

One point of interest to note is that because of a better natural resources endowment of the Ugandan ecosystem in comparison to the neighbouring countries of Southern Sudan, Kenyan Turkana and Pokot, the livestock of these communities always migrate to the Ugandan side for several months of the dry periods in search of water and pasture.

Status of pastures, soil and water resources along migratory routes

Pastures

There is a general variation in the herbaceous component of the pasture swards in selected grazing areas across the region. In some cases, where the legume component in pasture swards was clearly missing, it was suggested that the protein content obtained from such pasture is inadequate to achieve the potential animal productivity. The values for wet season dry matter production for selected grazing lands ranged between 890 and 5800 kg/ha\(^{-1}\) (Table 1).

The variations in dry matter production were partly attributed to the dominant grass species existing on the different grazing lands. The common grass species are *Sporobolus ioclados*, *Dactyloctenium aegyptium* and *Pennisetum mezianum*. *Cynodon dactylon* was noted to dominate areas previously occupied by kraals but the proportion of the species reduces with increasing distance away from kraal sites. *Sporobolus ioclados*, commonly referred to as “salty grass” and locally known as Eleti, is mainly predominant on the pastoral and agro-pastoral
agro-ecological zones of Karamoja. The grass has a high salt concentration making it very palatable to animals and hence one of the major determinants of wet season migratory patterns because herders deliberately search for sites dominated by the grass.

Table 1. Dry matter production and composition of pastures in selected grazing areas along migratory routes during the wet season

<table>
<thead>
<tr>
<th>District</th>
<th>Grazing land</th>
<th>Parish</th>
<th>Sub-county</th>
<th>Wet season dry matter (kg/ha⁻¹)</th>
<th>Basal Cover (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Grass</td>
</tr>
<tr>
<td>Kaabong</td>
<td>Kotor</td>
<td>Lolelia</td>
<td>Kapedo</td>
<td>5775</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Lolelia</td>
<td>Lolelia</td>
<td>Kapedo</td>
<td>5800</td>
<td>98.5</td>
</tr>
<tr>
<td></td>
<td>Lochom</td>
<td>Sidok</td>
<td>Sidok</td>
<td>2880</td>
<td>87</td>
</tr>
<tr>
<td>Amudat</td>
<td>Amuna</td>
<td>-</td>
<td>Karita</td>
<td>3074</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Abdi</td>
<td>Achorichori</td>
<td>Loroo</td>
<td>1095</td>
<td>45</td>
</tr>
<tr>
<td>Moroto</td>
<td>Nakonyeen</td>
<td>Katikekile</td>
<td>Tapach</td>
<td>843</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Katikekile</td>
<td>Katikekile</td>
<td>Tapach</td>
<td>890</td>
<td>65</td>
</tr>
</tbody>
</table>

On the other hand, the agricultural ecological zones on the western part of the region are largely grazed during the dry season and constitute the dry season migratory routes for pastoral communities. The areas are dominated by *Hyparrhenia* spp and *Setaria sphacelata* while *Panicum* species and *Chloris gayana* are largely found in protected areas such as under dense tree/shrub canopies that are hardly grazed by animals. Because these zones are grazed during the dry season, the pasture in these grazing areas are left to establish, grow and accumulate during the wet season forming what is normally referred to as “standing hay”.

Recognizing the fact that the pasture swards are dominated by *Hyparrhenia* spp, the nutritive value of this pasture is very low due to the low crude protein content (3.2%), high fibre (38.8%) and lignin content specially when it is matured. These results suggest that the dry matter
production for grazing areas within the wet season migratory routes is lower than that for dry season grazing areas. However, the wet season grazing areas are dominated by highly nutritious pastures while dry season grazing areas are dominated by poor quality *Hyparrhenia* species.

**Proposed pasture improvement interventions**

- Over-sowing existing native pasture with appropriate legumes that are compatible with the existing grasses: This will improve the protein content of the pasture as well as enhancing the digestibility of grass species with high fibre content. The legume species that are compatible with the dominant grass species (*Hyparrhenia* spp species) include Centrosema, Glycine, Stylosanthes and Desmodium,

- Over-sowing dry season grazing areas with more nutritious grass species that retain a high nutritive value even when mature: This will improve the value of standing hay as compared to hay obtained from areas dominated by *Hyparrhenia* species. A mixture of *Hyparrhenia* and *Brachiaria toledo* would form better quality standing hay as compared to *Hyparrhenia* hay alone species in the dry season grazing zones,

- Over-sowing existing natural pasture with high yielding grass species to boost the dry matter production in wet season grazing routes: High yielding grass species include *Panicum* species, *Brachiaria mulato* and *Brachiaria toledo* among others,

- Restoration of pasture on bare patches through reseeding with appropriate grass and legume species and

- Bush clearing followed by sustainable bush/weed management in all the zones.

