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Rapid appraisal of dairy value chains in Morogoro and Tanga regions in Tanzania

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Contents

Executive summary 1
Acknowledgements 5
Acronyms 6
Introduction 7
Methodology 8
Basic information on the communities and sites 12
Value chain mapping with producers, input supplier and milk vendors 15
Feed assessment 25
Dairy cattle breeding management 37
Gender roles in cattle production and milk marketing 42
Reasons to keep livestock 48
Livelihoods analysis 49
Participatory epidemiology 50
Cattle health 52
Public health 62
Milk-borne diseases and zoonoses 64
Discussion and conclusions 67
Findings 70
- Value chain mapping with producers in extensive system 70
- Availability of organisation of farmers 70
- Value addition 70
- Value chain mapping with input suppliers 70
- Feed availability 71
- Breeding management 71
- Gender roles, decision making and livelihood analysis 71
- Participatory epidemiology 72

Recommendations 73
References 75

Executive summary

Projections from the agricultural census carried out by the Government of Tanzania (2007/08) indicate that Tanzania currently has some 21 million cattle out of which only 700,000 are dairy cattle types consisting of Friesian, Jersey, Ayrshire and their crosses to the East African Zebu. Most of the cattle are indigenous Zebu producing milk and meat. About 70% of milk produced is from indigenous breeds. Milk productivity remains low at only 1.5-2 litres and about 5-7 litres per cow for indigenous and improved cattle, respectively. In recent years, an increased milk production was reported mainly due to increased herd size rather than increased productivity per dairy cow. Currently, small amounts of milk are marketed into urban areas, while the large amounts of milk produced are sold in rural areas mainly to neighbours and local restaurants. At the farm level, poor feeding and general management practices lead to seasonal milk production. This, coupled with unorganised marketing procedures such as price setting, hinders commercialisation of dairy products.

In view of this, ILRI and partners formulated projects known as MoreMilkIT (to adapt dairy market hubs for pro-poor smallholder value chains in Tanzania) and MilkIT (to enhance dairy feed innovations and value chains in India and Tanzania).

In 2012, with funding from Irish Aid, ILRI and partners organised focus group discussions in selected villages to diagnose the current status in relation to milk production, marketing, feeding practices, type of breed kept, epidemiological issues and livelihoods, including gender roles in the livestock sector.

The Focus Group Discussions (FGD) used a multidisciplinary team formulated by ILRI and Sokoine University of Agriculture (SUA). The team comprised a gender analyst, animal scientist, value chain analyst and veterinary scientist from Tanzania, Kenya and Uganda. The team worked under close supervision of ILRI and the Irish Aid project country coordinator in Tanzania. The team went through training on the PRA tools that were to be used in the field. Under the guidance of the village leaders, 24 men and women were interviewed in each of eight villages: Mbwade, Twatwatwa of Kilosa District, Kambala and Manyinga of Mvomero District, Kabuku and Sindeni of Handeni District and Kwang'wenda and Kwapunda of Lushoto District. The discussions dealt with village mapping, value chain mapping, epidemiological issues, feeding and breeding management, gender roles, livelihood assessment and decision making power in the livestock sector.

Natural resources and infrastructure in the 8 villages

The findings indicate that improvement in livestock production is possible due to the abundant natural resources available in the villages. Rivers across the villages provide the possibility to grow fodder for animal feed and provide water for livestock. Some of the villages had Chaco dams that serve as sources of water in the dry season. With the exception of two villages (Kambala and Mbwade) all the remaining villages had electric power supply that would enable installation of chilling plants for milk collection. With the exception of Kambala village, the remaining villages are accessible throughout the year due to presence of road infrastructure.

Value chain mapping

Seasonal milk production was a feature, especially in extensive systems, where much milk is produced in the wet seasons. Milk prices are low in the long wet season. Three main milk channels were identified in extensive systems: through collection centres

(Tanga Fresh and Tan Dairies), via local restaurants and neighbours, and through vendors. Some of the channels are dropped in the dry season (mainly the individual households and restaurants). Vendors complained about price fluctuations (changing 2-3 times in a year) offered by the collection centres, which leads to business unpredictability. The highest prices were offered by individual households and local restaurants. Vendors prefer selling milk to collection centres regardless of the low price offered as this maintains their income from collectors in the wet season when they buy large amounts of milk. Furthermore, payments modalities offered by the collection centres are preferred as vendors receive a lump sum of money after 10-15 days unlike the other channels where payment is done after 2-7 days or on cash basis.

