Preferences and adoption of livestock feed practices among farmers in dairy management groups in Kenya

Evelyne Kiptot, Steven Franzel, Judith Sinja and Eddah Nang'ole

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Summary

This report presents the results of a study that assessed farmer preferences and adoption of livestock feeds and feed practices promoted by the East Africa Dairy Development (EADD) Project. The study was carried out in nine out of 21 sites where the EADD project operates. The sites are situated in central Kenya, north Rift Valley and South Rift Valley regions of Kenya. They include Kabiyet, Siongiroi, Sirikwa, Olkalou, Olenguruone, Metkei, Sot, Cherobu and Taragoon. The sample was drawn from farmers belonging to dairy management groups. Collection of data was through a formal household survey that was conducted by interviewing individual dairy farmers using a structured questionnaire. Data collected was on socioeconomic and demographic characteristics, feed practices on farm, farmer preferences and criteria used for selection, constraints faced in the production of livestock feed practices, proposed interventions and future plans.

Farmers interviewed comprised 60 percent men and 40 percent women out of the total sample of 181 dairy farmers. The farmers were middle-aged; about 44 years old with an average of about 46 years and 41 years respectively for men and women. Almost all farmers (97%) had basic education. Overall land owned was about 13 acres with female-headed households owning less land than their male counterparts. The main enterprises practiced in order of importance were dairy farming, food crops (e.g. maize, beans and sweet potatoes), poultry and cash crops (e.g. tea and wheat). On average, farmers had about 13 years of experience in dairy. Livestock owned ranged from pure, cross and local breeds of cattle, goats, sheep and poultry. The majority of farmers (92%) had cross-breed dairy cows with an average number of 3 for both male and female-headed households. Only 13.8 percent of households had pure breed dairy cattle with an average of 6 per household. A higher proportion of male-headed households (14.6%) had pure breed adult cows compared to only 5.6 percent of female-headed households.

All dairy farmers interviewed had knowledge on the improved feed and feed practices introduced by EADD and other institutions. Almost all respondents (99.4%) were aware of Napier grass and about three quarters were aware of Boma Rhodes. Only about 5 percent farmers were aware of Sudan grass, Molasses grass, giant setaria, serato and Guetamala grass. Among herbaceous legumes, lucerne was the most known by 74 percent of farmers compared to desmodium (42%). Among fodder shrubs, calliandra was the most known by 36.5 percent of respondents followed by sesbania (12.7%). Other fodder crops known by over 40 percent of dairy farmers included sweet potato vines and oats. The most known fodder crop residue was dry maize stover (42%). Among feed practices, silage ranked highest.

Dairy farmers interviewed had multiple sources of information on livestock feeds and feed practices. Volunteer farmer trainers ranked first among the preferred sources of

information followed by farmer field schools, Ministry of Livestock, EADD and Ministry of Agriculture. As regards uptake of feeds and feed practices, Napier grass had the highest uptake of 91.2 percent followed by Boma Rhodes (43.1%). 33.1 percent of farmers planted fodder shrubs and 12.7 percent planted lucerne. Reasons for the uptake of various feeds and feed practices included use for livestock feeding, for supplementation, for feeding during dry spells, high nutritive content and multiple harvests. Lucerne had the highest percentage of farmers who were aware of the technology but did not take it up. Main constraints were lack of seed and high labour requirements.

Planting material for livestock feeds varied from feed to feed. Feed sources that were commonly cited by farmers included other farmers, neighbours, commercial agrovet shops and the EADD project. In relation to niches, the majority of farmers plant feed technologies in the cropland to protect from livestock. Among the livestock feeds preferred by farmers, Napier grass ranked highest followed by Boma Rhodes, dry maize stover, lucerne, oats and mineral supplementation. Napier grass is preferred because it is drought resistant, has fast growth, increases milk production and has high biomass. Some dairy farmers did not prefer certain feed practices due to the fact that some feeds are not drought resistant, require fertile soils, cause skin and throat irritation when harvesting, cause bloat in livestock, taint milk among many other reasons.

Despite the fact that farmers were aware of livestock feeds, some had not adopted them. Reasons given included unavailability of planting material, inadequate land, high cost of planting material, lack of technical knowledge, poor weather and labour intensiveness. Constraints experienced in the production and utilization of livestock feeds and feed practices included unavailability of planting material, lack of storage facilities, lack of technical knowledge, lack of machinery, among others. Proposed interventions include training, availing affordable seeds at agrovet shops, constructing proper storage and using machinery.

The study also found out that many farmers sell feeds particularly oats and Rhodes grass. Slightly less than 50 percent of dairy farmers are planning to increase feed production. This will be achieved by expanding acreage of land under feeds, acquiring loans and attending more training to gain more knowledge and skills. Motivation for increasing acreage of feeds is mainly due to the fact that there has been increased milk production, high returns from dairy, and availability of ready market for dairy products.

Findings from this study point to the fact that despite intensive promotion by the EADD project, there are high discrepancies between awareness of most livestock feed innovations and uptake. Issues of concern include lack of planting material (and if available expensive), technical knowledge and issues related to utilization. In order to increase uptake, concerted efforts need to be made by development partners in collaboration with Producer Organizations (POs) to make planting material accessible at

the local level, undertake more training, and work closely with farmers to come up with solutions to constraints related to utilization.

Keywords: Fodder innovations, fodder adoption, planting material, livestock feeds, volunteer farmer trainers

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Acronyms

AEZ	Agroecological zones
CESPs	Community Extension Service Providers
CGIAR	Consultative Group on International Agricultural Research
DMGs	Dairy Management Groups
EADD	East Africa Dairy Development Project
EMPFT	Exotic Multi-purpose Fodder Trees
FHH	Female-Headed Households
FTA	Forests, Trees and Agroforestry
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
KARI	Kenya Agricultural Research Institute
KES	Kenya Shilling
KFA	Kenya Farmer Association
MHH	Male-Headed Households
MOA	Ministry of Agriculture
MOL	Ministry of Livestock
MPFT	Multi-purpose Fodder Trees
NALEP	National Agriculture & Livestock Extension Programme
NGOs	Non-Governmental Organizations
PIM	Policies, Institutions and Markets
POs	Producer Organizations
UH	Upper Highland
VFT	Volunteer Farmer Trainer

1.0 Introduction

About 870 million people were chronically undernourished in 2010, the majority living in developing countries and depending on agriculture for their livelihoods (FAO 2012a, Ahmed et al 2007). In order to meet the global demand for food, which is expected to increase by 60 percent by 2050, agricultural production must increase by 70-100 percent. Most of this will have to come from developing countries on account of increased human populations, disposable incomes and urbanization (FAO 2011, FAO 2012b). Agricultural production has however been on the decline as a result of natural resource constraints, climate change and competing demands for land. One of the potential options to increase food security is through livestock production. Livestock production is an important economic activity that promotes and sustains people's livelihoods. It is estimated that the global demand for dairy and meat products is projected to increase by 74 percent and 58 percent respectively and a large part will emanate from developing countries (FAO 2012b, Delgado 2003)). According to FAO (2009), the global population for cattle in 2000 was 1.5 billion; it is projected to almost double by 2050. To meet the future demand for meat and milk products, livestock productivity will need to increase significantly. Availability and access to feed resources are the two major factors that affect livestock productivity. An adequate supply of livestock feed is therefore crucial to improving the livelihoods of millions of people across the developing world. Various types of feed resources exist worldwide. They include fodder shrubs, herbaceous legumes, pasture grasses, weeds gathered from cropping areas, crop by-products and residues, agro-industrial by-products and purchased concentrates. The importance and nutritive value of these feed resources vary seasonally (Abate et al 1992).

Livestock feed production and use is driven by increases in population and income, which increase milk demand and thus the demand for feeds (FAO 2012b). In East Africa for example, increases in incomes are driving greater per capita meat and dairy consumption (World Bank 2014). In Kenya, livestock population is estimated at 17.4 million cattle with 3.3 million exotic and 14.1 million indigenous cattle, 17 million sheep and 27 million goats (KNBS 2010). This is an indicator that demand for livestock feed is high in the country due to the large number of livestock and an increase in milk and meat demand due to the high population growth (Ngigi 2005). With the present trend of rising feed prices and global inflation, livestock production has been most hit in terms of scarcity and high cost of feeds. As a result, the greatest constraint to livestock productivity in developing countries currently is the shortage of feeds and forages especially in the dry season (Ayantunde et al 2005). Farmers are unable to provide sufficient quantity and quality feeds to their livestock on a consistent basis (Hall et al 2008). The problem of feed shortage can be addressed through promotion and improvement of feed production, value addition where applicable and marketing by smallholder producers.

The EADD Project which is a collaborative venture between Heifer International, Technoserve, African Breeders Services, International Livestock Research Centre (ILRI) and the World Agroforestry Centre (ICRAF) begun in 2008 with the objective of doubling the incomes of 179 000 dairy farmers in Kenya, Uganda and Rwanda through improved dairy production and marketing. The Feeds and Feeding System Component led by ICRAF contributes to this objective through developing of producer organization-driven site specific feed plans, and facilitating the creation of sustainable stakeholder linkages to implement the plans with the objective of increasing and sustaining milk production. The types of feed technologies already adopted by farmers include improved pastures and fodders, improvement of natural pasture, crop residue processing and utilization, pasture and fodder conservation (hay and silage making), and on-farm feed formulation (Kirui and Franzel 2011). The project currently uses a farmer-to-farmer extension approach, locally known as the volunteer farmer trainer (VFT) approach to disseminate livestock feeds and feed technologies. A total of 2520 VFTs (38% women) have been recruited and trained since the inception of the project. They host 2309 demonstration plots for training other farmers in the use of high value feeds and improved feeding systems.

1.1 Farmers' adoption of innovation

Economists have defined final adoption at the farm level as the degree of use of a new technology when the farmer has full information about the new technology and its potential (Feder et al 1985). Adoption typically has been viewed from two perspectives. At the individual farm level, each household chooses whether or not to adopt and the intensity of adoption. Farm-level adoption studies, then, are concerned with the factors influencing the adoption decision either statically or dynamically by incorporating learning and experience. At a macro-level, diffusion studies examine how adoption evolves across a population or region (Feder and Umali 1993).

Scanty information exists on the adoption of feeds and feed practices in general, however there is a lot that has been documented on agriculture and agroforestry adoption. Pattanayak et al (2003) for example reviewed 120 articles on adoption of agricultural and forestry technology by smallholders and concluded that the following five categories of factors explain technology adoption which may also be applicable to livestock feeds and practices: preferences, resource endowments, market incentives, biophysical factors, and risk and uncertainty. The review notes that preferences define the objectives and motivations of the economic agents choosing technologies. Resource endowments enable their technology choices. Market incentives and biophysical factors condition the extent, timing and nature of the technology choices. Risk and uncertainty can seriously undermine investments that pay dividends only in the long run. Pattanayak et al (2003) then used this framework to perform a simple meta-analysis of 32 empirical, regression-based analyses of agroforestry and related soil conservation investments. Although

household preferences and resource endowments were the most common variables included in the analyses, the most significant influences on agroforestry adoption behaviour appeared to be uncertainty and risk, biophysical conditions, market incentives, and resource endowment factors. Franzel (1999) revealed that other factors such as past perception of the problem, past use of measures for addressing the problem, current practices, economic importance of the enterprise and wealth all affect the adoption potential of a technology. Pawarda et al (2010) reported that the adoption of agroforestry technologies among smallholder farmers in Zimbabwe was significantly influenced by land ownership/size, awareness, training and local institutions.

Feder et al (1985) and Feder and Umali (1993) reviewed the extensive literature on adoption and diffusion of agricultural innovations. Focusing primarily on the initial stages of the Green Revolution technology adoption and diffusion, Feder et al (1985) concluded that farm size, risk and uncertainty, human capital, labour availability, credit constraints, and tenure were the most important factors determining adoption decisions. However, the impact of farm size depends on the characteristics of the technology and institutional setting and is often a surrogate for a large number of other factors such as access to credit, risk-bearing capacity, wealth, and access to information. Since these factors differ spatially and temporally, the relationship between farm size and adoption also varies.

In 37 empirical studies of agroforestry adoption, Mercer (2004) found that more secure land tenure always had a positive impact on adoption when significant. In a comparison of tree planting between Brazil and Panama, Simmons et al (2002) found that institutional variables were more important than household preference variables; noting that tree planting in the Brazilian Amazon is 15.4 times more likely under secure land tenure. Wiersum's (1994) study of contour hedgerow adoption in east Indonesia found that the landless comprised 31 percent of the population but only 11 percent were in *leucaena*-based farming systems. The long term nature of agroforestry investments appears to inhibit adoption by farmers lacking secure tenure who might otherwise adopt risky innovations for short-term production goals. Thus, risk and uncertainty may be more important for agroforestry than for annual cropping decisions. Feder et al (1985) found that empirical results often differed on the relation between land tenure and adoption and were "in accordance with the unsettled debate in theoretical literature over the relation between tenancy and adoption". Feder and Umali (1993) emphasized that later stages of adoption diffusion are determined by variables such as population density; access to markets, roads, and fertilizers; and irrigation availability. However, the agro climate appears to be the most significant determinant of locational differences in adoption rates (Feder and Umali 1993). Feder and Umali (1993) also examined the literature on early adoption of soil conservation technologies, which included many agroforestry practices such as contour hedgerows. They concluded that younger, more educated, wealthier

farmers who recognized erosion problems were more likely to adopt soil conservation technologies.

1.2 Farmer preferences of livestock feeds and feed technologies

Several studies have been carried out to assess availability of livestock feed resources on farms, farmer's perceptions and preferences of fodder trees. Nyaata et al (2000) assessed the use and availability of livestock feed resources on smallholder dairy farms of central Kenya. Findings indicate that Napier grass was grown by all the farms visited. Other forage crops found on the farms included Nandi setaria, sweet potato vines, desmodium and Guatemala grass. A number of pasture grasses were also observed on the contour lines in coffee fields, with ruzi grass (*Brachiaria ruziziensis*) being the most common. Crop residues such as maize stover, banana leaves and pseudostems were used as dry season supplements by all farmers. Other feeds reported by fewer farmers included weeds (from coffee fields and road sides), fodder tree leaves, and concentrates (mainly wheat and rice bran).

Mekoya et al (2008a) assessed farmer preferences of multipurpose fodder trees (MPFT) in the Ethiopian highlands. The study looked at preference criteria, compared farmer preference between exotic and local MPFT, and evaluated the relationship of farmers' knowledge of feed value assessment with laboratory indicators. The study used focus group discussions, and preference ranking and scoring in two districts. The comparison between exotic and local MPFT for their benefits and desired tree characteristics showed that farmers preferred local MPFT to exotics for biomass production, multi-functionality, life span, and compatibility to the cropping system. In another study, Mekoya et al (2008b) assessed the values of multipurpose fodder trees and farmers practices of growing fodder trees and the constraints they perceive for introducing and growing exotic multipurpose fodder trees (EMPFT) in the crop-livestock mixed farming system of the Ethiopian highlands. Using structured household interviews, the study assessed farmers' awareness of, perceptions about and motives to plant exotic multipurpose fodder trees and use, values and management. Findings showed that farmers were aware of the EMPFTs with development agents and farmer-to-farmer information exchange being the major sources of information. *Sesbania sesban* and *Calliandra calothyrsus* were noted to have fast growth as they could be cut 12 months after planting. The study also found out that a majority of adopters preferred exotic multipurpose fodder trees as compared to non-adopters who preferred local multipurpose fodder trees.

Roothaert and Franzel (2001) examined farmers' ranking of local fodder tree species of their choice; their criteria for assessing fodder trees; how the most preferred species rated on each criterion; species' uses, management, and ways of establishment. The study used both formal and informal surveys in three AEZs. Farmers used an indigenous board game, 'bao', to rank species. A total of 160 different local fodder trees and shrubs were

used by farmers in the three zones. The three most preferred species in the sub-humid zone were *Triumfetta tomentosa*, *Commiphora zimmermanii*, and *Bridelia micrantha*. In the medium zone *Aspilia mossambicensis*, *Lantana camara* and *Grewia tembensis* were the most preferred while in the low zone *Melia volkensii*, *Crotalaria goodiiiformis*, and *A. mossambicensis* were preferred. In the sub-humid zone, the most frequently mentioned criteria for preference of particular tree species were the ability of the fodder to satisfy hunger and contributions to animal health. Palatability and drought resistance of the tree were the most important criteria in the medium zone while effect on the condition of the animal and palatability were most important in the dry zone. Farmers' ratings on palatability for cattle and goats, and milk production for goats differed significantly among tree and shrub species.