**Control of invasive species**

The notable locations with significant proliferation of invasive species are Amudat and the eastern slopes of Mt Moroto. The forbs are
dominated by *Sanseveria fruticosa*, *Leonotis nepetifora* and *Cyathula caesius*. None of these forbs is palatable to animals and hence are considered as weeds. *Sanseveria fruticosa* is a notorious herbaceous weed endemic in Karamoja sub-region. The weed is very aggressive and has ability to survive in rocky sandy soils with little soil nutrients. The weed is gradually colonizing the grasslands and mainly thrives under shrub canopies. Its aggressiveness and tolerance to soils of differing physico-chemical properties has enabled it to out-compete desirable pasture species in areas where it establishes (Figure 1).

![Figure 1. Sanseveria fruticosa (Dragon trees / mother in law tongue) under shrub canopies](image)

Herders reported that the weed spread to Uganda grasslands from the rangelands of north Pokot District in Kenya. The herders further revealed that the weed is used in the treatment of malaria and was introduced in Kenya as a fencing material.

Generally, the proposed pasture improvement activities in Amudat District need to consider the following recommendations:

- Develop ecologically sound and cost-effective participatory weed control/management interventions especially for *Sanseveria fruticosa*
- Over-sowing the existing pasture swards with area-specific appropriate legume species that are compatible with the existing grasses. Such legume species include *Centrosema pubescens*, *Desmodium*, *Stylosanthes* and *Glycine* species among others.

- Conduct on-farm training and demonstrations on appropriate grazing and pasture management for key stakeholders.

- Sensitize communities on the devastating effects of invasive weeds and mobilize them for physical removal of such weeds.

In cases of grazing management, deliberate efforts to improve the physico-chemical characteristics of the soils need to take advantage of the current practice of establishment of "livestock bomas" along selected areas in migratory routes. "Livestock bomas" are enclosures that are established to accommodate livestock at night safeguard them from wild animals or even raids in the context of pastoral communities during migrations. The "bomas" allow accumulation of animal manure whose contribution to improvement of soil physico-chemical characteristics is very recommendable. Establishment of various smaller "bomas" scattered in different locations is a more cost effective in spatial, temporal and labour terms.

**Fodder bank management**

Nutrition, both in quantity and quality aspects, is obviously one of the leading constraints to sustainable livestock production and productivity in an ASAL region like Karamoja. In order to mitigate constraints to effective and efficient livestock nutrition deficiency, fodder provision through establishment of fodder banks is a crucial requisite. This should go a long way to trigger the ushering of the region into the regional livestock value chain development, being drummed for in the IGAD region.

Two major forms of fodder banks exist in Karamoja with a huge potential from its vast rangeland resources. This is the comparative advantage Karamoja has over its neighbouring pastoral regions of east Africa.
1. Hay harvesting and marketing: As seen in the discussions in this paper, the region is endowed with rich varieties of herbaceous leguminous fodder resources.

2. Conservation, harvesting of acacia pods: These are abundant in Karamoja and possess very high protein values as feeds supplement (Figure 3).

3. Promotion and provision of locally made mineral licks

4. All these are culminated with sustainable animal health care practice in order to exploit the abundant potentials of livestock rich natural resource inputs in Karamoja (Figure 4).

Figure 2. Good practices of Rangeland and fodder management in Karamoja, Uganda
Figure 3. Harvested Nutritious acacia pods storage for dry season supplementation

Figure 4. Community based Animal health workers
Summarized Minutes of Group Discussions

Group 1

Fodder Production and Utilization in the Rain Fed High Potential Areas

In this Group participants were requested to undertake discussion of the following points:

- Identify the best practices relating to: Fodder production and utilization in the rain fed high potential areas for each country
- Identify best practices relating to marketing adopted by small commercial farmers
- Identify the pre-requisites and limiting factors for each best practice and the possible modalities of exchanging and up-scaling of the best practices
- Identify key partners for implementation of the best practices
- Way forward nationally and regionally

The practice should be one that is being used by farmers and thus tested and found to be; appropriate, affordable technology, increases productivity, sustainable and can be replicated in similar ecological zones