Milk channels in semi-intensive systems were selling milk to neighbours and local restaurants directly by the farmers or through vendors. Lack of strong farmers' associations that could be used in organising farmers to solve some of the constraints related to milk selling activities was noted.

Supply of inputs, mainly veterinary drugs, in extensive systems is obtained from the primary auction markets, where informal drug dealers visit from nearby towns. Other sources are livestock officers employed by the Local Governments Authorities (LGA's) in the respective districts. Farmers complained of high prices offered by input suppliers in all the 8 villages. Vaccines and artificial insemination (AI) services are mainly provided by government officials through LGA's. Milling machines available in the villages or nearby towns provide maize bran as feed concentrate, mainly for farmers in semi-intensive systems. It was noted that molasses in some villages of Manyinga and Kabuku are currently not used as feed for animals. Lack of access to credit due to high interest rates offered by financial institutions was mentioned by input suppliers as a challenge to expand their business.

More generally, the lack of markets for milk in both semi-intensive and extensive production system was voiced as there are few collection centres. This requires interventions to improve the livelihoods of vendors and producers in the 8 villages. Low knowledge on various diseases affecting cattle was mentioned by farmers as a challenge especially under semi intensive/intensive production systems – in contrast to extensive systems where farmers are more knowledgeable as they often diagnose diseases and administer drugs on their own. Lack of knowledge and equipment for milk testing was also mentioned by vendors as a challenge.

Livestock feeds

Feed availability varied with seasons. In the long and short wet seasons there was abundant feed in the 8 villages. In the dry season, little feed was available in both extensive and semi-intensive production systems. The extensive system necessitated seasonal movement or migration (temporary transhumance system) of animals to areas where there is pasture and water. This affects milk availability in the three main milk channels and the price of milk increases.

Lack of access to feeds (concentrates) was mentioned as a challenge in semi-intensive systems. Preferential feeding was reported by farmers in semi-intensive/intensive systems, especially Manyinga village where pregnant cows were fed with concentrate 2-3 months before calving. There are fewer types of feed contributing to the diet of an animal in the extensive than in the intensive system, for example animals are fed on communal grazing land, legumes and cereal residues, grazing in the valley and transhumance while in semi-intensive and intensive systems animals have greater

varieties of feeds, including grasses from communal land, planted grasses, crop residue (cereals and legumes), maize bran, tree leaves, conserved feeds, as well as banana pseudo and stem tubers. Constraints related to feeds in extensive systems are attributed to scarcity of land and water, while lack of knowledge on feed conservation is the main constraint in the semi-intensive/intensive systems.

Breed management

In extensive systems, indigenous breeds dominate, with just a few improved breeds. The main traits of indigenous breeds include tolerance to harsh environments and diseases. The types of animals kept in semi-intensive and intensive systems are mainly crossbreds of indigenous breed (Tanzania shorthorn Zebu and Boran) with exotic breeds of dairy cattle mainly Friesian, Ayrshire and Jersey and few exotic breeds (only one farmer in Kwang'wenda village kept pure exotic breed). The main characteristics of the improved breeds include producing high quantity of milk and meat, high growth rate, and high prices in the market.

The main mating method in the extensive system is through use of bulls (natural mating) while in semi-intensive/intensive systems, both AI and natural mating are practiced. There were challenges of low conception rates when AI was used. Farmers in the extensive system reported that they acquire new animals through purchasing from the primary market and from neighbours, while farmers in semi-intensive areas (Mvomero and Lushoto) acquired animals through Heifer Project International (HPI). Others purchase from neighbours. Livestock keepers in Handeni and Lushoto normally purchase crossbred animals from a government institution known as Buhuri Livestock Institution located in Tanga.

Gender roles

There is a clear gender division of labour in the extensive system. Men oversee all activities related to livestock production. On top of domestic chores, women perform the daily management of calves, milking and selling of milk. Women spend more hours performing activities related to animals than men in the extensive system. Both men and women fetch grasses and water for animals in semi-intensive systems. Similarly, important decisions on livestock management are jointly made in semi-intensive systems. In the extensive system, men make most decisions except on issues related to marketing of milk. Women also control income from sale of milk in both semi-intensive and extensive systems.