Lukuyu et al (2011) assessed feeds and feeding practices in smallholder dairy systems. The study identified feed resources available year round in three EADD project areas. The study found that majority of farmers relied on natural pastures for feeds. Less than 30 percent of farmers practiced stall-feeding with Napier grass being the main basal feed resource. Crop residues such as green and dry maize stover, wheat straws, bean haulms, banana pseudo-stems, vegetable waste and weeds were also important livestock feed among a majority of small-scale dairy farmers. Other feed resources used on farms were Sudan grass, sorghum, Rhodes grass and fodder trees such as *Leucaena* spp, *Sesbania* spp, and *Calliandra* spp. Few herbaceous fodder legumes such as lucerne and desmodium were found on very few farms. The slow adoption of forage legume technologies in Africa has been attributed to lack of participatory approaches, lack of understanding of the systems, lack of recognition of farmers' perceptions as well as unfavourable policies (Thomas and Sumberg 1995, Elbasha et al 1999), among other reasons. To reduce the time lag in adoption, considerable effort is being given to understanding smallholder systems and ensuring effective farmer participation in testing, disseminating, monitoring and evaluating fodder technologies in Africa (Shelton et al 2005, Franzel et al 2003, Peters and Lascano 2003).

Since preferences are extremely difficult to measure directly, a variety of proxy variables are usually used to examine the impact of preferences on adoption. Education, age, gender, and sociocultural status are the most frequently used proxies for household preferences and were included in almost half of the studies examined by Pattanayak et al (2003). The studies conducted so far indicate that farmers' preference of livestock feeds extends beyond the scientific interpretation of biomass production potential and nutritive value. Farmers use complex criteria for evaluation of species in the frame of their multiple farm objectives (Thapa et al 1997, Roothaert and Franzel 2001, Kiptot 2007). A review of literature suggests that there is no detailed information available on uptake of livestock feeds and feeding practices used by farmers in Kenya, preference between feeds and the reasons underlying preferences. Farmers generally possess invaluable knowledge

about local and exotic species that can be used to determine the most appropriate feeds in regions where smallholder dairy farmers are located. This study will therefore evaluate the uptake of livestock feed and feed practices promoted by the EADD project. It will examine farmers' preference of livestock feeds and practices and find out reasons that influence the choice of preferred livestock feeds and practices.

1.3 The objectives of the study

The overall objective was to evaluate the adoption of livestock feeds and feed practices promoted in EADD sites in Kenya and the reasons behind farmers' choices of preferred practices.

Specific objectives:

1. Identify livestock feed and feed practices grown and used by farmers.
2. Determine farmer's preferred feeds and feed practices and the criterion used for selection.
3. Among the feeds and feeding practices that the EADD project has disseminated, determine which ones the farmer knows about, which they have tried and which they are continuing or expanding. For the ones they have not tried or have tried and stopped, find out the reasons why.
4. Determine farmers' future plans and strategies related to feed and feed practices.

1.4 Hypothesis

The study is intended to help identify the most preferred livestock feed resources by farmers and hence it will address the hypotheses that:

1. All livestock farmers know about livestock feeds and feed practices; however the type and number of species vary depending on exposure (research, extension, NGOS, mass media), level of education, membership in groups, number of groups a farmer belongs to, type of feeding system and type of livestock.
2. Livestock feed and feed technologies implemented by farmers vary from agro-ecological zone to agro-ecological zone.
3. Selection of livestock feed and feed practices to grow and use depends on availability of germplasm (seed, seedling, cuttings etc.), inputs, previous knowledge and ease of establishment and management.

Research Questions

1. Are farmers adopting feed and feed practices promoted by the EADD Project? Why or why not?

2. What livestock feed and practices promoted by VFTs do farmers grow and use on their farms?
3. What are the factors that determine the selection of livestock feed and feed practices to be grown and used on farms?

2.0 Methodology

2.1 Description of study sites

EADD works in 21 sites in Kenya which are managed by POs spread out in several districts. The study was undertaken in 2012 in 9 PO sites. These were Kabiye, Sirikwa, Metkei, Taragoon, Olenguruone, Sot, Siongiroi, Cherobu and Olkalou. These sites were selected to represent the different agroecological zones (AEZ) and different farming systems. Kabiye, Siongiroi and Sirikwa fall in the Upper Midlands; Olkalou, Olenguruone and Metkei are in the Upper Highland (UH); Sot, Cherobu and Taragoon are in the lower highland (Table 1).

Table 1: Description of study sites

Region	PO	Date of Engagement	AEZ	Feeding System	Elevation (m)	Rainfall (mm)
North Rift	Kabiye	February-09	UM	GSF,G	1600 – 2000	1200 -1600
South Rift	Siongiroi	November-08	UM	GSF, G	1800 – 1900	1400 - 1650
North Rift	Sirikwa	June-10	UM	GSF,G	1500-2000	1500-2000
Central Kenya	Olkalou	January-08	UH	ZG, SFG	2400-3000	1150 - 1600
South Rift	Olenguruone	September-09	UH	GSF,G	2400-2970	1200-1800
North Rift	Metkei	February-09	UH	GSF,G	2350-2800	1150-1700
South Rift	Sot	February-09	LH	ZG, GSF, G	1900 – 2350	1200 - 1500
South Rift	Cherobu	September-09	LH	ZG, GSF, G	1850 – 2350	1200 - 1500
North Rift	Taragoon	June-08	LH	GSF,G	2000 – 2350	900 - 1500

GSF- grazing and some stall feeding; G – pure grazing; ZG- zero grazing UM-Upper midland; UH-Upper highlands; LH-Lower highlands

In the study sites, smallholder dairy production is combined on farm with the cultivation of coffee, tea and food crops – mainly maize, beans, potatoes and market vegetables. The cattle feeding systems vary considerably and include zero grazing where cattle are confined and stall-fed, pure grazing where cattle graze freely on private land in paddocks, and grazing with some stall-feeding where cattle are grazed on private land but supplemented with extra feeds for stall feeding at night (Lukuyu et al 2011). Kabiye, Siongiroi, Sirikwa, Metkei, Olenguruone and Taragoon are characterized by pure grazing and a few farms with grazing and some stall-feeding. Olkalou is characterized by stall-feeding and some grazing while Sot and Cherobu are characterized by pure grazing, zero grazing and grazing with some stall feeding (Table 1).

Improved livestock feed technologies/practices disseminated to farmers in the EADD project sites

Forage species/varieties

- Improved Napier grass varieties (KAK,1 KAK2, EX Mariakani, Clone 13,
- Bana grass, French Cameroon).
- Hyparrhenia rufa
- Columbus grass
- Guatemala grass
- Giant setaria
- Oats
- Forage sorghum (Kinyaruka, JB 26, BM 30, Lanet I, Kaw Kandy, E6518 and E1291)
- Fodder shrubs such as calliandra (*Calliandra calothyrsus*), tree lucerne (*Chamaecytisus palmensis*) , *Leucaena trichandra* , mulberry (*Morus alba*)
- Rhodes grass commonly known as Boma Rhodes (*Chloris gayana*)
- *Desmodium spp* intercrop
- Lucerne
- Lupin
- Dual-purpose sweet potato vines: Mugande, SPK 013 and Mafuta, Naspot1, Kemb23 Kemb 36, Gweri, Wagabolige and 103001
- Mangold (*Beta vulgaris*)
- Burgundy bean (*Macroptilium bracteatum*)
- *Clitoria ternatea*
- Vetch (*Vicia villosa-dasycarpa*)
- Pigeon pea (*Cajanus cajan*)
- Canavalia brasiliensis
- Dolichos (*Lablab purpureus*)

Types of Demonstrations/Practices

- Napier grass and Desmodium spp.(green leaf and silver leaf) intercrop
- Feed ration formulation (total mixed rations) using locally available materials such as Napier grass, natural pastures, cotton cake, wheat bran, maize bran, maize germ, fodder shrubs and fodder legumes as ingredients
- Pasture improvement through bush clearing, paddocking, spot and strip sowing with legumes
- Feed conservation through tube silage and above-ground silage
- Feed conservation through box baling hay
- Improved storage, processing and utilization of crop residue e.g. dry maize stover using pulverizers and chaff cutters

2.2 Sampling

The study was carried out in the EADD project sites. The POs where the study was carried out were purposefully selected. These are the sites where ICRAF dissemination facilitators provided the list of farmers belonging to Dairy Management Groups (DMGs). The POs belong to different AEZs and feeding systems. In the selected POs, a list of 3234 farmers who have been trained and belong to DMGs was obtained. The 181 (5%) farmers to be interviewed were randomly sampled using STATA statistical software. Locations of interviewed farmers are shown in Figure 1.

Table 2: Number of farmers interviewed

Region	PO	No of farmers
North Rift	Kabiyet	19
South Rift	Siongiroi	23
North Rift	Sirikwa	18
Central Kenya	Olkalou	21
South Rift	Olenguruone	12
North Rift	Metkei	29
South Rift	Sot	26
South Rift	Cherobu	12
North Rift	Taragoon	21
Total		181

2.3 Data collection

Collection of data was through a formal survey that was conducted by interviewing individual farmers using structured questionnaires. The questionnaires were designed to collect information on farmer preferences, ranking of feeds and socioeconomic data. Questionnaires were used to capture the quantitative data that would enable us understand the factors that influence farmer uptake and preference of feeds and feed practices.

Training enumerators in Metkei PO

Figure 1: Map of Kenya showing interview locations

3.0 Results

3.1 Demographic and socioeconomic characteristics of respondents

Farmers interviewed comprised 60 percent men and 40 percent women (Table 2). The farmers were middle-aged (about 44 years old) with an average of about 46 years and 41 years respectively for men and women. There was a statistically significant difference between the ages of men and women at $p < 0.10$. Very few farmers (less than 3%) did not have any education (Table 3). Slightly below half of the men had attained secondary education compared to half of the female respondents. More men than women had tertiary (college) level education. In relation to group membership, 86 percent of the farmers interviewed belonged to groups. There was however a higher proportion of males in groups compared to their female counterparts (89% to 83%). This is in contrast to most studies in Kenya that have shown that more women than men belong to groups.

Table 3: Age, literacy levels and group membership of respondents by gender

	All respondents (n=181)	Male (n=109)	Female (n=72)
Average age* (years)	43.9 (12.6)	45.7 (13.2)	41.2 (11.2)
Education			
None (%)	2.8	1.8	4.1
Primary (%)	30.6	27.8	34.7
Secondary (%)	44.4	49	50
College (%)	17.2	21.2	11.1
Group membership	86.3	88.6	82.5

Significance level * $p < 0.10$. Figures in parenthesis are standard deviations

Overall land owned averaged about 13 acres with female-headed households (FHH) owning only 40 percent as much land as their male counterparts (Table 4). Male-headed households (MHH) also had about one and a half as much land under pasture compared to FHH. FHH rented about 30 percent more land than MHH, perhaps due to the fact that they owned less land. The difference is statistically significant at $P < 0.01$. This confirms studies that have been done in the past that have shown the disadvantaged position of FHH in relation to ownership and access to resources such as land (Croppenstedt et al 2013, McIntyre et al 2010). About 15 percent of MHH leased land compared to 11 percent of FHH. Distance to the nearest main road was about 1 km for both types of households with the nearest source of water being about 1 km.

Main enterprises on the farm

There were four main enterprises practiced by farmers interviewed in the project sites. These are in order of importance: dairy farming, food crops, poultry and cash crops (Table 5). Both MHH and FHH mentioned dairy and crop farming as their first and second most important enterprises. This was followed by poultry for MHH and cash crops for FHH.

Table 4: Socio-economic characteristics of households in the project sites.

Variable	Male HH (n=164)	Female HH (n=17)	All households
Land owned (acres)	13.8(55.6)	5.5 (5.0)	13.1 (53.2)
Land rented (acres)**	3.0 (3.4)	11.5 (10.6)	3.7 (4.5)
Land cultivated (acres)	8.3 (48)	2.4 (2.3)	7.8 (45.8)
Land fallow (acres)	4.3 (9.6)	3.6 (4.7)	4.3 (9.3)
Land under pasture (acres)	2.7(4.1)	1.7 (1.4)	2.6 (4.0)
How much for land rent in KES	8925.7 (14285.4)	20500 (26451.2)	10112.8 (15826.7)
Distance to nearest main road in M*	130.3 (201.9)	105.2 (167.2)	127.9 (198.6)
Distance to nearest source of water in M	135.1 (186.4)	137.9 (169.1)	135.4 (184.2)

Figures in parenthesis are standard deviations. Significance level * $p < 0.10$, *** $p < 0.01$.

Table 5: Main enterprises on farm by type of households

Enterprise	Total sample (n=181)	Male HH (n=164)	Female HH (n=17)
	Percentage of households		
Dairy	95.5	95.7	94.1
Food crops	86.1	87.1	76.4
Poultry	70.1	71.3	47
Cash crops	59.1	59.8	52.9

Main crops grown

Crops grown by over 50 percent of the households were maize and beans (Table 6). Cash crops such as tea, wheat, sugarcane and pyrethrum were grown by less than 20 percent of the households with the majority growing tea (13.8%). None of the FHH grew cash crops such as wheat and sugarcane, perhaps due to the fact that they had less land as was shown in Table 3.

Tea in the background

Table 6: Main crops grown on the farm

	All HH (N=181)	Male HH (N=164)	Female HH (N=17)
	Percentage of households		
Maize	84.0	84.1	82.4
Beans	51.9	53.0	41.2
Sweet potatoes	34.8	34.8	35.3
Vegetables	29.8	29.9	29.4
Tea	13.8	14.0	11.8
Wheat	8.8	9.8	0.0
Irish potatoes	8.8	3.0	5.9
Peas	6.1	6.1	5.9
Bananas	4.4	1.2	17.6
Sorghum	4.4	4.9	0.0
Millet	3.3	3.7	0.0
Sugarcane	1.1	1.2	0.0
Soya beans	1.1	1.2	0.0
Oats	1.1	1.2	0.0
Pyrethrum	0.6	0.6	0.0

Livestock ownership

Livestock owned ranged from pure, cross and local breeds of cattle, goats, sheep and poultry (Table 7). Other types of livestock included rabbits and donkeys. Only 13.8 percent of the households had pure breed dairy cattle with an average of 6 per household. A higher proportion of MHH (14.6%) had pure breed cows compared to only 5.6 percent of FHH. The majority of farmers (92%) had cross-breed adult dairy cows; the same average number for both types of households. It is however important to note that all FHH interviewed had cross-breed dairy cattle compared to 91 percent of their male counterparts.

Table 7: Number and type of livestock owned

	Total sample (n=181)		MHH (n=164)		FHH (n=17)	
Variable	%	Mean	%	Mean	%	Mean
Cross-breed adult dairy cattle	92.3	3(3)	91.5	3(3)	100.0	3(2)
Cross-breed calves	76.8	3(3)	76.8	3(4)	76.5	2(1)
Local poultry	74.0	13(12)	75.0	13 (12)	64.7	12 (7.8)
Cross-breed sheep	26.5	4(3)	27.4	4(3)	17.6	4(1)
Pure breed adult dairy cattle	13.8	6 (12)	14.6	6(12)	5.9	1
Pure breed calves	13.8	3(4)	14.0	3(4)	11.8	2(1)
Cross breed beef cattle	12.7	3(4)	13.4	3(4)	5.9	2
Local sheep	11.0	10(20)	10.4	11(20)	17.6	2(2)
Donkeys	11.0	1(1)	11.6	1(1)	5.9	1
Local goats	9.4	11(18)	8.5	13(19)	17.6	2(2)
Improved local poultry	9.4	24(25)	8.5	28(26)	17.6	6 (5)
Pure breed sheep	8.3	7(5)	7.9	7(5)	11.8	9(7)
Dairy goats cross breed	7.2	5(4)	7.9	5(4)	0.0	0)
Rabbits	6.6	3(2)	7.3	3(2)	0.0	0
Poultry broilers	6.6	18(27)	6.7	19 (28)	5.9	4
Local beef cattle	6.1	2(1)	5.5	2(1)	11.8	3(2)
Poultry layers	6.1	63(92)	6.1	69 (96)	5.9	10
Dairy goats pure breed	5.5	2(2)	5.5	2(2)	5.9	2
Local adult dairy cattle	4.4	2 (1)	3.7	2(1)	11.8	2 (1)
Local Calves	3.3	2(1)	2.4	2(1)	11.8	2(1)

Figures in parenthesis are standard deviations

Asset ownership (chaff cutter and pulverizer)

A chaff cutter is a mechanical device with or without a motor for cutting fodder into small pieces before mixing together with other forages and feeding to livestock. This is one of the labour-saving technologies promoted by the EADD project to reduce the tasks performed by dairy farmers. About 12 percent of the households had chaff cutters. A higher proportion of FHH had chaff cutters compared to MHH (Table 8). However, none of the FHH had a pulverizer whereas 7 percent of MHH owned it. A pulverizer is a type of mechanical devise that grinds different types of materials. In the EADD project, it is promoted to farmers for grinding maize stovers and other feeds.