Good / Best Practice 1

Fodder production and utilization in the Highlands

- Elephant grass (Cut and Carry and used for silage). Grown on conventional plots, pits (Tumbukiza-increases yields by 20%) and gullies for soil stabilisation.
- Legumes (A third of diet –*desmodium, siratro, centrosema* – usually mixed sward, *calliandra, leucaena* grown along boundaries *mucuna, lablab*-mixed sward or separate plot, *Lucerne* usually separately grown)
- Use of Crop residues.
• Use of concentrates for milking cows, (brans e.g. maize, wheat or dairy meal- Usually replace 1kg of concentrate with 3kg fodder tree legume) and
• Use of Mineral blocks

The prerequisites for considering these best practices are:
• Quarter to one hectare/cow
• Disease resistant varieties (planting materials)
• Practice fit for commercialized market- oriented dairy system
• Enabling policy environment –especially harmonization within the region

The limiting factors for implementation in the region are:
• Diseases
• Limited research in new and high yielding varieties
• Weak seed system
• Exchanging vegetative material within the region (Patent rights and regulatory restrictions)
• Knowledge management is weak (including weak extension services)

The assumptions and risk are:
• No new diseases will arise
• Effects of climate change on propagation

The key partners in each country are:
• Farmer organization, Research institutions, Private sector, Academic institutions, Policy makers, Community leaders, Regional bodies / platforms e.g. ASARECA etc, NGOs and CSOs.

Good / Best Practice 2

Napier / Maize Silage

The prerequisites for considering these best practices are:
• Market-oriented farmer
• Silage additive (if using napier)
• Chopping equipment
• Material for silage making
The limiting factors for implementation in the region are:
- Limited acreage
- Lack of knowledge and skills in silage making
- Limited access to additives (e.g. molasses)

The assumptions and risk are:
- Excess fodder for silage making
- Decreasing land holdings

The key partners in each country are:
Private sector (equipment for silage making and commercial silage making), Academic institutions, Research institutions

Good / Best Practice 3:

Oats – Vetch mixture
Oats and Vetch (1,800 -2,500 m ASL) 25:75 mixture or pure stand and use as either fresh (cut and carry), Hay making, As grain (grinding, boiling and bread/cake), Silage making

The prerequisites for considering these best practices are:
- Very good seed system (quality and variety)
- Cold highland areas

The limiting factors for implementation in the region are:
- Low yields
- Poor extension system
- No improved varieties because of limited research
- Policy to promote good varieties is lacking

The assumptions and risk are:
- If too much rain fall, diseases e.g. rust

The key partners in each country are:
Research institutions, Private sector (commercial seed production and equipment)
Good / Best practice for Food / feed system

Practice 1

Dense planting of maize, sorghum and millets
Farmers can use maize, sorghum, millet etc. depending on availability. More meaningful with dense planting (Increases fodder available through defoliation, stripping and thinning)

The prerequisites for considering these best practices are:
- Strong seed system including varieties

The limiting factors for implementation in the region are:
- May require more manure/fertilizer
- After stripping and topping, remaining stover is poor quality (Can be mixed with manure to increase quantity, supplementing with urea may not be economical but microbes can be used to improve digestibility).

The assumptions and risk are:
- Urea at affordable costs

The key partners in each country are: Research institutions and academic institutions

Practice 2

Mineral blocks
Locally made mineral blocks (combined with above best practices is highly recommended). May use molasses and urea; red soils and rock salt; industrial byproducts, crop residues and farm waste e.g. poultry litter.

Best practice for Fodder Marketing

Hay/silage production as business (maize, fodder as cash crop)

The prerequisites for considering these best practices are:
- Balers and cutters required
- Transportation facilities
- Storage facilities
- Well developed marketing information system
- Access to credit
The limiting factors for implementation in the region are:
- Spoilage (especially for silage)
- Lack of harvesting equipment
- Poor extension services

The key partners in each country are:
Academic institutions, research institutions, private sector, extension service providers and ICT companies

Group 2
Fodder Production and Utilization in the Pastoral / Agro-Pastoral Area

In this Group participants were requested to undertake discussion of the following points:

- Identify the best practices relating to: Fodder production and utilization in pastoral/ agro-pastoral for each country
- Identify the best practices relating to marketing adopted by small commercial farmers
- Identify the pre-requisites and limiting factors for each best practice and the possible modalities of exchanging and up-scaling of the best practices
- Assumptions and risks in implementing the best practices
- Identify key partners for implementation of the best practices
- Way forward nationally and regionally