Sources of livelihoods

Livestock production was the main source of income among farmers in the extensive system, with crop production being the second source. Crop production was the main source of income among farmers in semi-intensive systems, followed by livestock keeping.

Participatory epidemiology

Farmers practicing extensive farming are more knowledgeable on livestock diseases compared to those in the intensive systems. There is less knowledge on zoonotic diseases, as farmers in the extensive system believed that raw milk is safe after filtering and they did not link raw milk consumption to any diseases. The participants had less knowledge of zoonotic diseases like anthrax, brucellosis, rift valley fever or salmonellosis that could be associated with human illness sourced from animals.

It is recommended that short and long term interventions are required to improve livestock production across the 8 villages. Awareness/training of farmers on issues related to zoonotic diseases, feed production, conservation and storage is required. Furthermore, farmer based hubs are recommended in both extensive and intensive production systems as there is enough milk to be collected in some areas, and all farmers need inputs and services in all areas. Concerted effort in the management of the farmer based hubs is required in collaboration with the local government and private sectors to ensure sustainability of the venture.

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Acronyms

AI	Artificial Insemination
BMZ	Federal Ministry for Economic Cooperation and Development
CGIAR	Consultative Group on International Agricultural Research
DADP	District Agricultural Development Program
ECF	East Coast Fever
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HPI	Heifer Project International
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
KIPOK	Maasai word means "Healing"
KIWAMA	*Kikundi cha Wafugaji Manyinga* (Manyinga Livestock keepers association)
KIWAMAKA	*Kikundi cha Wauza Maziwa Kambala* (The Kambala Milk Marketing association)
KIWAMA-VICOBA	Manyinga Livestock Association and Village Community Bank
LFO	Livestock field officer
MKURABITA	*Mpango wa Kurasimisha Rasilimali na Biashara Tanzania* (Property and Business Formalization)
MPTs	Multipurpose Trees
MVIWATA	*Muungano wa Vikundi vya Wakulima Tanzania* (An umbrella organisation for farmers association Tanzania)
NGO	Non-Governmental Organisation
PRA	Participatory rural appraisal
SUA	Sokoine University of Agriculture
UWAKA	*Umoja wa Wafugaji Kabuku* (Kabuku Livestock keepers' Association)
VCA	Value chain assessment
WEO	Ward Executive Officer

Introduction

The livestock production sub-sector is the second employer next to agriculture in Tanzania. Of 4.9 million agricultural households, about 36% keep livestock (35% are engaged in both crop and livestock production; only 1% are purely livestock keepers). The livestock sector contributed 5.9% to total GDP in 2006, of which dairy production contributed about 30%, after beef production (40%). Other stock provided 30%. Livestock not only contributes to the national GDP but also provides food (meat, milk and eggs) to communities. The sector therefore acts as a living bank as it acts as a source of income for the livestock keepers. Furthermore, the sector contributes manure and draft power (Njombe and Msanga, 2009).

Despite its importance, the contribution of livestock could be higher. This is because, among others, subsistence production dominates the sector and commercial (smallholder) dairy production is constrained by diseconomies of scale. Other constraints include high risks associated with unorganised milk sales particularly in relation to prices, limited feed sources and animal health problems. Furthermore, complex cooperative models and technology-driven solutions for smallholder cattle owners in most locations have largely failed because they presuppose an unrealistic level of production and organisational commitment and capacities. Moreover, the sector lacks suitable organisational models to facilitate collective action for bulking milk. This could be an entry point to milk markets and access to inputs and services while increasing the capacity of poor cattle keepers to innovate, manage risk, reduce vulnerability, increase their income and ensure food security.

Based on these challenges, a project known as “adapting dairy market hubs for pro-poor smallholder value chains in Tanzania” was formulated to ensure inclusive growth and reduced poverty and vulnerability among dairy dependent households. ILRI and the Sokoine University of Agriculture (SUA) are implementing the project (also known as MoreMilkIT). The FGDs were carried out to inform the next steps in this projecy as well as two others: the IFAD-funded MilkIT project and the BMZ-funded Safe Food Fair Food (SFFF2) project.