A farmer trainer, Francis Warui, using a chaff cutter in Olkalou

A modified pulverizer in Rift valley

Table 8: Ownership of chaff cutter and pulverizer by type of household

	MHH (n=164)	FHH (n=17)	Total (n=181)	HH
	Percentage of households			
Chaff cutter	11.5	17.6		12.1
Pulverizer	7.3	0		6.6

When data was categorized by site, a high proportion of households in Olkalou owned a chaff cutter compared to other sites. This was followed by Siongiroi and Kibiyet (Table 9). As for the pulverizer, a higher proportion of households in Kibiyet owned it followed by Taragoon and Sirikwa. Note that none of the households in Taragoon, Metkei and Olenguruone had chaff cutters while none of the households in Metkei, Sot and Siongiroi had pulverizers. This is a result of the costs which are too prohibitive. A manual chaff cutter costs about KES 20 000 while a motorized one is about KES 35 000. The cost for the pulverizer ranges between KES 35 000-100 000 depending on the quality and output.

Table 9: Ownership of chaff cutter and pulverizer by site

	Chaff cutter		Pulverizer	
	N	%	N	%
All sites	181	12.1	181	6.63
Kibiyet	19	21.05	19	21.05
Sirikwa	18	5.56	18	11.11
Taragoon	21	0	21	14.29
Metkei	29	0	29	0
Cherobu	12	8.33	12	8.33
Olkalou	21	33.33	21	4.76
Sot	26	3.85	26	0
Siongiroi	23	30.43	23	0
Olenguruone	12	0	12	8.33

3.2 Experience in dairy farming and awareness of livestock feeds and practices

Dairy farming experience

A majority of farmers interviewed (95%) had dairy farming experience ranging from 1 year to 57 years. The average years of dairy experience for male farmers was 13 years compared to 11 years for females. About 31 percent of farmers interviewed had between 1 and 5 years of experience in dairy farming while 7 percent had between 41 and 57 years of experience (Table 10).

Table 10: Years of experience in dairy farming

Years of experience	Percentage of farmers (N=181)
1-5	30.9
6-10	27.6
11-15	16.0
16-20	6.6
21-25	4.4
25-30	3.9
31-40	1.7
41-57	3.9

3.3 Farmers' awareness of feeds and feed technologies promoted by EADD

All farmers interviewed had knowledge on the improved feed and feed practices introduced by the EADD project and other institutions. Among grasses, almost all respondents were aware of Napier grass and about three-quarters were aware of Boma Rhodes (Table 11). Between 20 and 30 percent of the farmers were aware of Nandi setaria and Columbus grass. Grasses that farmers were less aware of (less than 5%) were Sudan grass, molasses grass, giant setaria, serato, Elimba Rhodes among many other grasses that have been classified in Table 10 as other grasses. Among herbaceous legumes, lucerne was the most known by 74 percent of the farmers compared to desmodium (42%). Less known herbaceous legumes (less than 10%) were vetch, lupin and lablab. Among the fodder shrubs, calliandra was the most known followed by sesbania.

Table 11: Percentage of farmers aware of feeds/feed practices promoted by EADD project

Feeds and Practices		% of farmers (n=181)
Grasses	Napier	99.4
	Boma Rhodes	75.1
	Nandi setaria	26
	Columbus grass	28.2
	Other grasses	13.9
Herbacious legumes	Lucerne	73.5
	Desmodium	42
	Lupin	9.9
	Purple vetch	1.1
	Lablab	2.2
Fodder shrubs	Calliandra	36.5
	Sesbania	12.7
	Leucaena trichandria	5
	Mulberry	9.4
	Tree Lucerne	3.9
Other fodder crops	Oats	63
	Sweet potato vines	44.2
	Forage sorghum	37
	Yellow maize	0.6
Crop residues	Maize stover dry	42
	Maize stover green	20.4
	Bean husks	30.9
	Sunflower cake	21.5
	Wheat straws	8.8
	Millet straws	3.3
	Maize ground	15.5
	Barley straws	0.6
	Sugarcane residues	7.7
	Other crop residues	7.8
Feed Practices	Silage	40.9
	Hay	24.9
	Dairy meal/commercial concentrates	19.9
	Feed/ration formulation	7.2
	Home- made concentrates	1.7

NB: Kikuyu grass and other common livestock feeds such as banana pseudo stems, and vegetable residues used by farmers have not been included since they are not among those promoted by EADD project.

Less known were tree lucerne, *Leuceana trichandria* and mulberry. Among other fodder crops, 63 percent of the farmers were aware of oats and 37 percent were aware of forage sorghum. Farmers were aware of the use of several crop residues as livestock feed, with dry maize stover mentioned by 42 percent of the respondents, bean husks by 31 percent and green maize stover by 20 percent. Among feed practices, 41 percent of the farmers knew about silage. Less than 30 percent of the farmers knew other feed practices (Table 11), and less than 2 percent knew about home-made concentrates.

3.4 Sources of information on feeds and feed practices

Dairy farmers have multiple sources of information. VFTs, Ministry of Livestock (MOL) and other farmers were the three main sources of information for both men and women dairy farmers (Table 12). This is attributed to the fact that farmers interviewed belonged to DMGs which mostly receive training from VFTs.

Table 12: Sources of information between genders

Source of information	Male (N=109)	Female (N=72)
Volunteer farmer trainer (VFT)	57.9	45.5
Ministry of Livestock	35.7	33.3
Other farmers	34.3	26.7
EADD	21.4	24.4
Ministry of Agriculture (MOA)	24.3	21.1
Home/family members	23.6	23.3
Farmer field days	25.7	18.9
Community Extension Service Providers (CESPs)	12.1	17.8
Exchange visits	15.7	6.7
Neighbours	10.0	10.0
Agriculture Society of Kenya shows	11.4	7.8
NALEP	2.1	8.9
Agrovets/stockists	10.6	2.2
Radio	5.0	3.3
Producer organization	1.4	2.2
Own trials	2.1	1.1
KARI	2.9	1.1
Catholic church	0.0	1.1
Written material (books, brochures)	1.4	1.1

Sources of information for grasses

For grasses such as Napier, Boma Rhodes and Nandi setaria, more than 20 percent of farmers received information from VFTs (Table 13). This is an indication that VFTs are an important source of information for these technologies. Other important sources of information for Napier grass were other farmers and Ministries of Agriculture (MOA) and Livestock (10% and 14.6% respectively). For Boma Rhodes and Nandi setaria, other important sources other than VFTs are the EADD project and CESP.

Table 13: Sources of information for grasses

Sources	Napier (n=178)	Boma Rhodes (n=133)	Nandi Setaria (n=46)
	Percentage of farmers		
VFT	25.3	24.1	26.1
MOL	14.6	9.0	0
Other farmer	11.8	7.5	13.0
MOA	10.1	3.0	0
Home	9.0	1.5	4.4
EADD	7.9	18.8	13.0
CESPs	6.2	17.3	13.0
Neighbour	4.5	0	4.4
Farmer field days	3.4	6.0	10.9
NALEP	2.3	0	0
Farmer group	1.7	0.8	0
Exchange visits	1.1	4.5	2.2
KARI	1.1	1.5	0
Catholic church	0.6	0	8.7
Demonstrations	0.6	0	0
ASK shows	0	2.3	0
Radio	0	0	2.2
Local market	0	0	2.2
Agrovet	0	0.8	0
PO	0	3.0	0

Sources of information on herbaceous fodder legumes

The most common sources of information for herbaceous fodder legumes are VFTs, CESP, EADD project and the MOL (Table 14). Slightly less than 30 percent of the farmers who were aware of lucerne obtained information from VFTs followed by the EADD project and CESP. Twenty-six (26) percent of the farmers obtained information on desmodium from the EADD project, followed by CESP and MOL.

Table 14: Percentage of farmers obtaining information on herbaceous fodder legumes from different sources

Information sources	Lucerne (n=129)	Desmodium (n=73)
	% of farmers	
VFTs	28.7	13.7
CESPs	14.7	24.7
EADD	14.7	26.0
MOL	8.5	15.1
Farmer field days	7.8	5.5
MOA	6.2	1.4
Exchange visits	4.7	7.0
Other farmer	4.7	1.4
Home	2.3	0
PO	2.3	1.4
ASK show	1.6	1.4
Radio	1.6	0
Agrovet	0.9	0
KARI	0.8	0
NALEP	0.8	1.4
Farmer groups	0	1.4

Sources of information on fodder shrubs

Farmers accessed information on fodder shrubs mainly from EADD project, CESP, VFTs and MOL (Table 15). More specifically, 32 percent of the farmers accessed information on calliandra from the EADD project followed by CESP (24.6%) and VFTs (15%). About 22 percent of farmers accessed information on *Leuceana trichandria* from MOL while 35 percent accessed information on mulberry from the EADD project,

followed by VFTs and CESP. About 43 percent of the farmers accessed information on tree lucerne from VFTs and 28.6 percent from other farmers (Table 14).

Sources of information on other fodder crops, crop residues and feed practices

Farmers accessed information on other fodder crops such as oats, forage sorghum, sweet potato vines and sunflower cake mainly from VFTs, CESP and the EADD project. Information on sugarcane as a fodder crop was mainly accessed from neighbours (Table 16).

Table 15: Sources of information on fodder shrubs

	Calliandra (n=65)	L. trichandria (n=9)	Mulberry (n=17)	Tree lucerne (n=7)
	% of farmers			
EADD	32.3	11.1	35.3	14.3
CESPs	24.6	0	23.5	0
VFTs	15.4	11.1	29.4	42.9
MOL	10.8	22.2	0	0
Farmer field days	4.6	11.1	5.9	14.3
Exchange visits	3.1	0	5.9	0
NALEP	3.1	11.1	0	0
PO	3.1	0	0	0
ASK show	1.5	11.1	0	0
Kenya Farmer Association (KFA)	1.5	0	0	0
Neighbours	0	11.1	0	0
Other farmer	0	11.1	0	28.6

Information on crop residues such as maize stover (green and dry) and bean husks was mainly accessed from VFTs, the EADD project and MOL (Table 17). Information on feed practices such as hay and silage-making, sunflower cake, feed formulation and dairy meal was mainly accessed from VFTs, CESP, MOL and the EADD project (Table 18).

Table 16: Farmers' access to information on other fodder crops from different sources

	Oats n(113)	Forage Sorghum (65)	Sweet potato vines (n=76)	Sugar cane (n=14)
VFTs	31.9	13.9	18.4	21.4
Home	13.3	1.5	1.3	0
Other farmers	12.4	4.6	5.3	0
EADD	9.7	20	22.4	0
CESPs	8.9	27.7	14.5	21.4
MOL	7.1	10.8	15.8	14.3
Farmer field days	6.2	1.5	1.3	0
MOA	3.5	1.5	4.0	0
Exchange visits	1.8	3.1	4.0	0
KARI	1.8	1.5	0	0
ASK show	0.9	1.5	4.0	0
Radio	0.9	4.6	0	0
Farmer group	0.9	0	0	0
Demonstrations	0.9	0	0	0
Neighbours	0	1.5	2.6	35.7
Own trials	0	1.54	0	0
NALEP	0	0	2.63	7.14
KFA	0	1.54	0	0
PO	0	3.08	3.95	0

Table 17: Sources of information on crop residues

	Maize green (n=34)	Maize dry (n=69)	Bean husks (=14)	Wheat straw (n=45)	Sun flower cake (n=37)
Other farmer	26.5	18.8	7.1	13.3	10.8
MOA	23.5	4.4	14.3	6.7	5.4
VFTs	14.7	17.4	14.29	17.8	46
EADD	8.8	1.5	0	11.1	10.8
Home	5.9	20.3	0	2.2	0
Farmer field days	5.9	1.5	0	4.4	0
MOL	5.9	13.0	50	13.3	8.1
ASK show	5.9	0	0	0	2.7
NALEP	2.9	2.9	7.1	2.2	0
CESPs	0	14.5	0	13.3	0
Neighbour	0	2.9	7.1	0	0
Exchange visits	0	1.5	0	4.4	2.7
Own trials	0	1.5	0	0	0
Radio	0	0	0	2.2	0
Farmer group	0	0	0	6.7	16.7
Demonstration	0	0	0	2.2	0

Table 18: Sources of information on feed practices

	Hay baling (n=45)	Silage making (n=72)	Feed formulation (N=11)	Dairy meal (N=15)
VFTs	17.8	29.2	45.5	46.7
CESP	13.3	9.7	0	0
EADD	13.3	19.5	9.1	0
MOA	13.3	9.7	0	0
Other farmers	13.3	12.5	18.2	6.7
MOA	6.67	2.8	0	0
PO	6.7	2.8	0	0
Farmer field days	4.4	6.9	18.2	33.3
Exchange visits	4.4	4.2	0	6.7
Home	2.2	1.4	0	0
NALEP	2.2	1.4	0	0
Radio	2.2	0	0	0
Neighbour	0	0	9.1	0
ASK show	0	0	0	0
Farmer group	0	0	0	6.7

Rating of information sources

When farmers were asked to rate information sources, VFTs were ranked highest followed by farmer field schools, MOL, EADD project and 5th was the MOA (Table 19). Of the farmers who mentioned VFTs as a source of information, 55 percent rated it as the most important source, followed by 33 percent who rated it as an important source of information while a paltry 3 percent rated it as the least important. During the time of the interviews, Ministry of Agriculture and Ministry of Livestock were separate ministries but they have since been merged to form the Ministry of Agriculture, Livestock and Fisheries Development. Although farmer field schools ranked second overall, farmers who used them rated them highly.