Kenya:

Good / Best practices of fodder production and utilization

- Rehabilitation of grazing land using indigenous range grasses
- Community seed based systems (Seed availability)
- Construction of hay bans for storage of hay
- Use of crop residues maize and sorghum
Good / Best practices of marketing adopted by small scale farmers

- Marketing of fodder and seeds (sudan and cenchrus grass) by community members
- Sale of hay

The prerequisites for considering these best practices are:
- There is market for the products (milk, seed, hay meat, live animals)
- Technical back up to the farmers extension research
- Through group formation e.g PFS, CIGs
- Favourable market for fodder
- Reliable water supply for irrigation

The limiting factors for implementation in the region are:
- Seed sources
- Frequent and prolonged droughts
- Unfavorable seed policy farmers cannot sale the seed in a formal market
- Labor intensive in the irrigated and agro-pastoral
- High taxes from the water sector
- Escalating fuel prices
- Unfavorable land policy
- Reliance on one grass species which may be disastrous

Modalities of exchanging technology
- Linkage between extension and research
- Common interest group
- Field days
- Demonstrations
- Farmer on farm trials
- PFS (pastoralists had limited knowledge on cultivation)
- stakeholders institutions (involvement)

Modalities of upscaling
- Farmer on farm trials
- Training of trainers (mentor new groups
Assumption and risks in implementing best practices
- Conflicts will be amicably resolved
- Less severe droughts
- Farmers’ adoption (willingness)
- Favorable enabling environment
- Sufficient input supply for up-scaling (seeds e.g)

Key partners for implementation of best practices
KARI, MOLD, FAO, COOPI, GAA., GIZ, IOM, KEPHIS, Farmers/Pastoralists, TARDA, KLMC, ILRI, ICRAF, Seed companies, Land O LAKES, Pastoralists and farmer associations, NGOs, Pastoralists and farmer associations

Ethiopia

Good / Best practices for fodder production and utilization
- Napier grass grown along the irrigation canal (ASALs) and distributed provide feed and conserve the soils
- Seed production provide support to small scale farmers and alleviate seed shortage working with private sector
- Cattle fattening using maize napier

Good / Best practices of marketing adopted by small scale farmers
- Sale of napier grass cuttings to farmers
- Sale of hay
- Seed production and sale

The prerequisites for considering these best practices are:
- Reliable seed sources
- Community groups
- Strong cultural institutions
- Markets for the products

The limiting factors for implementation in the region are:
- Frequent and prolonged droughts
- Limited sources of seeds
- Limited Access to markets
- Labor intensive in the irrigated and agro-pastoral
- Inadequate credit
- Absence of land certification (land is communally owned in pastoral areas)
- Limited investment in agro-pastoral and pastoral in terms of service provision

**Modalities of exchanging technology**
- linkage between extension and research
- Field days
- Demonstrations
- Farmer on farm trials
- PFS (pastoralists had limited knowledge on cultivation)
- stakeholders institutions (involvement)
- Media leaflets, brochures, local Radio
- Credit arrangement (matching fund)
- commercialization (private involvement)

**Modalities of upscaling:**
- Demonstrations
- Farmer field trials
- Trainings
- Seed out growers

**Assumption and risks in implementing best practices**
- Conflicts will be amicably resolved
- Less severe droughts
- Farmers adoption (willingness)
- Favorable enabling environment
- Sufficient input supply for up-scaling (seeds e.g)

**Key partners for implementation of best practices**
EIAR, MOA, NGOs FAO; Ethiopian Society of Animal Production, Ethiopian Livestock Traders Association, Pastoral Community Development program, Seed companies, Farmers / Pastoralists.
Uganda

Good / Best Practices of fodder production and utilization

- Reseeding of pastoral areas using indigenous grass species
- Use of crop residues maize and sorghum

Good / Best practices for marketing adopted by small scale farmers

- Sale of pods for dry season
- Supplementation to livestock

The prerequisites for considering these best practices are:

- Reliable seed sources
- Institutional capacity building through PFS
- National Agricultural Advisory services
- Community groups
- Strong cultural institutions
- Local government
- Good soil water conservation
- Organized groups

The limiting factors for implementation in the region are:

- Frequent and prolonged droughts
- Limited investment in agro-pastoral and pastoral in terms of service provision
- Inadequate seeds for fodder production
- Weak pastoralists institutions

Modalities of exchanging technology

- Establishment of APFS fodder demonstration sites (Provision of fodder to animals)
- Field days/exchange visits

Modalities of up scaling

- Training on animal nutrition module incorporated into the wider APFS curriculum
Assumption and risks in implementing best practices

- Conflict will be amicably resolved
- Less severe droughts
- Farmers adoption (willingness)
- Favourable enabling environment
- Sufficient input supply for up-scaling (seeds e.g.)