The diagnostic (value chain assessment) toolkit applied in this phase was developed under the three CGIAR research programs on Livestock and Fish, Agriculture for improved Nutrition and Health and Policies, Institutions, and Markets. The kit was adapted for Tanzania with various national partners. The FGDs aimed to:

- Characterize the context, and community perspectives of the current situation with respect to dairy production, market channels and actors, including flows of dairy inputs and outputs along the marketing chain;
- Identify constraints, barriers to participation by poor men and women, opportunities for value chain upgrading and expansion, and associated risks with particular regard to domains of feeds, breeding, animal health and food safety;
- Characterize the possible forms and functions of dairy hubs, by looking at producers’ problems and opportunities and identifying key indicators to be factored into detailed site selection for the hubs and baseline survey to address.

Methodology

Eight FGDs were conducted, each with about 24 male and female cattle keepers, in Morogoro (Kilosa and Mvomero districts) and Tanga regions (Handeni and Lushoto districts). These sites were previously identified through spatial analysis, consultation with stakeholders and pre-site selection scoping studies.

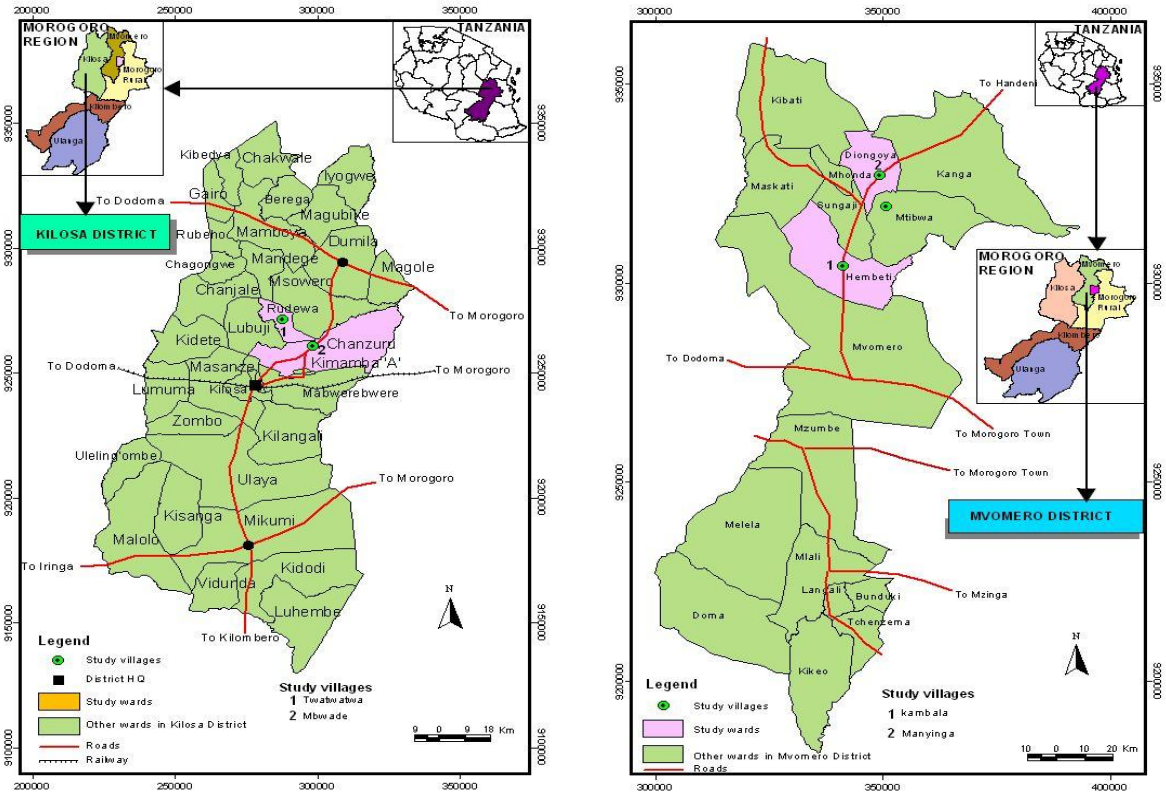


Figure 1: Kilosa and Mvomero maps of Morogoro Region

The districts were chosen to represent: a) pre-commercial rural production to rural consumption and b) relatively more commercial rural production to urban consumption. Within each district, the aim was to randomly select a village that represents the dominant and emerging (if ≥5% of cattle) dairy production systems: extensive/ (agro) pastoral, semi-intensive/sedentary and intensive/also sedentary as indicated in Table 1.