Farmers in Kaptumo learning about calliandra

Table 19: Rating of information sources

Information source	Most important (5)	Important (4)	Neutral (3)	Less important (2)	Least important (1)				Overall Rank
	Frequency					Total frequency	Total Score	Average score	
VFT	58	35	6	6	3	108	463	4.29	1
Farmer field schools	52	23	4	2	2	83	370	4.45	2
MOL	21	12	13	11	7	64	221	3.45	3
EADD	27	5	2	3	2	39	169	4.33	4
MOL	20	8	2	8	4	42	142	3.38	5
Other farmers	13	8	12	3	0	36	139	3.86	6
CESPs	17	5	3	2	1	28	119	4.25	7
Home	5	6	13	3	1	28	80	2.86	8
Neighbour	7	2	5	3	1	18	65	3.61	9
Exchange visit	8	2	0	3	2	15	56	4.31	10
ASK show	3	4	3	2	1	13	45	3.46	11
NALEP	3	5	1	0	0	9	38	4.22	12
Radio	4	0	0	0	0	4	20	5.00	13
Farmer groups	4	0	0	0	0	4	20	5.00	13
KARI	1	1	0	0	0	2	9	4.50	15
Own trials	1	0	0	0	0	1	5	5.00	16
KFA	1	0	0	0	0	1	5	5.00	16
Local market	1	0	0	0	0	1	5	5.00	16
Agrovet	1	0	0	0	0	1	5	5.00	16
Catholic church	0	1	0	0	0	1	4	4.00	20

Total frequency is the number of farmers using the particular source who also rated it

Total scores are weighted scores calculated by multiplying the frequencies by the rating as follows; most important=5, important=4, neutral=3, less important=2, least important=1

Overall ranking was based on the total scores

Average score is the total score divided by total frequency and it shows the average rating of farmers using that particular source

3.5 Feeds and feed practices on the farm

Table 20: Percentage of farmers with feed practices on farm and those aware of the technology but not implemented

Feeds and Practices		% of farmers aware of technology (n=181)	No. with technology	% of the sample with technology (n=181)	% of cases aware of technology but not implemented
Grasses	Napier	99.4	165	91.2	8.3
	Boma Rhodes	75.1	78	43.1	32.0
	Columbus grass	23.8	21	11.6	12.2
	Nandi setaria	26	9	5.0	21.0
	Sudan grass	4.4	3	1.7	2.7
Herbacious legumes	Lucerne	73.5	23	12.7	60.8
	Desmodium	42	17	9.4	32.6
	Lupin	9.9	5	2.8	7.1
	Purple vetch	1.1	2	1.1	0
	Lablab	2.2	1	0.6	1.6
Fodder shrubs	Calliandra, Leuceana, Mulberry, Tree lucerne, Sesbania	67.5	60	33.1	34.4
Other fodder crops	Oats	63	65	36.5	26.5
	Sweet potato vines	44.2	49	27.1	17.1
	Forage sorghum	37	32	17.7	19.3
	Cow candy	2.2	4	2.2	0
Crop residues	Maize stover dry	42	66	36.5	5.5
	Maize stover green	20.4	31	17.1	3.3
	Bean husks	30.9	41	22.7	8.2
	Sunflower cakes	21.5	13	7.2	14.3
	Wheat straws	8.8	8	4.4	4.4
	Millet straws	3.3	7	3.9	-0.6
	Maize stover ground	15.5	8	4.4	11.1
	Barley straws	0.6	1	0.6	0
	Yellow maize	0.6	1	0.6	0
Feed Practices	Silage making	40.9	17	9.4	31.5
	Hay making	24.9	14	7.2	17.7
	Dairy meal/commercially mixed concentrates	19.9	13	7.7	12.2
	Home-made concentrates	1.7	1	0.6	1.1
	Ration/feed formulation	7.2	5	2.8	4.4

A heifer feeding on homemade concentrates in Kabiye

A farmer in his sunflower farm

Napier was the most common grass planted. 91.2 percent of the households in all the sites had Napier, 43.1 percent had Boma Rhodes and less than 2 percent had planted Sudan grass (Table 20). Among herbaceous legumes, 12.7 percent of farmers had planted lucerne on their farms while only 0.6 percent had lablab. Out of 67.5 percent of farmers who were aware of fodder shrubs, only about 33.1 percent had planted fodder shrubs on their farms with calliandra being the most common. Slightly less than 20 percent of the farmers had calliandra on their farms, while sesbania, leucaena, mulberry and tree lucerne were planted by less than 5 percent of farmers respectively. Among other fodder crops, oat was planted by 58.7 percent of the farmers while 27.1 percent had sweet potato vines and 17.7 percent had forage sorghum. Maize stover is a common crop residue among farmers in all the study sites. About 36.5 percent of respondents used dry maize stover while 17.1 percent used green maize stover. Other crop residues used by farmers included bean husks, sunflower cakes, among others (Table 20). Regarding feed practices, 9.4 percent of respondents practiced silage-making and hay making. Other practices that farmers used included feed formulation and home-made concentrates, among others.

Disaggregating data by gender, Napier grass was the most grown grass by both male and female farmers, with slightly less than 90 percent of male farmers having it on their farms compared to over 90 percent of female farmers (Table 21). Boma Rhodes was the second most grown grass by both male and female farmers at 40.4 percent and 47.2 percent respectively. Among herbaceous fodder legumes, lucerne was the most grown by both male and female farmers, followed by desmodium although the proportions were less than 20 percent. Reasons are explored in the next section. About 38.7 percent of male farmers had planted fodder shrubs as compared to about 25 percent of female farmers. In regards to other fodder crops, a higher proportion of male farmers had planted oats

Table 21: Feeds and feed practices on the farm across gender

Feeds and practices		% of male farmers (n=109)	% of female farmers =(n=72)
Grasses	Napier	88.9	94.4
	Boma Rhodes	40.4	47.2
	Nandi setaria	6.4	2.8
	Columbus grass	11.9	11.1
	Sudan grass	0	4.2
Herbaceous legumes	Lucerne	13.8	11.1
	Desmodium	10.1	8.3
	Lupin	3.7	1.4
	Purple vetch	0	2.8
Fodder shrubs	Calliandra, Mulberry, Sesbania, Tree Lucerne, Leucaena	38.5	25
Other fodder crops	Oats	41.3	27.8
	Sweet potato vines	23.9	31.9
	Forage sorghum	16.5	19.4
Crop residues	Maize stover dry	38.5	33.3
	Maize stover green	18.3	15.3
	Bean husks	19.3	27.8
	Sunflower cakes	8.3	5.6
	Wheat straws	5.5	2.8
	Millet straws	0.9	6.9
	Maize ground	2.8	6.9
	Barley straws	0.9	0
Feed practices	Silage	11	6.9
	Hay	8.3	6.9
	Dairy meal/commercial concentrates	9.1	4.2
	Feed/ration formulation	4.6	0
	Mineral supplementation	11.0	00
	Pasture improvement	3.7	5.6
	Homemade concentrates	0.9	0.0

compared to females. In contrast to this, a higher proportion of women farmers had planted sweet potato vines and forage sorghum compared to male farmers. This could be because these two crops are dual purpose – used for human consumption and as livestock feed. Among crop residues, dry maize stover was the most widely used by 38.5 percent of male and 33.3 percent of female farmers. A higher proportion of male farmers had implemented different feed practices compared to female farmers.

A farmer in his calliandra farm

Feed practices on-farm across POs

Napier grass was the most common grass across all the sites with over 90 percent of respondents having it on their farms in all POs except in Taragoon and Sirikwa (Table 22). All farmers interviewed in Olenguruone had planted Napier grass. Boma Rhodes was also common across all the study sites. Sudan grass was grown by less than 10 percent of farmers in Taragoon, Olkalou and Sot POs. Among the herbaceous legumes, lucerne was available on farms across all the sites except Olenguruone. Desmodium was also planted by farmers in all sites except Metkei and Olenguruone. Lablab was only planted by farmers interviewed in Kabiye while purple vetch was only found in Olkalou. Lupin was only found in Metkei. Among fodder shrubs, calliandra was available on farms across all the sites with 47 percent of farmers having it in Kabiye, 33 percent in Cherobu and 35 percent in Sot. Tree lucerne was only found in Metkei. Among other fodder crops, 90 percent of farmers had oats in Metkei, 71 percent in Olkalou and 75 percent in Olenguruone – these sites all fall under the UH zones. This could be attributed to oats

thriving well in the highlands. In Taragoon which falls under the lower highlands, 57 percent of the farmers plant oats. Sweet potato vines were planted by farmers across all the sites except in Olenguruone and Taragoon. Among crop residues, dry maize stover was used by farmers across all the sites (Table 22). Wheat straw was used in three sites; Sirikwa, Taragoon and Siongiroi while barley straw was used in only Taragoon. Among feed practices, silage-making was practiced in only two sites, Taragoon, Metkei and Olkalou.

Tube silage in south Rift Valley

A farmer in her Napier grass farm in south Rift Valley

Table 22: Percentage of farmers with feeds and feed practices on farm per PO

	Feeds and feed practices	Kabiyet (n=19)	Sirikwa (n=18)	Taragoon (n=21)	Metkei (n=29)	Cherobu (n=12)	Olkalou (n=21)	Sot (n=26)	Siongiroi (n=23)	Olenguruone (n=12)
Grasses	Napier	95	89	71	97	92	90	96	91	100
	Boma Rhodes	68	67	29	3	50	19	54	91	8
	Nandi setaria	0	0	0	3	8	0	4	9	42
	Columbus grass	0	0	5	0	8	14	0	65	8
	Sudan grass	0	0	5	0	0	5	4	0	0
Herbaceous legumes	Lucerne	5	6	14	14	8	14	15	26	0
	Desmodium	26	6	5	0	8	10	15	13	0
	Lablab	5	0	0	0	0	0	0	0	0
	Purple vetch	0	0	0	0	0	10	0	0	0
	Lupin	0	0	0	17	0	0	0	0	0
Fodder shrubs	Calliandra	47	6	5	3	33	14	35	26	8
	Sesbania	0	6	0	7	17	0	8	0	17
	Leucaena	0	6	0	0	8	0	4	9	0
	Mulberry	16	0	0	7	8	0	0	0	0
	Tree lucerne	0	0	0	17	0	0	0	0	0
Other fodder crops	Oats	0	6	57	90	0	71	0	9	75
	Forage sorghum	21	28	5	0	33	29	38	9	0
	Sweet potato vines	53	11	0	3	42	5	69	52	0
Crop residues	Maize stover green	11	56	31	0	14	4	4	17	8
	Maize stover dry	5	44	67	24	33	76	31	22	35

	Banana pseudo stems	0	11	17	5	15	5	15	26	8
	Sunflower cakes	5	22	5	21	0	0	0	0	8
	Wheat straws	0	6	24	0	0	0	0	9	0
	Barley straws	0	0	5	0	0	0	0	0	0
	Millet straws	0	33	0	0	0	0	0	0	0
	Bean husks	0	50	43	17	0	0	33	35	0
Feed practices	Silage-making	0	0	38	7	0	33	0	0	0
	Hay making	0	17	23	3	8	19	0	0	0
	Commercially mixed concentrates	0	0	10	21	0	4	0	17	17
	Feed formulation	0	0	24	0	0	0	0	0	0
	Pasture improvement	0	0	14	7	0	0	0	9	8

Hay and green maize stover in a store

Reasons for planting livestock feeds

Livestock feeding was mentioned by farmers as the main reason for planting grasses. Apart from livestock feeding, other reasons for planting grasses included drought resistance for Napier, and increase in animal productivity for Boma Rhodes and Columbus grass (Table 23)

Table 23: Reasons for planting grasses

Reason	Napier grass (n=164)	Boma Rhodes (n=77)	Columbus grass (n=21)	Nandi setaria (n=8)	Giant setaria (n=3)
	Percentage of farmers				
Livestock feeding	43.9	37.6	23.6	37.5	33.3
Drought resistance	15.2	2.5	0	0	0.0
Supplement	7.3	3.9	9.5	12.5	0.0
Increases animal production	7.3	15.6	0	12.5	33.3
For dry spell	4.9	3.9	0	12.5	0.0
Silage-making	3.7	0.0	4.8	0	0.0
Grows fast	3.0	2.5	10	0	0.0
Bulking	3.0	1.3	0	0	0.0
Easy to grow	1.8	1.3	0	0	0.0
Easy to manage	1.8	0.0	0	12.5	0.0
High palatability	1.2	1.3	0	0	0.0
Availability of planting material	0.6	0.0	0	0	0.0
Low maintenance	0.6	0.0	0	0	0.0
Ability for regrowth	0.6	0.0	0	0	0.0
Substitute for Kikuyu grass	0.6	0.0	0	0	0.0
High yielding	0.6	2.5	9.5	0	33.3
Evergreen	0.6	0.0	0	0	0.0
Control soil erosion	0.6	0.0	0	0	0.0
Hay making	0.0	7.8	0	0	0.0
High protein	0.0	1.3	28.6	0	0.0
Easily conserved	0.0	15.6	4.8	0	0.0
Very nutritive	0.0	1.3	4.8	0	0.0
Multiple harvests	0.0	1.3	0	0	0.0

Oat was mainly planted for animal feeding while about 13.8 percent indicated that it also increased animal productivity. About a third of farmers grew forage sorghum for livestock feeding while about 23.3 percent planted it because they used it as a supplement feed for livestock. In contrast to oat and forage sorghum, sweet potato vines were mainly grown because of their dual-purpose ability (for human consumption and livestock feed) followed by the ability to increase animal productivity and high protein content (Table 24).

Table 24: Reasons for planting oats, forage sorghum and sweet potato vines

Reasons	Oats (n=65)	Forage sorghum (n=30)	Sweet potato vines n=49)
	Percentage of farmers		
Livestock feeding	32.3	33.3	16.3
Supplement	7.6	23.3	0.0
Hay making	3.1	0.0	0.0
Silage-making	0.0	6.6	0.0
High protein	0.0	3.3	18.4
Increases animal productivity	13.8	3.3	18.4
Drought resistance	0.0	6.6	0.0
Easy to grow	4.6	0.0	0.0
Availability of planting material	1.5	0.0	0.0
Low maintenance	1.5	3.3	0.0
Dual purpose	0.0	16.7	32.7
Grows fast	7.6	3.3	0.0
Easily conserved	7.6	0.0	0.0
High palatability	0.0	0.0	2.0
Substitute to concentrates	0.0	0.0	2.0
Very nutritive	1.5	0.0	4.1
Easy to manage	3.1	0.0	0.0
Seeds available	3.1	0.0	0.0
Reduce expenses for buying feeds	1.5	0.0	0.0

Apart from livestock feeding, a third of farmers planted lucerne because of its high protein content while desmodium was planted also as a livestock feed supplement. Apart from livestock feeding, the other reasons for planting fodder shrubs was because of their high protein content (Table 25).

Table 25: Reasons for planting herbaceous fodder legumes and shrubs

	Lucerne (n=23)	Desmodium (n=17)	Lupin (n=5)	Calliandra (n=34)	Sesbania (n=9)	Mulberry (n=6)	Tree lucerne (n=5)
Livestock feeding	43.5	35.3	20.0	50.0	44.4	33.3	0.0
High protein	30.4	11.8	20.0	26.5	22.2	33.3	40.0
Supplement	13.0	23.5	20.0	5.9	11.1	16.7	0.0
Grows fast	4.3	0.0	0.0	2.9	0.0	0.0	0.0
Easily conserved	4.3	5.9	0.0	0.0	0.0	0.0	0.0
Very nutritive	4.3	11.8	0.0	0.0	0.0	0.0	0.0
Improves animal production	0.0	5.9	20.0	2.9	0.0	0.0	40.0
Low maintenance	0.0	0.0	0.0	0.0	11.1	0.0	0.0
For dry spell	0.0	5.9	0.0	0.0	0.0	0.0	20.0
High yielding	0.0	0.0	0.0	2.9	0.0	0.0	0.0
Substitute to concentrates	0.0	0.0	0.0	5.9	0.0	0.0	0.0
Easy to manage	0.0	0.0	0.0	2.9	0.0	0.0	0.0
Soil fertility improvement	0.0	0.0	20.0	0.0	0.0	0.0	0.0

Sources of seeds and planting materials for various feeds and feed practices

Fellow farmers as a source was cited by more farmers interviewed than any other source for obtaining Napier grass planting material and Nandi setaria seed. This was followed by neighbours. Farmers mainly obtained seeds for Boma Rhodes and Columbus grass from commercial agrovet (Table 26).

Table 26: Main sources of seeds for grasses

	Napier (N=153)	Boma Rhodes (N=76)	Columbus grass (N=21)	Nandi setaria (N=8)
	% of farmers			
Fellow farmer	44.4	1.3	9.5	62.5
Neighbour	35.2	10.5	0	25.0
Friend	4.6	1.3	4.7	0.0
Farmer trainer	3.9	0.0	9.5	0.0
On farm	2.6	0.0	0	0.0
KARI	2.6	0.0	4.7	0.0
Commercial agroveter	1.9	47.3	52.3	0.0
Ministry of Agriculture/Livestock	1.9	3.9	0	0.0
EADD	0.6	2.6	4.7	0.0
Kenya Seed company	0.6	9.2	4.7	12.5
KFA	0.6	10.5	4.7	0.0
Model farmer	0.6	0.0	0	0.0
Stockist	0	0	0	0.0
ICRAF	0	1.3	0	0.0
Local market	0	9.2	4.7	0.0
CESPs	0	0.0	0	0.0
ASK show	0	2.6	0	0.0

As regards to herbaceous fodder legumes such as lucerne, a majority of farmers obtained seed from agrovets followed by Kenya Farmers Association (Table 27). The most cited source for desmodium was neighbours and the EADD project (Table 27). Other sources included stockists and fellow farmers. About 46.8 percent of farmers obtained oats seed from commercial agrovets, while a few farmers bought from stockists (20.3%). About a third of farmers got sweet potato vines planting material from other farmers and neighbours. Other important sources included EADD and ICRAF.