Key partners for implementation of best practices
National Agricultural research organization, FAO, Ministry of Agriculture Animal Industry and Fisheries; National Agricultural Advisory services, NGOs, VSF, Belgium Seed companies, Heifer international

Rwanda

Good / Best Practices of fodder production and utilization

- Fodder development along river bank feed and protect the soils
- Use of crop residues maize stovers and beans

Good / Best practices of marketing adopted by small scale farmers

- Harvest Napier and sale to neighbors
- Cooperatives buy seeds for farmer to enhance milk production

The prerequisites for considering these best practices are:

- Capacity building
- Good soil conservation structures
- Group formation

The limiting factors for implementation in the region are:

- Small land size
- Limited mechanization
- Droughts

Modalities of exchanging technology

- Workshops
- Demonstrations
Study tours
- Research linkage

**Modalities of up scaling**
- Mechanized technology
- Conservation techniques

**Assumption and risks in implementing best practices**
- Conflicts will be amicably resolved
- Less severe droughts
- Farmers’ adoption (willingness)
- Favorable enabling environment
- Sufficient input supply for up-scaling (seeds e.g)

**Key partners for implementation of best practices**
- Ministry of Agriculture and Industry, Rwanda Agricultural Board,
  Ministry of Commerce Heifer international, Land O LAKES,
  Research Institute FAO

**South Sudan**

**Good / Best practices of fodder production and utilization**
- Use of crop residues

**The prerequisites for considering these best practices are:**
- Organized groups

**The limiting factors for implementation in the region are:**
- Lack of Policy
- Droughts

**Modalities of exchanging technology**
- Exchange visits

**Modalities of up scaling**
- Field visits

**Assumption and risks in implementing best practices**
- Conflicts will be amicably resolved
- Less severe droughts
- Farmers adoption (willingness)
- Favorable enabling environment
- Sufficient input supply for up-scaling (seeds e.g)
Key partners for implementation of best practices
- Ministry of Animal Research and Fisheries, Ministry of Agriculture and Forestry, FAO, Pastoralists and farmer associations, NGOs Pastoralists and farmer associations, SNV

Group 3
Range Management and Improvement

- Identify best practices relating to rangeland improvement in agro-pastoral/pastoral areas
- Identify the pre-requisites and limiting factors for each best practice
- Identify key partners for implementation of the best practices
- Way forward nationally and regionally

Definition of Rangelands
Rangelands are vast natural landscapes in the form of grasslands, shrublands. Rangelands are distinguished from pasture lands because they grow primarily native vegetation, rather than plants established by humans. Rangelands are also managed principally with extensive practices (livestock grazing and prescribed fire) rather than more intensive agricultural practices of seeding, irrigation, and the use of fertilizers.

1. Good / Best practices related to rangeland improvement in Ethiopia
Rangeland management and utilization of range – Borena pastoralists

Kallo systems

- Grazing management (Herd movement and herd splitting)
- Reseeding
Kallo system

It is a traditional feed management practice, in which enclosures (kallos) are established for very special feeding purposes in the dry season. It is mainly used for lactating animals, sick animals and calves which are left behind to provide milk for the children and the old people. It can be owned by an individual or managed by communities (community can set it up or an NGO can help them set it up)

Prerequisites for Kallo system
- It should be close to the homestead
- It should be established at the onset of the rainy season and open in the dry season
- There is selective bush clearing to remove weeds
- The stocking rate is determined by the size of the kallo.
- It has to be close to a permanent water source since it is near a homestead
- There should be availability of fencing material
- Customary institutions and by laws are used to manage the system

Limiting factors of Kallo system
- Limited/inadequate grazing land to promote the Kallo system
- Inadequate fencing materials and there is need for continued maintenance every year
- Weak customary systems
- Policy – conflict with development plans

Way forward for the Kallo
- Policy and institutional support to mainstream system as a rangeland practice
- Water infrastructure
- Improved fodder conservation practices
- Species enrichment to increase productivity (reseeding)
- Seed harvesting is an opportunity
- Integrate Kallo system with re-seeding and proper grazing management
- Improve marketing for animal and animal products including value addition
- Avail market information
2. Good rangeland practices in Uganda (Karamoja)