Table 27: Sources of seed/planting material for lucerne, desmodium, oats and sweet potato vines

	Lucerne (n=22)	Desmodium (n=16)	Oats (n=64)	Sweet potato vines (n=47)
	Percentage of farmers			
Agrovet	45.5	0	46.8	2.1
KFA	22.7	6.3	3.1	0
Stockist	9.0	12.5	20.3	0
ASK show	4.5	6.3	0	0
EADD	0	25	0	19.1
Kenya Seed Company	4.5	0	12.5	0
MOA	4.5	6.3	0	0
Neighbour	0	25	1.5	29.7
Fellow farmer	4.5	12.5	15.6	31.9
On farm	0	0	0	0
CESPS	0	6.3	0	0
Model farmer	0	0	0	2.1
ICRAF	4.5	0	0	10.6
Friend	0	0	1.5	2.1
Farmer group	0	0	0	2.1

Table 28: Sources of planting material for fodder shrubs

	Calliandra (n=34)	Mulberry (n=4)	Tree lucerne (n=5)	Sesbania (n=9)	Leucaena (n=4)
	Percentage of farmers				
Agrovat	11.8	0	40	0	0
EADD	23.5	0	0	22.2	25
ICRAF	14.7	0	0	0	0
Neighbour	5.8	0	0	33.3	0
Fellow farmers	8.8	50	40	11.1	0
Private nursery	5.8	0	0	0	25
Farmer trainer	2.9	50	0	0	0
MOL/MOA	5.8	0	0	11.1	50
KFA	0	0	0	0	0
Market	11.7	0	0	0	0
Others	9.2	0	20	33.3	0

Farmers obtained calliandra seeds/seedlings mainly from the EADD project and ICRAF, and others bought from private nurseries and the market (Table 28). Other sources were MOA and MOL which have since been combined to form the Ministry of Agriculture, Livestock and Fisheries development (MOLFD) and fellow farmers. Mulberry had been planted by a few farmers who obtained planting material from farmer trainers and fellow farmers. Farmers obtained sesbania material from neighbours and the EADD project. Tree lucerne seeds were obtained from agrovets (40%) and fellow farmers. Leucaena seeds were obtained mainly from MOLFD, the EADD project and private nurseries.

Niches where improved livestock feed is planted

The most common niche for planting grasses is the cropland. Planting grasses in the cropland offers protection from animals. Fodder shrubs are planted either on the boundary or in the cropland (Table 29).

Table 29: Niches where livestock feeds are planted

Niche			Boundary	Cropland	Grazing land
		N	Percentage of n		
Grasses	Napier grass	160	20.7	81.2	1.8
	Boma Rhodes	75	1.3	97.3	1.3
	Columbus grass	20	0.0	100.0	0.0
	Nandi setaria	9	11.1	88.8	0.0
Fodder shrubs	Leuceana	5	100.0	0.0	0.0
	Calliandra	35	74.2	25.7	0.0
	Tree lucerne	5	80.0	20.0	0.0
	Mulberry	6	33.3	66.7	0.0
Herbaceous legumes	Desmodium	17	11.8	88.2	0.0
	Lucerne	21	0.0	100.0	0.0
Other fodder crops	Oats	65	6.1	93.9	0.0
	Sweet potato vines	47	0.0	100.0	0.0
	Forage sorghum	31	0.0	100.0	0.0
	Sunflower	13	23.1	76.9	0.0

n=total number of farmers that responded to the question

Calliandra, leuceana and tree lucerne are mainly planted along the boundary while mulberry is mostly found in the cropland. Herbaceous fodder legumes and other fodder crops such as oats, sweet potato vines, sunflower and forage sorghum are mostly found in the cropland

Mean acreage of feed practices/number of trees per household

Among grasses, Boma Rhodes had the highest acreage of 0.8 followed by Napier grass (Table 30). Among fodder shrubs, tree lucerne had the highest mean number of trees, followed by calliandra. It is however important to note that tree lucerne was planted by

five farmers only with three of them having between 51-100 trees (Table 31). Among herbaceous legumes, lucerne had the highest mean acreage of 0.9 followed by purple vetch that was planted by two farmers.

Table 30: Mean acreage of feed practices/number of trees per household

		n	Mean acreage/no. of trees	Standard deviatio
Grasses	Napier grass	157	0.5	0.6
	Boma Rhodes	78	0.8	1.0
	Columbus grass	21	0.3	0.4
	Nandi setaria	8	0.2	0.1
	Giant setaria	3	0.2	0.1
Fodder shrubs	Leuceana	5	*24.0	23.9
	Calliandra	33	*69.6	128.6
	Tree lucerne	5	*80.4	54.5
	Mulberry	3	*5.3	4.5
	Sesbania	9	*8.9	9.9
Herbaceous legumes	Desmodium	17	0.1	0.1
	Purple vetch	2	0.8	0.4
	Lucerne	21	0.9	2.3
Other fodder crops	Oats	64	0.8	1.0
	Sweet potato vines	49	0.2	0.2
	Forage sorghum	32	0.2	0.2
	Edible cana	1	0.1	.
	Sunflower	12	*45.3	105.7

n=total number of farmers that responded to the question

**Mean number of plants/trees*

Calliandra hedge (Kapcheno, Rift valley)

Tree lucerne in a hedge (Central Kenya)

Table 31: Frequency showing number of farmers and number of trees

No. of trees	Leuceana	Calliandra	Sesbania	Mulberry	Tree lucerne
	Number of farmers				
1.00-10.00	3	10	7	3	1
11.00-50.00	2	16	2	0	0
51-100	0	2	0	0	3
101-150	0	0	0	0	1
151-200	0	3	0	0	0
500	0	1	0	0	0
538.00	0	1	0	0	0
Total	5	33	9	3	5

3.6 Livestock feed preferences

Reasons why farmers prefer different types of feeds

Napier grass was the most preferred feed overall, followed by Boma Rhodes, maize stover dry, lucerne and oats (Table 32). Reasons why farmers preferred Napier grass included its drought resistant ability, high nutrient content, ability to increase milk production and its fast growth (Table 33). On the other hand, Boma Rhodes was preferred because it has the ability to increase milk production (and its high growth rate).

Table 32: Farmers' preferences about livestock feeds/feed practices

Feed/feed practice	Most preferred	Preferred	Neutral	Less preferred	Least preferred	Total frequency	Total score	Average score	Overall Rank
	5	4	3	2	1				
	Percentage of farmers								
Napier	58.79	20	9.09	4.85	7.27	165	690	4.18	1
Boma Rhodes	72.04	11.83	5.38	2.15	8.6	93	406	4.37	2
Maize stover (dry)	45.28	16.98	18.87	5.66	13.21	106	398	3.75	3
Lucerne	57.14	11.9	11.9	7.14	11.9	42	166	3.95	4
Oats	71.43	12.7	4.76	4.76	6.35	63	225	3.57	5
Mineral supplement	75	9.09	6.82	4.55	4.55	44	195	4.43	6
Maize stalk (green)	54.17	14.58	8.33	6.25	16.67	48	184	3.83	7
Wheat-straw	80.49	4.88	0	2.44	12.2	41	180	4.39	8
Other crop residues	75	9.38	3.13	0	12.5	32	139	4.34	9
Silage	66.67	6.06	0	6.06	21.21	33	129	3.91	10
Forage sorghum	37.5	9.38	25	12.5	15.63	32	117	3.66	11
Calliandra	37.04	18.52	14.81	18.52	11.11	27	95	3.52	12
Columbus grass	40	20	20	5	15	20	73	3.65	13
Feed formulation	80	6.67	0	6.67	6.67	15	67	4.47	14
Desmodium	26.67	20	26.67	13.33	13.33	15	49	3.27	15

NB: Only feeds/feed practices mentioned by over 15 respondents are reported in the Table. Total score is the sum of scores for each preference. Scores were got by multiplying frequencies on each preference level by scores assigned where least preference was given a score of 1 and high preference a score of 5. The overall rank is derived from the total score with the highest having rank 1.

Table 33: Reasons why farmers prefer different types of grasses as feeds

Reasons	Napier (n=163)	Boma Rhodes (n=93)	Sudan grass (n=7)	Columbus grass (n=17)	Nandi setaria (n=11)
	Percentage of farmers				
Drought resistant	14.3	2.2	0.0	0.0	0.0
High nutrition content	13.7	7.5	0.0	17.6	18.2
Increase milk production	12.4	25.8	14.3	23.5	27.3
Fast growth	10.6	15.1	14.3	5.9	18.2
Easy to manage	10.6	3.2	14.3	0.0	0.0
High biomass	9.9	7.5	0.0	5.9	0.0
Ability to re-grow after harvest	6.2	5.4	0.0	0.0	0.0
Easy to establish	5.6	2.2	0.0	0.0	0.0
Reliable	3.1	0.0	14.3	0.0	0.0
High palatability	2.5	2.2	0.0	0.0	0.0
Improve fertility and health of animal	2.5	2.2	0.0	0.0	0.0
Good for silage-making	2.5	0.0	0.0	5.9	0.0
Feed supplement	2.5	0.0	0.0	0.0	9.1
Evergreen	1.9	0.0	0.0	0.0	0.0
To use during drought or deficit	1.2	4.3	0.0	0.0	0.0
Planting material easily available	1.2	1.1	0.0	0.0	0.0
Longer storage duration	0.6	4.3	14.3	0.0	0.0
Multiple harvests in a year	0.0	1.1	0.0	0.0	0.0
Protein supplement	0.0	0.0	14.3	41.2	0.0
Good for hay making	0.0	8.6	14.3	0.0	27.3
Improve milk production	0.0	2.2	0.0	0.0	0.0
Easy to conserve	0.0	5.4	0.0	0.0	0.0

n = number of respondents who gave reason for the particular feed/practice

Lucerne, which was the most preferred herbaceous fodder legume (Table 32), was liked because of its drought resistant ability, use as a protein supplement and the fact that it has the ability to increase milk production (Table 34). Two farmers preferred purple vetch because of its ability to increase milk production and one said he preferred it due to the fact that it can be intercropped. Desmodium was preferred mostly because of its use as a protein supplement and its ability to increase milk production. Only one farmer preferred lablab because of its ability to regrow after harvest. Oats was preferred mostly because of its ability to increase milk production while forage sorghum was preferred because of its high nutrition content and the fact that it is dual purpose – used both for human and livestock consumption.

Table 34: Reasons why farmers prefer different types of herbaceous fodder legumes, oats and forage sorghum

Reasons	Lucerne (n=53)	Desmodium (n=14)	Oats(n=63)	Forage sorghum (n=30)
	Percentage of farmers			
Drought resistant	26.4	14.3	1.6	3.3
Protein supplement	26.4	28.6	15.9	10.0
Increase milk production	24.5	28.5	30.2	13.3
High nutrition content	9.4	7.1	6.3	20.0
Longer storage duration	3.8	0.0	7.9	0.0
Fast growth	3.8	0.0	15.9	3.3
Easy to manage	3.8	0.0	12.7	6.7
Can be intercropped	1.9	14.3	0	0.0
Ability to re-grow after harvest	0.0	0.0	0	0.0
High palatability	0.0	7.1	0	0.0
Easy to establish	0.0	0.0	0	3.3
To use during drought	0.0	0.0	11.1	0.0
Good for hay-making	0.0	0.0	6.3	0.0
Easy to conserve	0.0	0.0	3.2	0.0
High energy	0.0	0.0	1.6	0.0
Dual purpose	0.0	0.0	0.0	20.0
Improve fertility and health of animal	0.0	0.0	1.6	0.0
Feed supplement	0.0	0.0	1.6	1.7

n = number of respondents who gave reason for the particular feed/practice

Table 35: Reasons why farmers prefer fodder shrubs

	All fodder shrubs (n=52)	Leuceana (n=9)	Mulberry (n=8)	Calliandra (n=26)	Sesbania n=7
	Percentage of farmers				
Protein supplement	34.6	22.2	37.5	38.5	14.3
Increase milk production	21.1	11.1	25	27.0	14.3
Easy to manage	13.5	33.3	25	3.9	14.3
High nutrition content	11.5	22.2	0	11.5	14.3
Drought resistant	3.8	0.0	0	7.7	0.0
High palatability	3.8	11.1	0	3.9	0.0
Dual purpose	3.8	0.0	0	3.9	14.3
Fast growth	1.9	0.0	0	0.0	14.3
Easy to establish	1.9	0.0	12.5	0.0	0.0
Bulky	1.9	0.0	0.0	3.9	0.0
Good for hedges	1.9	0.0	0.0	0.0	14.3

n = number of respondents who gave reason for the particular feed/practice

Farmers preferred fodder shrubs because of their high nutrition content, and the fact that the shrubs are easy to manage (Table 35). More specifically, leuceana was preferred mostly because it is easy to manage, has high nutrient content and because it is used as a protein supplement; while mulberry was preferred because it is easy to establish and also due to the fact that it is used as a protein supplement. Calliandra was preferred because of its protein content, increases milk production and the fact that it has high nutrient content. Only two farmers indicated their preference for tree lucerne and its ability to be used as a protein supplement.

Crop residues were preferred because they have high nutrition content, are used during the dry season and some of them can be stored for long (Table 36). More specifically, green maize stalk was preferred because of its high nutrient content while dry maize stover was preferred because it can be stored for a long duration of time for use during dry periods. Hay and silage were preferred mostly because they can be used during the dry season when there's a deficit of feeds while commercially mixed concentrates and feed formulations were preferred mostly because of their ability to increase milk production (Table 37).

Table 36: Reasons why farmers prefer crop residues

	Wheat straw (n=9)	Maize stalk (green) n=48	Maize-stover (dry) n=103
	Percentage of farmers		
High nutrition content	22.2	47.92	8.74
Used during drought or deficit	22.2	12.50	20.39
Reliable	22.2	8.33	9.71
Longer storage duration	11.1	0	22.33
Increase milk production	11.1	8.33	8.74
Easy to conserve	11.1	4.17	2.91
Protein supplement	0.0	2.08	0.97
High palatability	0.0	6.25	0.97
Easy to establish	0.0	0.0	0.97
Easy to manage	0.0	4.17	10.68
Bulky	0.0	0.0	3.88
Evergreen	0.0	2.08	0.97
Dual purpose	0.0	0.0	0.97
Improve fertility and health of animal	0.0	0.0	0.97
Good for silage-making	0.0	2.08	1.94
Feed supplement	0.0	2.08	4.85

n = number of respondents who gave reason for the particular feed/practice

Table 37: Reasons why farmers prefer different types of feed practices

	Mineral supplementation (n=31)	Ration formulation (n=13)	Hay (n=40)	Silage (n=31)	Pasture improvement (n=8)	Commercially mixed concentrates (n=63)
	Percentage of farmers					
To use during drought or deficit	29.0	23.1	37.5	25.8	0	12.7
High nutrition content	16.1	15.4	5	16.1	25	6.4
Longer storage duration	16.1	0.0	15	3.2	0	7.9
Increase milk production	9.7	38.5	12.5	16.1	25	30.2
Reliable	9.7	0.0	2.5	3.2	0	
Easy to manage	6.5	15.4	5	0.0	0	12.7
Easy to store for long	6.5	0.0	10	9.7	0	3.2
Protein supplement	3.2	0.0	0	9.7	12.5	0.0
Feed supplement	3.2	0.0	0	0.0	0	1.6
High palatability	0.0	0.0	0	3.2	0	
Planting material easily available	0.0	0.0	0	0.0	12.5	
Provides high energy	0.0	0.0	2.5	0.0	0	
Improve animal productivity	0.0	7.7	0	0.0	25	1.6
Improve fertility and health of animal	0.0	0.0	0	0.0	0	1.6

n = number of respondents who gave reasons for the particular feed/practice

NB: Some respondents gave invalid reasons hence the total does not in some cases add up to 100

Reasons why farmers do not prefer certain feeds/feed practices

Table 38: Reasons why farmers do not prefer certain grasses

	Napier grass (n=100)	Boma Rhodes (n=4)	Sudan grass (n=7)	Nandi setaria (n=6)	Columbus grass (n=14)
Reason	Percentage of farmers				
Not drought resistant	44.0	36.4	14.3	33.3	14.3
Requires fertile soils	14.0	0.0	0.0	0.0	0.0
Skin and throat irritation	9.0	11.4	0.0	0.0	28.6
Grows slowly	8.0	6.8	14.3	0.0	0.0
Bulky	7.0	4.5	0.0	16.7	7.1
Causes bloat	6.0	13.6	0.0	16.7	14.3
Less milk production when fed few hours to milking	5.0	2.3	0.0	0.0	0.0
Low yields	3.0	6.8	14.3	0.0	14.3
Unavailability of seeds/planting material	1.0	0.0	0.0	16.7	0.0
High mortality rate	1.0	4.5	0.0	0.0	0.0
Not fed fresh	1.0	2.3	0.0	0.0	7.1
Not very palatable	1.0	0.0	0.0	0.0	0.0
Seeds expensive	0.0	4.5	14.3	0.0	0.0
Difficult to establish after transplant	0.0	0.0	14.3	0.0	0.0
Taints milk if fed few hours to milking	0.0	0.0	14.3	0.0	0.0
Not perennial	0.0	0.0	0.0	0.0	7.1
Requires storage facilities	0.0	2.3	0.0	0.0	0.0
Expensive	0.0	2.3	0.0	16.7	0.0
Seasonal	0.0	0.0	0.0	0.0	7.1

n=total number of farmers that responded to the question

When asked about reasons why they did not prefer certain grasses, not being drought resistance was mentioned by a substantial number of farmers (Table 38). Other reasons included skin and throat irritation for Napier grass, bloat, slow growth, etc. Reasons for herbaceous fodder legumes varied from high mortality rate for lupin, low biomass for desmodium, high cost of seed for lucerne and unavailability of seeds for lupin, lucerne and desmodium (Table 39). One farmer cited difficulty in establishment after transplanting for lablab. A substantial number of farmers also mentioned bloat as a reason

why they did not prefer lucerne. Lucerne was also said to taint milk if fed to livestock a few hours to milking.