- Grazing Management in rangelands
- Dry season migratory routes management
- Use local legumes as a source of protein
- Conservation of fodder
- Use of CAHWs
- Agro pastoral field schools

Prerequisites for grazing management – Karamoja
- Proper tenure management
- Safe migratory corridors
- Infrastructure for animals (watering facilities)
- Local extension and animal health services
- Community ownership with support of agro pastoral field schools
- Availability of Community Animal Health Workers (CAHWS)
- Controlled bush clearing

Limitations of the grazing management
- Insufficient watering points
- Conflicts along the migratory corridors
- Land degradation
- Unfavorable migratory policies
- Limited extension and animal health workers in the communities
- Spread of animal diseases
- Invasive species (e.g. Sanseveria fruticosa, Lantana camara)

Way forward for grazing management in rangelands
- Control of invasive species
- Institutional support for rangeland development e.g. building for water facilities
- Rangeland improvement (over-sowing and conservation)
- More research on use of Acacia pods and others as source of protein for animals
- Improve marketing for animal and animal products including value addition to improve income/welfare
- Avail market information
Capacity building on grazing management and fodder conservation

3. Good rangeland practices in Kenya

*Prosopis* spp as alternative source for animal feed
- *Prosopis* invasion has grown out of control and covers approximately 500,000 hectares in Kenya and 800,000 hectares in Ethiopia. It is suggested that it is spreading at an alarming rate of 18% p.a.

**Prerequisites for use of Prosopis as animal feed**
- There has been availability of the Prosopis
- Awareness and change of perception on benefits
- Capacity building on utilization and facilitation on processing equipment
- Product development and market linkage on Prosopis as an alternative feed

**Limitations of Prosopis**
- Negative perception on use of Prosopis
- Limited awareness on benefits
- Labour intensive in collection of pods
- Need of processing equipment
- Resource tenure - conflicts

**Way forward for Prosopis**
- Improve awareness on benefits
- Commercialization
- Further research on utilization in animals and humans
- Diversification of use e.g. charcoal, honey enterprise development, timber
- Policy support – for management and mobilize community on utilization

4. Good rangeland practices in South Sudan
- Grazing management
- Highland to lowland (dry) to look for pastures
- Lowland to highland (wet) to avoid the floods

Prerequisites for good grazing management (movement)
- Land availability and good land tenure systems
- Kraal leadership
- Favorable weather
- Water availability
- Community animal health workers
- Herders trained on animal health treatment

Limitations of grazing management (movement)
- Security for the herders and the animals
- Disease transfer
- Lack of infrastructure (e.g. watering facilities, crushes, dips etc.) and support services (e.g. for vaccination) due to movement of animals
- Conflict between the cultivators and cattle keepers
- Land degradation

Way forward for rangelands
- Pasture improvement in lowlands and highlands with more nutritive species
- Government support in set up of necessary infrastructure and provision of extension/animal health services
- Disarmament for small arms

Partners for good range management
The community, Local authority, Government (Veterinary services, Extension, Water and Research institutions), Development partners and Civil society for advocacy
Way Forward for fodder and rangelands Management in East Africa

Nationally

- Documentation and promotion of evidence based best practices and invest in research and development of viable options (Respective Ministries in collaboration with research and development partners FAO)
- Sensitize pastoralists/farmers (Respective Ministries in collaboration with research and development partners FAO)
- Support to mobilization of resources for up-scaling (Respective Ministries in collaboration with research and development partners FAO)
- Enhance trade to improve livelihoods of communities through developing fodder market infrastructure and develop capacity of value chain actors
- Encourage group work e.g. (make silage on farmers’ plots in turn, dealing in fodder production and marketing)

Regionally

- Advocacy work in collaboration with ICPALD/IGAD, FAO, ASARECA and other development partners – connecting with national/regional platforms. E.g. ICPALD support in advocacy to improve investment and dissemination of technology in livestock, rangeland and fodder development
- Develop a regional knowledge management system (appropriate packaging of information and develop systems to share it)
- Work on resources mobilization at regional levels to improve investment in best practices and appropriate research
- Regional workshop to regularly exchange best practices
- Harmonize policy environment across the regional to enable sharing of pasture/forage genetic resources
- Disease control
- Representation and participation of IGAD in standard settings market compliance CODEX ALIMENTARIUS, OIE
- Establish Intra-regional trade
- Trans-boundary security for mobility