Table 39: Reasons why farmers do not prefer certain herbaceous fodder legumes

	Lupin (n=9)	Lucerne (n=21)	Desmodium (n=10)
	# of farmers		
High mortality rate	4	0	0
Unavailability of seeds	2	3	2
Labour intensive	2	1	1
Skin and throat irritation	1	0	0
Seeds expensive	0	6	2
Difficult to establish after transplant	0	0	0
Taints milk if fed few hours to milking	0	1	0
Not drought resistant	0	1	0
Difficult to establish	0	1	0
Not fed fresh	0	1	0
Requires fertile soils	0	1	1
Grows slowly	0	2	0
Expensive	0	1	0
Low biomass	0	0	4
Causes bloat	0	3	0

n=total number of households that responded to the question

Reasons given for fodder shrubs were unavailability of seeds and if available they were expensive (Table 40). Forage sorghum and oats were not preferred by some farmers because they considered them labour intensive (Table 41).

Table 40: Reasons why farmers do not prefer certain fodder shrubs

Reasons	All n=25	Sesbania n= 5	Leuceana n= 4	Mulberry n= 2	Calliandra n= 14
	# of farmers				
Unavailability of seeds	6	0	1	0	5
Seeds expensive	2	0	1	0	1
Lack of knowledge on management	1	1	0	0	0
Labour intensive	4	1	0	0	3
Not drought resistant	3	1	1	0	1
Requires fertile soils	1	0	0	1	
Grows slowly	8	2	1	1	4

Calliandra hedge

Table 41: Reasons why some farmers do not prefer oats and forage sorghum

Reason	Oats (n=28)	Forage sorghum (n=17)
	# of farmers	
Labour intensive	6	6
Requires more storage	5	0
Seeds expensive	4	3
Poor germination during high rainfall	3	0
Not drought resistant	3	0
Expensive	2	0
Unavailability of seeds	1	0
Lacks nutrients	1	0
Grows slowly	1	5
Requires more acreage	1	0
Seasonal	1	0
Lack of knowledge on management	0	1
Difficult to establish	0	1
Needs supplementation	0	1

n = total number of households that responded to the question

Table 42: Reasons why some farmers do not prefer feed formulation, hay and silage

	Feed formulation (n=11)	Hay baling (n=14)	Silage making (n=14)
	# of farmers		
Labour intensive	5	4	10
Needs supplementation	1	0	0
Unavailability of seeds	2	0	0
Lacks nutrients	2	0	0
Feeds seasonal	1	0	0
Lack of knowledge	0	2	3
Materials for making hay grow slowly	0	1	0
Less milk production when fed a few hours to milking	0	0	1
Bulky	0	3	0
Requires more storage	0	4	0

n=total number of farmers that responded to the question

Slightly more than 70 percent of the farmers who did not prefer silage-making said they considered it labour intensive. Slightly less than 40 percent and 30 percent of farmers did not prefer feed formulation and hay baling respectively because they considered the two practices to be labour intensive (Table 42). Hay was also not preferred by some farmers because it requires storage facilities. One farmer indicated that he does not prefer dairy meal because it taints milk if fed few hours to milking.

Hay in a store in Rift Valley, Kenya

3.7 Feeds and feed practices that farmers have not taken up and reasons

Table 43: Reasons why some farmers have not adopted certain grasses

	Napier grass (n=6)	Boma Rhodes (n=43)	Columbus grass (n=18)	Nandi setaria (n=24)	Sudan grass (n=6)
	Percentage of farmers				
Inadequate land	50.0	23.3	11.1	29.2	0.0
Unavailability of planting material/seed	16.7	27.9	44.4	58.3	50.0
Lack of technical knowledge	16.7	9.3	22.2	8.3	0.0
Labour intensive	16.7	0.0	5.6	0	0.0
Poor performance on the farm	0.0	7.0	16.7	0.0	16.7
Affected by weather	0.0	0.0	0.0	0.0	16.7
Requires a lot of capital	0.0	2.3	0.0	0.0	0.0
Good return from cash crops	0.0	2.3	0.0	0.0	0.0
Just learnt about it	0.0	2.3	0.0	0.0	0.0
Slow growth	0.0	2.3	0.0	0.0	0.0
Expensive seeds	0.0	23.3	0.0	4.2	16.7

n=total number of farmers that responded to the question

Out of the total sample of 181 farmers, only six farmers (3.3%) had not taken up Napier grass. Half of the farmers cited inadequate land while the others cited unavailability of planting material, lack of technical knowledge and it'slabour intensive. Of the 23.7 percent of the total sample who had not taken up Boma Rhodes, 27.9 percent indicated unavailability of seeds and inadequate land (23.3%) as some of the reasons (Table 43). The main impediment for uptake of Columbus grass and Nandi setaria was lack of seeds, technical knowledge and inadequate land. Lack of seeds was mentioned as the main reason for lack of adoption of herbaceous fodder legumes. Apart from the lack of seeds, high cost was also an impediment (Table 44), Two farmers indicated having inadequate technical knowledge for lupin while one indicated lack of seeds. Unavailability of planting material/seeds was mentioned by farmers as the main reason for non-adoption of fodder shrubs such as calliandra (Table 45). Out of six farmers who gave reasons for non-adoption of sesbania, half of them cited unavailability of planting material. Two farmers who had not taken up mulberry cited unavailability of planting material as a reason. Half of the farmers who had not adopted forage sorghum and oats cited unavailability of planting material as the main reason for non-adoption (Table 44).

Table 44: Reasons why some farmers have not adopted herbaceous legumes

	Lucerne (n=100)	Desmodium (n=56)
	Percentage of farmers	
Lack of seeds	41.0	55.4
Expensive seeds	22.0	16.1
Lack of technical knowledge	19.0	16.1
Inadequate land	10.0	3.6
Poor performance on the farm	3.0	1.8
Affected by weather	2.0	1.8
Difficult to establish	1.0	0.0
Low yields	1.0	0.0
Labour intensive	1.0	1.8
Requires a lot of capital	0.0	3.6

n=total number of farmers that responded to the question

Table 45: Reasons why some farmers have not adopted fodder shrubs

	Calliandra (n=32)	Sesbania (n=6)
	Percentage of farmers	
Unavailability of planting material	87.9	50.0
Affected by weather	0.0	0.0
Difficult to establish	3.1	0.0
Short life span	0.0	16.7
Lack of technical knowledge	3.1	16.7
Expensive seeds	6.3	0.0
Labour intensive	0.0	16.7

n=total number of farmers that responded to the question

Mulberry trees

Table 46: Reasons why some farmers have not adopted oats, forage sorghum and sweet potato vines

	Oats (n=31)	Forage sorghum (n=30)	Sweet potato vines (n=6)
	Percentage of farmers		
Lack of seeds	51.6	50.0	0.0
Inadequate land	25.8	23.3	25.0
Lack of technical knowledge	9.7	6.7	6.3
Unavailability of planting material	3.2	3.3	25.0
Requires a lot of capital	3.2	0.0	0.0
Difficult to establish	3.2	0.0	0.0
Labour intensive	3.2	3.3	16.7
Limited time	0.0	3.3	0.0
Poor performance on the farm	0.0	3.3	6.3
Affected by weather	0.0	0.0	31.3
Low yields	0.0	3.3	6.3
Slow growth	0.0	3.3	0.0

n=total number of households that responded to the question

Table 47: Reasons why some farmers have not adopted various feed practices and crop residues

	Sunflower cake (n=34)	Silage making (n=63)	Hay making (n=30)	Feed formulation (n=13)
	Percentage of farmers			
Unavailability of planting material	38.2	0.0	0.0	0.0
Inadequate land	23.5	1.6	6.7	0.0
Lack of technical knowledge	14.7	23.8	23.3	15.4
Requires a lot of capital	5.9	19.0	23.3	0.0
Poor performance on the farm	5.9	0.0	0.0	0.0
Labour intensive	2.9	11.1	20.0	0.0
Affected by wild animals	2.9	1.6	0.0	0.0
Low yields	2.9	0.0	0.0	0.0
Just learnt about it	2.9	0.0	0.0	0.0
Lack of ingredients	0.0	39.7	23.3	0.0
Limited time	0.0	1.6	0.0	84.6
Affected by weather	0.0	1.6	0.0	0.0
Expensive seeds	0.0	0.0	0.0	0.0
Difficult to establish	0.0	0.0	3.3	0.0

n=total number of households that responded to the question

Lack of ingredients was mentioned by about 40 percent of farmers who had not adopted silage-making as the main reason (Table 47). For those farmers who had not taken up the use of sunflower cake, 38.2 percent cited unavailability of planting material as the main reason.

3.8 Constraints and interventions in production of feeds and feed practices

Farmers experience different types of constraints in producing grasses. The main constraint for Napier grass, Boma Rhodes and Columbus grass experienced by farmers was labour (Table 48). The main constraint in producing Nandi setaria was difficulty in establishment followed by labour.

Table 48: Main constraints in producing grasses

Constraint	Napier (n=169)	Boma Rhodes (n=89)	Columbus grass (n=8)	Nandi setaria n=9
	Percentage of farmers			
Labour intensive	58.6	31.5	16.7	33.3
Inputs	9.5	12.4	11.1	0.0
Establishment/low germination	8.3	29.2	5.6	44.4
Inadequate land	6.5	2.2	5.6	0.0
Pests and diseases (moles, rats)	3.6	0.0	0.0	0.0
Seeds/planting material not available	3.6	13.5	16.7	22.2
Management	1.2	0.0	5.6	0.0
Overgrazed	1.2	0.0	0.0	0.0
Too much rain/frost/drought	11.9	6.8	11.1	0.0
Needs supplementation	0.6	1.1	22.2	0.0
Seasonal	0.6	0.0	5.6	0.0
Storage	0.0	3.4	0.0	0.0

n=total number of farmers that responded to the question

Table 49: Proposed interventions to constraints related to the production of grasses

Grasses	Constraint in production	Proposed intervention
Napier grass	Difficult to establish	Proper timing
	Labour intensive	Hire labourers Use chaff cutter
	Irritating when harvesting	Harvest early in the morning Wear protective clothing
	Weeds	Regular weeding Use herbicides
	Infertile soils	Use manure
	Overgrown	Make silage Harvest when 3-4ft
	Pests and diseases (moles, rats)	Pesticides Seek advice from MOALFD
	Inadequate land	Training on where to plant on the farm
	Needs supplementation	Mix with other feeds/add molasses
Boma Rhodes	Labour intensive	Use chaff cutter/pulverizer
	Weeds	Regular weeding, herbicides
	Weather/frost/too much rain/drought	Proper timing
	Seeds not available	Avail seeds at Agrovets
	Seeds expensive	Avail affordable seeds
	Low quality seeds	Use certified seed
	Low germination	Use cuttings/root splits
Giant setaria	Weeds	Regular weeding
Columbus grass	Weeds	Regular weeding
	Drought	Proper timing of rains
	Unavailability of seeds	Avail seeds at Agrovets

Proposed interventions for tackling the problem of labour in grasses was hiring more labourers and also using a chaff cutter to chop (Table 49). For those who experienced skin and throat irritation when harvesting Napier, farmers said harvesting early in the morning solves the problem. If not, one should wear protective clothing. Boma Rhodes was reported by many farmers to have a problem of low germination. The suggested intervention was for farmers to use root splits instead of seeds. Seeds for Boma Rhodes were not easily available, and if available they were expensive. The proposed solution was to avail affordable seeds at PO agrovets.

The main constraints in producing lucerne were labour and seeds while for desmodium and lucerne it was seed (Table 50). To tackle the problem of seeds, farmer suggested that seeds should be availed at the POs agrovets (Table 51). For oats, the main problem was seeds/planting material, while for sorghum and sweet potato vines it was labour (Table 52).

Proposed interventions included availing affordable seeds/planting material at the POs agrovets among other interventions (Table 53). The main constraint in production of silage was inputs followed by labour (Table 54). For hay, the main problem was labour (Table 55). Proposed interventions included availing affordable silage bags, using hay boxes for baling among other interventions (Table 56).

Table 50: Main constraints in producing herbaceous legumes and fodder shrubs

Constraint in production	Lucerne n=24	Desmodium N=12	Fodder shrubs (n=23)
	Percentage of farmers		
Labour intensive	25.0	8.3	4.3
Seeds unavailable	25.0	58.3	60.9
Establishment difficult	16.7	8.3	17.4
Inputs expensive	8.3	16.7	0.0
Management	8.3	0.0	0.0
Pests and diseases	8.3	0.0	13.0
Frost	4.2	0.0	0.0
Inadequate land	4.2	8.3	0.0
Drought	0.0	0.0	4.3

Table 51: Proposed interventions to constraints related to the production of lucerne, desmodium, fodder shrubs and oats

Technology	Constraint in production	Proposed intervention
Lucerne	Unavailability of seeds	Avail seeds/planting material at agrovets
	Weeds	Regular weeding
	Seeds expensive	Avail affordable planting material at agrovets
	Pests and diseases	Training on control
Desmodium	Planting material unavailable	Avail seeds/planting material at agrovets
Fodder shrubs	Seeds not available	Avail seeds/planting material at agrovets

Table 52: Constraints experienced in producing oats, sorghum and sweet potato vines

Problem	Oats (n=59)	Sorghum (n=24)	Sweet potato vines (n=23)
	Percentage of farmers		
Unavailability of seeds/planting material	32.2	25.0	17.4
High cost of inputs	23.7	4.2	4.4
Labour intensive	10.2	45.8	43.5
Inadequate land	6.8	0.0	4.4
Difficult to establish	5.1	8.3	13.0
Seasonal	5.1	0.0	0.0
Lack of storage	3.4	0.0	8.7
Weather (drought, too much rain)	13.6	4.2	0.0
Pests and diseases	0.0	12.5	8.7

Forage sorghum

Dry maize stover in central Kenya

Table 53: Proposed interventions to constraints related to the production of oats, forage sorghum and sweet potato vines

Technology	Constraint	Proposed intervention
Oats	Weeds	Regular weeding
	Weather/frost/too much rain/drought	Proper timing
	Seeds expensive	Avail affordable seeds/planting material at agrovets
	Low quality	Use certified seeds
	Lack of seeds	Avail seeds/planting material at agrovets
	At times does not germinate	Use certified seed
	Lack of storage	Construct proper storage
Forage sorghum	Eaten by birds	Plant close to the homestead Use scare crow
Sweet potato vines	Planting material/seeds not available	Avail seeds/planting material at agrovets
	Inadequate land	
	Planting material not available	Avail affordable seeds/planting material
	Require fencing	Fence the area
	How to store	More training on silage making
	Pests and diseases	Ministry of Agriculture should intervene

Table 54: Constraints experienced in production of different feed practices

Problem	Silage (n=20)	Hay (n=16)	Feed formulation (n=6)
	# of farmers		
High cost of inputs	12	4	2
Labour Intensive	5	10	4
Lack of storage	1	2	0.0
Weather (rain)	2	0.0	0.0

Table 55: Proposed interventions to constraints related to the production of feed practices

Technology	Constraint	Proposed intervention
Silage-making	Lack of materials	Make silage bags available
	Lack of technical knowledge	More training
	Rots if not properly conserved	More training
	Requires skilled labour	More training
	Pests (rats/moles)	Avail quality silage bags
Hay baling	Labour intensive	Use hay boxes
Sunflower cake	Eaten by birds	Use scare crow
Maize stover	Lack of machine for chopping	PO explore subsidizing cost of chaff cutters
Ration formulation	Lack of technical knowledge	More training

3.9 Constraints experienced in the utilization of feeds/feed practices and proposed interventions

Table 56: Constraints experienced in the utilization of grasses

Problem	Napier grass (n=147)	Boma Rhodes (n=76)	Columbus grass (n=14)	Nandi setaria (n=5)
	Percentage of farmers			
Wastage during feeding	25.9	31.6	7.1	0
Labour intensive (requires chopping)	10.9	6.6	0.0	0
Needs supplements/additives	9.6	2.6	0.0	0
Irritating when harvesting	7.5	0.0	0.0	0
Bulky	6.8	3.9	0.0	0
Long processing	5.4	3.9	0.0	40
Lack of machinery (requires machine)	4.7	2.6	0.0	0
Inputs	4.1	1.3	0.0	0
Lack of storage/poor storage	4.7	26.3	71.4	20
Causes bloat	2.7	0.0	0.0	0
Causes diarrhoea in animals	2.7	0.0	0.0	0
Expensive	2.7	0.0	0.0	0
Lack of technical knowledge	2.0	7.9	0.0	0
Conservation	1.4	0.0	7.1	20
Lack of silage bags	1.4	0.0	0.0	0
Poor nutrition	1.4	1.3	0.0	0
Not reliable	1.4	0.0	0.0	0
Unpalatable	1.4	7.9	14.3	20
Requires drying	0.7	2.6	0.0	0
Lack of feed troughs	0.7	1.3	0.0	0
Not efficient	0.7	0.0	0.0	0
Timing in feeding	0.7	0.0	0.0	0
Transport	0.7	0.0	0.0	0

Constraints experienced in the utilization of grasses included labour, bloat, irritation when harvesting, diarrhoea among others listed in Table 56. The main constraint for Napier and Boma Rhodes grass was wastage during feeding. This was followed by lack of storage facilities for Boma Rhodes. For Columbus, the main problem was lack of storage facilities while for Nandi setaria farmers had a problem with processing. Proposed interventions include hiring labourers, having proper storage facilities, among other interventions (Table 57).

Table 57: Proposed interventions to constraints related to the utilization of grasses

Technology	Constraint	Proposed intervention
Napier grass	Labour intensive	Hire labourers
	Lack of silage bags/expensive	Use cheap bags
	Lack of storage	More/proper storage facilities
	Needs supplementation	Mix with other feeds
	Lack of knowledge in making silage	More training
	Causes bloat	More training Do not feed directly after cutting/need wilting
	Wastage during feeding/chopping	Acquire chaff cutter/machine Use feed troughs
	Too dry	Mix with other feeds
	Poor nutrition	Mix with other feeds
	Lack of machine for chopping	Acquire chaff cutter/machine
	Causes diarrhoea when fed immature	Feed when mature (3-4ft)
	Chopping machine expensive	Raise money as group to buy pulveriser
	Too watery when wet	Wilt before feeding to cow
	When overgrown loses nutrients	Harvest at 3-4ft
Boma Rhodes	Labour intensive	Hire labourers Have storage facilities
	Lack of storage	Construct storage facilities
	Needs supplementation	Mix with other feeds
	Wastage during feeding/chopping	Use feed troughs
	Too dry	Mix with other feeds
	Chopping machine expensive	Provision of loans to purchase machine
	Pests during storage	Construct proper storage facilities
	Cow may refuse to eat	Mix with other feeds
	Lack of knowledge on baling	More training
Columbus grass	Lack of storage	Construct proper storage facilities
	Cow may refuse to eat	Mix with other feeds
Nandi Setaria	Lack of storage	Construct proper storage facilities
	Needs processing	Raise money as group to buy pulveriser
Sudan grass	Taints milk when given fresh	Wilt before feeding

Table 58: Constraints in utilization of oats, sweet potato vines, forage sorghum, desmodium and lucerne.

	Oats (n=48)	Sweet potato vines (n=17)	Forage sorghum (n=17)	Lucerne (n=11)	Desmodium (n=6)
Constraints	Percentage of farmers				
Lack of storage/poor storage	18.9	0.0	0.0	0.0	0.0
Needs supplements/additives	16.7	0.0	5.9	0.0	0.0
Labour intensive	12.5	5.9	11.8	0.0	0.0
Wastage during feeding	12.5	0.0	11.8	0.0	0.0
Conservation problem	8.3	11.7	0.0	9.1	0.0
Long processing	8.3	11.7	11.8	0.0	16.7
Causes bloat	6.3	0.0	0.0	36.4	0.0
Unpalatable	6.3	0.0	17.6	9.1	33.3
Expensive	4.2	0.0	0.0	0.0	0.0
Lack of machinery	4.2	0.0	0.0	0.0	0.0
Causes diarrhoea	2.1	0.0	0.0	0.0	0.0
Bulky	0.0	23.5	23.5	9.1	0.0
Lack of technical knowledge	0.0	17.6	5.9	18.2	0.0
Low yields	0.0	5.9	0.0	0.0	16.7
Causes toxicity if fed in excess	0.0	0.0	11.8	0.0	0.0
Taints milk	0.0	23.5	0.0	0.0	0.0
Weather	0.0	0.0	0.0	18.2	18.7
Seasonal	0.0	0.0	0.0	0.0	16.7

The main constraint in the utilization of oats was lack of storage facilities (Table 58). The main constraint with sweet potato was the fact that it tainted milk when fed to livestock while lucerne caused bloat according to 36.4 percent of farmers. Forage sorghum was said to be bulky by 23.5 percent of the farmers. Proposed interventions included constructing proper storage facilities and raising money as a group to buy pulverizers (Table 59). The problem of tainting milk caused by sweet potato vines and bloat when livestock is fed with lucerne can be solved by wilting and also mixing with other feeds.

Table 59: Proposed interventions to constraints related to the utilization of oats, sweet potato vines, forage sorghum, desmodium and lucerne

Technology	Constraint	Proposed intervention
Oats	Gets spoiled if not properly conserved	Construct proper storage facilities
	Labour intensive	Raise money as a group to buy pulverizer
	Lack of storage/poor storage	Construct proper storage facilities
	Wastage during feeding/chopping	Use feed troughs
	Lack of machine	Raise money as a group to buy pulverizer
	Lack of knowledge on conservation	More training
	Bad smell	Add additives such as molasses
	Pests during storage	More training on pest control
	Cow may refuse to eat	Train cow to eat
	Long processing	Raise money as group to buy pulverizer
Sweet potato vines	Labour intensive	Acquire chaff cutter/machine
	Lack of knowledge in making silage	More training in silage-making
	Taints milk when given a lot	Give in small portions
Forage sorghum	Lack of storage	Construct proper storage facilities
	Wastage during feeding/chopping	Use feed troughs
	Needs processing	Acquire chaff cutter/machine
	Cow may refuse to eat	Train cow to learn to eat
Lucerne	Causes bloat	More training, mix with other feeds, give in small portions and wilt
	Lack of knowledge on feed ratio	More training on feed rationing
	Lack of knowledge on conservation	More training on conservation
	Unpalatable	Mix with other feeds
	Taints milk when given fresh	Wilt before feeding to cow
Desmodium	Low yields	Increase acreage
	Unpalatable (Cow may refuse to eat)	Train cow to learn to eat
Fodder shrubs	Needs processing	Acquire machine
	Cow may refuse to eat	Mix with other feeds
	Causes toxicity when given a lot	Give in small quantities

Table 60: Constraints in utilization of crop residues

	Maize stover green (n=50)	Maize stover dry n=36	Bean husks n=16	Wheat/millet straw (n=17)
Wastage during feeding	28	27.8	18.8	17.6
Requires processing	14	0.0	6.3	5.9
Lack of machinery	12	8.3	6.3	0.0
Lack of storage/poor storage	14	5.6	12.6	17.6
Bulky	8	2.8	0.0	0.0
Conservation problem	6	0.0	0.0	14.3
Needs additives/supplements	6	36.1	48.8	0.0
Unpalatable	6	2.8	0.0	0.0
Labour intensive	4	2.8	6.3	5.9
Lack of technical knowledge	2	5.6	6.3	0.0
Inputs	0	2.8	0.0	14.3
Lack of silage bags	0	0.0	0.0	5.9
Low yields	0	2.8	0.0	5.9
Taints milk	0	0.0	0.0	5.9
Indigestion	0	2.8	0.0	0.0
Pests	0	0.0	0.0	5.9

The main constraints in the utilization of crop residues included wastage during feeding, processing, lack of machinery and storage (Table 60). Proposed interventions included using troughs during feeding to avoid wastage, constructing good storage facilities, using a chaff cutter to chop and raising money as a group to buy machinery for processing (Table 61).

Table 61: Proposed interventions to constraints related to the utilization of crop residues and other feed practices

	Constraint	Proposed intervention
Maize stover green	Wastage during feeding/chopping	Use feed troughs
	Poor storage	More training
Maize stover dry	Labour intensive	Hire labourers
	Lack of storage/poor storage	Construct proper storage
	Needs supplementation	Mix with molasses and other feeds
	Wastage during feeding/chopping	Acquire chaff cutter/machine, use feed troughs
	Too dry	Mix with other feeds
	Lack of machine/expensive	Raise money as group to buy machine
	Difficult to chop when dry	Use sharp 'panga' (machete)
	Requires chopping/processing	Use chaff cutter
	Seasonal	More/proper storage facilities
Bean husks	Lack of storage	More/proper storage facilities
	Needs supplementation	Mix with other feeds
	Wastage during feeding/chopping	Use feed troughs
	Too dry	Mix with other feeds
	Cow may refuse to eat	Train cow to eat
Sunflower cake	Needs processing	Raise money as a group to buy a pulveriser
Silage	Lack of silage bags	Use cheap/affordable bags
	Lack of machine	Provision of loans to purchase machine
	Poor storage	Proper storage facilities
Hay	Lack of storage/poor storage	More/proper storage facilities/more training
	Wastage during feeding/chopping	Use feed troughs
	Lack of machine	Raise money as group to buy pulveriser
Wheat straw	Poor storage	More training on conservation
Feed rationing	Lack of knowledge on proper rations	More training

Green maize stover

3.10 Feed selling

Farmers were asked whether they had sold any feeds during the last 12 months and the quantities sold. Metkei PO had the highest percentage of farmers who had sold feeds at slightly over 40 percent (Figure 2). Other sites that had over 30 percent of farmers who had sold feeds were Siongiroi and Taragoon. None of the farmers in Cherobu sold any livestock feed. Out of the famers who sold feeds, 22 percent were male farmers while females were 19 percent.

Figure 2: Percentage of farmers across sites that sold livestock feed

The amount of feed sold depended on the type of feed. The unit of measurement also varied. For instance, Napier was sold in kilogrammes, Boma Rhodes by bales and gunny bags and oats by 90 kg bags (Table 62). Oats had been sold by the highest number of farmers, followed by Boma Rhodes.

A couple in Rift Valley next to stored Boma Rhodes

Table 62: Number of farmers selling each feed and the average quantities

Variable	n	Quantity (Mean)
Napier (kg)	1	1000.0
Boma Rhodes (bales)	12	46.1
Oats (bags)	15	68.1
Maize green stover (sack)	1	2.0
Maize dry stover (sacks)	3	13.7
Columbus grass seeds (kg)	1	5.0
Bean husks (sacks)	1	10.0
Boma Rhodes grass (sacks)	1	5.0
Nandi setaria (sacks)	1	5.0
Sunflower cake (sacks)	1	2.0

n=the number of farmers selling each feed

Table 63: Mean price at which each type of feed is sold

Variable	n	Mean price (Ksh)
Napier (1000 kg)	1	5000
Boma Rhodes (bales)	12	295.8
Oats	13	576.9
Maize stover (green, per sack)	1	200.0
Maize stover (dry, per sack)	4	160.0
*Columbus grass seeds	1	100
Hay	3	383.3
Bean husks (sack)	1	150.0
**Rhodes grass	1	100
Nandi setaria (sack)	1	200.0
Sunflower cake (sack)	1	250.0
Dairymeal (1 large amt.)	1	1500.0

n=number of households that responded to the question

*Columbus grass: KES 100 for 5 kg and KES 3000 for 0.15 acres

**Rhodes grass: KES 100 for 5 kg and KES 5000 for 0.5 acres

Oats: 1 acre for 5000

Dairy meal: Large quantity for KES 1500

Table 64: Feed sale and profitability

	All		Male		Female	
	n	%	n	%	n	%
Sale was profitable (yes)	35	92.1	23	95.8	12	85.7
<i>Reason why profitable</i>						
High returns compared to production costs	30	88.2	20	90.9	10	83.3
<i>Reason not profitable</i>						
High production cost	2	5.9		0.0	2	16.7
Low demand	2	5.9	2	9.1		0.0
<i>Why did not sell</i>						
Enough for own livestock	83	72.2	50	70.4	33	75.0
Small size of land	11	9.6	7	9.9	4	9.1
No surplus	21	18.3	14	19.7	7	15.9

Table 65: Type of feeds to be sold in future

	All (n=181)	Male (n=109)	Female (n=72)
Feed	Percentage of farmers		
Boma Rhodes	33.6	31.25	37.3
Oats	20.0	22.5	16.9
Napier	10.7	11.25	10.2
Hay	5.7	7.5	3.4
Maize stover dry	5.0	5	5.1
Lucerne	3.6	3.75	3.4
Columbus grass	2.9	1.25	5.1
Sweet potato vines	2.1	2.5	1.7
Nandi setaria	2.1	2.5	1.7
Forage sorghum	1.4	2.5	0.0
Silage	1.4	1.25	1.7
Maize stover green	0.7	0	1.7
Desmodium	0.7	0	1.7
Sudan grass	0.7	0	1.7
Coloured guinea	0.7	1.25	0.0
Sweet potato vines	0.7	0	0.0
Calliandra	0.7	1.25	0.0
Bean husks	0.7	0	1.7

3.11 Future plans

When asked about their future plans regarding feeds, slightly less than half the farmers wanted to increase feed production (Table 66). This was followed by increasing land acreage for feeds. Strategies for increasing feed production included expanding acreage of land and acquiring loans (Table 67).

Table 66: Future plans

Future plans	All (n=181)	Male (n=109)	Female (n=72)
	% of farmers		
Increase feed production	49.2	48.6	50.0
Increase land acreage for feeds	28.7	26.6	31.9
Expand storage facility	19.3	18.3	20.8
Introduce variety of feeds	18.8	21.1	15.3
Acquire machinery/chaff cutter	8.3	10.1	5.6
Put up zero grazing unit	4.4	5.5	2.8
Use certified seeds	3.9	3.7	4.2
Use modern technology	3.9	6.4	0.0
Attend more trainings	3.3	2.8	4.2
Improve breeding through artificial insemination	3.3	0.0	8.3
Add more cows	2.2	2.8	1.4
Produce for commercial purposes	1.7	2.8	0.0
Switch from cash crops to dairy	1.1	1.8	0.0
Becoming a model farmer	0.6	0.0	1.4
Fencing the land	0.6	0.9	0.0
Hire management staff	0.6	0.0	1.4
Start feed processing	0.6	0.9	0.0

Table 67: Strategies to increase production of livestock feeds

	All (n=181)	Male (n=109)	Female (n=72)	All (n=181)
	Percentage of farmers			
Expand land acreage of fallow land	30.9	29.4	33.3	30.9
Acquire loans	22.7	23.9	20.8	22.7
Attend more trainings and exchange visits	11.0	10.1	12.5	11.0
Source for information and technical knowledge	10.5	8.3	13.9	10.5
Buy certified seeds and plant on farm	10.5	11.0	9.7	10.5
Proper management	8.3	7.3	9.7	8.3
Upgrade cattle through artificial insemination	7.2	8.3	5.6	7.2
Plant using latest technology	6.1	6.4	5.6	6.1
Acquire processing machines	5.5	7.3	2.8	5.5
Rent land	5.0	6.4	2.8	5.0
Hire casual workers	4.4	3.7	5.6	4.4
Attending field days and ASK shows	3.9	3.7	4.2	3.9
Use capital from sales	2.8	3.7	1.4	2.8
Build storage facilities	2.2	0.9	4.2	2.2
Switch from cash crops	1.7	1.8	1.4	1.7
Acquire more improved livestock	1.7	1.8	1.4	1.7
Plant Napier on boundaries	1.1	0.9	1.4	1.1
Use savings	0.6	0.9	0.0	0.6
Reduce grazing land	0.6	0.0	1.4	0.6
Practice intensive dairy farming	0.6	0.0	1.4	0.6
Plant sunflower after harvesting crops	0.6	0.0	1.4	0.6
Availability of capital	0.6	0.9	0.0	0.6

Motivation for increasing acreage of feeds

About 49.2 percent of farmers interviewed indicated that they wanted to increase feed production and another 28.7 percent indicated they wanted to increase acreage under feed technologies/practices (Table 66). Disaggregating data by gender, 29.4 percent of male farmers and 33.3 percent of female farmers wanted to increase acreage and utilization of feed. The main motivation for increasing acreage of feeds was that there had been an increase in milk production (Table 68). This was mentioned by slightly over half of the sampled farmers with more females than males citing it as a reason. High returns from dairy products was the second reason mentioned by both male and female farmers.

Table 68: Motivation to increase acreage of feeds

Reason	All farmers (n=181)	Male (n=109)	Female (n=72)
	% of farmers		
Increased milk production	50.3	46.7	55.6
High returns from dairy products	21.0	22.9	18.06
Availability of ready market for dairy products	13.3	14.7	11.11
Acquired more livestock	12.2	13.8	9.72
Feed livestock during dry season	7.7	4.6	12.50
For commercial purposes	7.7	10.1	4.17
Acquired technical knowledge	5.5	5.5	5.56
Dairy farming is profitable	5.5	5.5	5.56
High returns from sale of feeds	4.4	3.7	5.56
Availability of land	2.8	3.7	1.39
Demand for quality feeds	2.8	4.6	0.00
Good milk prices from PO	2.2	1.8	2.78
Introduction of different variety of feeds	1.7	0.9	2.78
Reduced prices of purchasing dairy cows	1.7	2.8	0.00
Set up of semi-zero grazing unit	1.7	2.8	0.00
Favourable climate	0.6	0.0	1.39
Fertile soils	0.6	0.0	1.39

4.0 Discussion, conclusion and recommendations

The findings of this study have shown that dairy farmers in the study sites were all aware of improved livestock feed practices disseminated by the EADD project and other institutions. Awareness of a technology is the first step towards uptake. Once farmers are aware of a technology, then the next logical step is to make a decision on whether to take it up or not. The level of awareness varied from technology to technology with over 70 percent of farmers being aware of pasture grasses such as Napier and Boma Rhodes and herbaceous legumes such as lucerne. Regarding uptake, farmers have adopted various livestock feed practices ranging from improved pasture grasses, herbaceous legumes, fodder shrubs, crop by products, crop residues, feed conservation technologies, concentrates and other fodder crops such as oats, forage sorghum and sweet potato vines. The level of adoption however varied from technology to technology. Napier grass had the highest adoption Except for Napier grass, there were big discrepancies between awareness and adoption of other practices. For example, slightly over 30 percent of farmers who were aware of Boma Rhodes had not adopted it. The percentage was even higher for herbaceous fodder legumes and fodder shrubs. Why does Napier grass have a high uptake while fodder legumes have low uptake? What lessons can we learn about Napier adoption that can be applied to fodder legumes to enhance their uptake? In terms of species preference, Napier grass also ranked highest. What factors do farmers consider? Other findings of this study also give insights on constraints that farmers face in production and utilization of livestock feed practices and their future plans. Below is a critical analysis of the reasons for the low and high uptake of improved legume forages and Napier grass respectively, farmers' preferences, constraints experienced in production and utilization of preferred species, and their future plans.

Understanding the low adoption of herbaceous fodder legumes

Herbaceous fodder legumes promoted by the EADD project and other institutions were mainly lucerne and desmodium. Less promoted were lupin, purple vetch and lablab. About 74 percent and 42 percent of farmers were aware of lucerne and desmodium respectively. However, only a paltry 12.7 percent and 9.4 percent of farmers in the study sites had adopted lucerne and desmodium respectively.

Why the low adoption? The low adoption of herbaceous fodder legumes in the tropics is not a new phenomenon. Reviews of adoption of tropical forage legumes around the world have revealed disappointing results (Thomas and Sumberg 1995, Elbasha et al 1999, Peters and Lascano 2003). In Kenya, several attempts have been made by different government projects to promote fodder legumes. These include the National Dairy Development Project (NDDP) which introduced two species of desmodium a decade ago (NDDP 1990). KARI also introduced fodder legumes in the 1990s (Wandera 1995). In the late 1990s, the Legume Research Network Project also introduced herbaceous legumes mainly for green manure. Since 2008, the EADD project has been promoting the use of herbaceous fodder legumes and other livestock feed practices in central and Rift Valley regions of Kenya. Despite these and many other attempts, adoption of forage

legumes has been low in Kenya (Mwangi and Wambugu 2003). To explain the low adoption of fodder legumes, researchers have pointed to issues such as land tenure, labour, lack of reliable seed supply and associated costs, and lack of markets (Paterson et al 1998, Elbasha et al 1999, Mwangi and Wambugu 2003). The lack of markets is not an issue in this study since farmers have a ready market for their milk. They supply their milk to chilling plants run by producer organizations.

When farmers were asked why they had not adopted the use of herbaceous fodder legumes, a high percentage of farmers cited lack of seed and planting material for lucerne and desmodium respectively. This was followed by high costs associated with seeds. Other reasons included lack of technical knowledge, poor performance on the farm, difficulty in establishment for lucerne, low yields and labour. It is clear from this study that the main reasons are to do with the availability and associated costs of seeds. This is a perennial problem that has been reported by most studies that have reviewed the adoption of herbaceous fodder legumes. When asked where their sources of planting material were from, neighbours, EADD project, KFA and agrovet shops were the most cited sources. Promotion of herbaceous fodder legumes has not been matched by the supply of seed and planting material. If these issues are not addressed, then adoption of fodder legumes will remain a mirage. Attempts have been made by the EADD project to encourage VFTs to host demonstration plots that serve a dual purpose of training and bulking seed/planting material, but judging from the findings of this study, availability of planting material still remains a challenge. Agroverts are selling lucerne seeds but cost has been cited as an impediment. If the issues of availability and cost are not addressed, then low adoption of the legume fodder technology will persist for a long time to come.

Understanding the low adoption of fodder shrubs

Fodder shrubs that have been promoted by EADD include *Calliandra calorthysus*, *Leuceana trichandria*, *Sesbania sesban*, tree lucerne and mulberry. Findings from this study have shown that despite the fact that 67.5 percent of farmers were aware of fodder shrubs, only 33.1 percent had planted them on their farms. Calliandra was the most commonly grown fodder shrub among the farmers surveyed. Reasons farmers gave for the low adoption included unavailability of planting material. It could also be due to the fact that farmers lack the skills to establish nurseries or if they do have the skills, they find it tedious to do it. This confirms the findings from farm survey reports that attributed poor adoption of fodder shrubs to lack of seed/seedlings (Mwangi and Wambugu 2003). Sources of seed/seedlings for calliandra are mainly the EADD project, ICRAF and private nurseries. The dependence on projects and organizations for the supply of seed is not sustainable. Mechanisms that are community based need to be developed to ensure a reliable supply of fodder shrub seeds/seedlings.

Lessons from the high adoption of Napier grass

In contrast to the low adoption of herbaceous fodder legumes and fodder shrubs, Napier grass has been adopted by 91.2 percent of the farmers interviewed. Reasons given for the high adoption

included drought-tolerant ability for some varieties, high nutrition content, fast growth, easy to manage, high biomass, ability to regrow after harvest, palatability, evergreen, planting material easily available and the fact that it can be used to make silage. Napier grass has a long research and development history in Kenya. It has mainly been adopted in intensive farming systems where animals are stall-fed. Studies done in the 1980s and 1990s have shown that Napier grass is grown by over 70 percent of farmers in central Kenya (Stotz 1983, Bayer 1990, Staal et al 1998). The proportion has since gone up. When data in the current study was segregated by site, Olkalou, a site in central Kenya, recorded 90 percent of households planting Napier grass. The high adoption is therefore expected because of its agronomic qualities and the fact that planting material is easily available. Napier in Kenya is propagated mainly from cuttings. These could be in the form of root splits, canes with 3 nodes or whole canes. The main source for planting material for the farmers surveyed was other farmers and neighbours. It is no wonder that uptake of Napier was quite high as farmers can easily obtain planting material from their fellow farmers. Average acreage of Napier was 0.5 and therefore for a farmer to part with a few canes or root splits does not affect the overall productivity of the Napier. A study done by Kiptot and Franzel (2012) showed that some VFTs sold Napier canes to their fellow farmers at a small fee. This is in contrast to desmodium where the few farmers who had it on their farms planted it on very small portions, an average of 0.1 of an acre. Sharing vines of desmodium from these small plots may be a challenge. This observation is confirmed by a study undertaken by Sinja et al (2004) in central Kenya that showed that the amount of desmodium a farmer has on the farm had the greatest effect on both the extent and probability of giving out desmodium vines. A key lesson from Napier adoption is that making germplasm available at the farm/local level ensures sustainability of seed/planting material delivery mechanisms. Past research by Kiptot et al (2006) and Sinja et al (2004) has shown that farmers mostly share seed/planting material through their informal social networks.

Farmer preferences of livestock feed practices

The findings of this study have shown that the five most preferred livestock feed resources in order of importance are Napier, Boma Rhodes, dry maize stover, lucerne and oats. This suggests that more research and development attention should be given to these feed resources to ensure that farmers get maximum productivity. The main reasons for the preference of Napier were its drought-resistant ability, increases milk production, fast growth and easy to manage. Boma Rhodes was preferred because of the ability to increase milk production, fast growth, good for hay-making, high biomass and high nutrition content. Maize stover, a crop residue, was preferred because it can be stored for long, used during drought, and easy to manage. Lucerne was preferred because it is drought-resistant, is used as a protein supplement and increases milk production. Oats was preferred because it increases milk production, is a protein supplement, it grows fast and can be used during the dry season. The findings show that farmers not only consider agronomic attributes, management, nutritional content but also the availability of the fodder during the dry season. Napier, Boma Rhodes, oats and maize stover can be conserved for use during the dry season. During discussions with farmers, they indicated that surplus Napier and maize stover was usually ensilaged. The major agricultural activity on almost all the smallholders was arable cropping with maize forming the major crop. Maize is a staple crop in Kenya. Maize stover is therefore the most abundant arable by-product on all the smallholdings.

According to Mwangi and Wambugu (2003), maize crop residues supply about 23 percent of dry matter available to dairy farmers in central Kenya. Farmers have learnt to store the residue for the dry season or make silage out of it. Farmers make hay out of surplus Boma Rhodes and oats. Lucerne is also said to be drought-tolerant and therefore available during the dry season.

Constraints and opportunities in production of preferred livestock feed resources

The main constraint that farmers experienced in the production of Napier and Boma Rhodes was labour. Considerable amount of labour is needed in establishment and weeding. Farmers used different methods to establish Napier. Some used the newly introduced 'tumbukiza' method which is considered labour intensive. The method entails the planting of Napier in round or rectangular pits 60-90 cm wide and 60-90 cm deep, filled with a mixture of topsoil and manure in the ratio of 1:2. Considerable labour is required to dig the pits. Once the Napier is established, the pits conserve moisture for longer periods and concentrate fertility at a point of easy use by the Napier grass resulting in higher productivity per unit area of land. Research conducted by Muyekho et al (2003) has shown that the tumbukiza method of planting Napier grass is superior to the conventional method in terms of herbage dry matter. Consequently, a study by Otieno et al (1999) demonstrated that 0.1ha of Napier grass planted using the tumbukiza method could produce enough herbage to support one mature cow; in contrast, the conventional method would require 0.4ha of land to produce a similar amount of fodder. The labour used appears to have a high economic return. Farmers should therefore be provided with the two options with clear facts so that they can make informed decisions on what method is convenient for them depending on their resource endowments. If labour is a major constraint, it is recommended that farmers use the conventional method with inorganic fertilizer. Where labour is not a major constraint, it is recommended that farmers use the tumbukiza method because it gives a higher net present value benefit:cost ratio. In order to maximize returns to labour, there is a need for researchers to further explore ways of intercropping Napier grass with food crops.

Weeding of Napier grass is also another labour-intensive activity. Weeding eliminates re-growth of undesirable plants and increases soil aeration. In order to avoid weeding regularly, farmers are advised to use close spacing to ensure that Napier quickly forms a closed canopy that suppresses weeds. Planting of forage legumes within Napier rows is also recommended to ensure that the forage legumes suppress weeds. However, Mwangi and Wambugu (2003) reported poor persistence of legumes such as *Desmodium intortum* when planted with Napier. Timing and spacing are therefore crucial when intercropping Napier with legumes. Future studies to address labour should aim at developing establishment and management methods that reduce labour requirements. Apart from labour constraints, some farmers indicated that they experienced establishment difficulties for Boma Rhodes when seeds are used. A few innovative farmers have tried using root splits which they consider to solve the problem of establishment. More research on different methods for propagating Boma Rhodes need to be undertaken since it is one of the preferred livestock feed technologies.

The main constraint in production of herbaceous legumes and fodder shrubs is unavailability of planting material. Land area occupied by desmodium is about 0.1 acres and lucerne about 0.9 acres while the average number of trees of fodder shrubs per household is 24 for leuceana, callindra 70 and tree lucerne 80. This is way below the recommended 500 number of calliandra shrubs that are required to feed 1 cow per year (Wambugu et al 2011). What is not clear is whether unavailability of planting material was the reason for the low acreage/number of plants or not. As had been suggested earlier, community mechanisms to make seed/planting material should be given priority if high rates of adoption of forage legumes are to be achieved.

Constraints and opportunities in the utilization of preferred livestock feed resources

Constraints experienced in utilization of Napier include wastage during feeding, labour during chopping, and skin and throat irritation during harvesting caused by the prickly hairs. Proposed interventions by farmers included using feed troughs for feedings and a chaff cutter for chopping. The EADD project has trained farmers on how to use chaff cutters to reduce labour, however, this study has shown that only 12 percent of farmers have chaff cutters. This is due to the high cost. A suggestion given by farmers was to have them organized into groups and linked to micro-credit institutions. This will enable them get loans for purchasing machinery to reduce labour requirements. To address the problem of prickly hairs, future research should consider selecting Napier grass varieties that have less prickly hairs.

The main constraint in the utilization of Boma Rhodes and oats was the lack of proper storage for hay. Hay is an important investment for all livestock operations and should therefore be baled and stored in a way that maximizes the amount of available feedstuff, nutritional quality and palatability. Storing hay inside a permanent shelter is considered to be an excellent option for many livestock and commercial hay operations. Proper storage of hay prevents many of the negative effects of weathering such as loss of dry matter and reduced digestibility. More training needs to be organized so that farmers learn about site preparation, drainage, access, orientation, proximity to other farm structures such as the zero grazing unit, appropriate size, ventilation and safety of the store.

The main constraint related to the utilization of lucerne was the fact that it causes bloat when fed fresh to livestock. Farmers need more training on how and when to feed lucerne to avoid bloat which may lead to death in livestock.

Dairy farmers' future plans

About half the farmers interviewed were planning to increase feed production on their farms. The main motivation has been increased milk production and high returns from the farm. This can only be achieved if constraints raised are addressed. Key among them is unavailability of seeds/planting material. Establishment of functional seed delivery systems to match demand and supply should be given a priority. Community mechanisms of seed production should be given more emphasis. Research done in the past by Kiptot et al (2006) and Sinja et al (2004) has shown

that farmer-to-farmer sharing of planting material is quite effective in making germplasm available. VFTs in the EADD project host demonstrations for training and bulking seed/ planting material. What is not clear is whether these demonstration plots are functional. A first step is to undertake a status update on the demonstration plots hosted by VFTs to find out whether they are indeed bulking seed/planting materials for farmers. Mechanisms of making them functional should be put in place to ensure that farmers access the seeds/planting material that they require. According to Peters et al (2003), having community-based seed production systems ensures sustainability, provides farmers with extra income and ensures that seed is available at the local level. Certified seed that is sold in agrovets may be available, however, access to farmers is limited because of the high cost. To solve this problem, seed dealers should package seed in small quantities that farmers can afford.

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