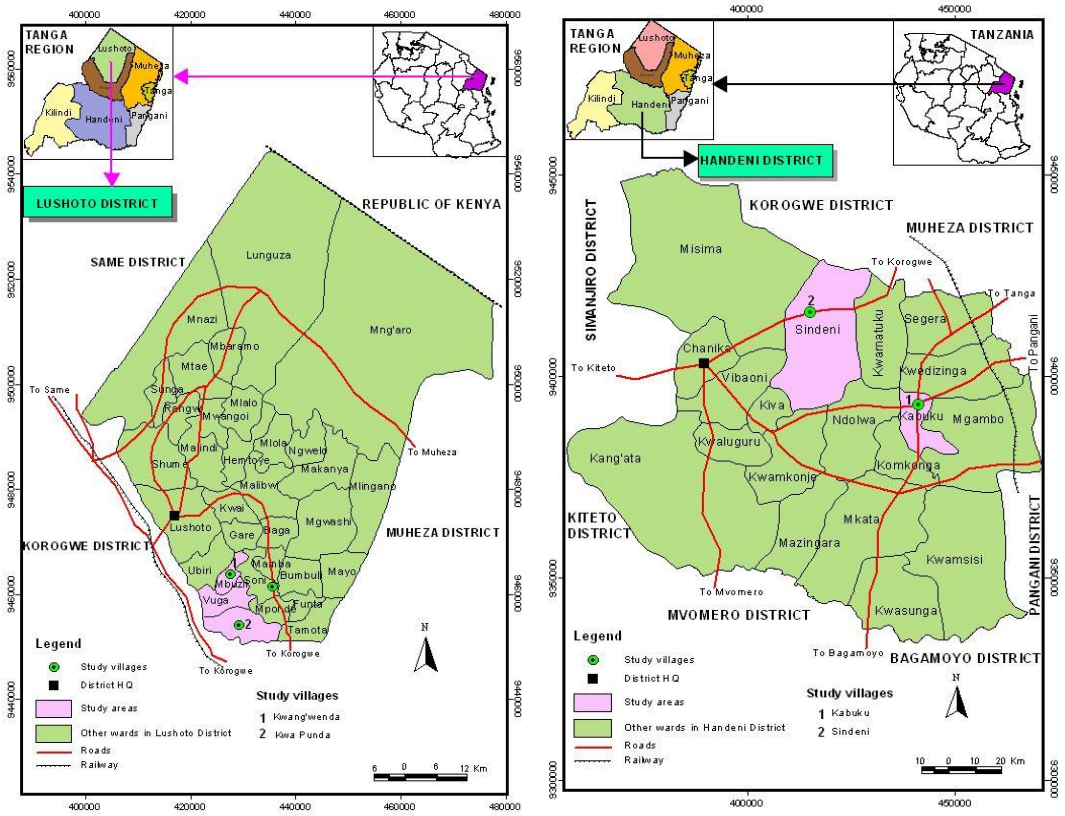


Figure 2: Lushoto and Handeni map of Tanga Region

Table 1: Profiles of selected districts

Region	District	Cattle population*	% improved dairy breeds	Dominant Production system
Morogoro	Kilosa	215,100	1	Extensive/Agro-pastoral (Zebu)
	Mvomero	187,350	5	Extensive/Agro-pastoral (Zebu) with significant semi-intensive and intensive (improved)
Tanga	Handeni	126,780	1	Extensive/Agro-pastoral and Extensive/Sedentary with semi-intensive and Zebu
	Lushoto	119,492	24	Extensive/Sedentary (Zebu) with significant semi-intensive and intensive (improved)

*Most recent figures available from district profile reports

The first two production system categories mainly have Zebu cattle while the latter represent improved dairy that is a total of about 192 farmers (2 regions x2 districts x2 systems=8 FGDs x 24 farmers each) as shown in Table 2. The aim was to have a relatively homogenous group of farmers in terms of their production system/breeds during each PRA.

Table 2: Farmer selection

Criteria	District	Production system	Breeds	No of farmers invited
Pre commercial: rural production to rural consumption	Kilosa	FGD 1: Extensive/Agro-pastoral	Zebu	24
		FGD 2: Extensive/Sedentary	Zebu	24
	Handeni	FGD 1: Extensive/Agro-pastoral and semi-intensive	Zebu	24
		FGD 2: Extensive/Sedentary	Zebu	24
More commercial: rural production to urban consumption	Mvomero	FGD 1: Extensive/Agro-pastoral	Zebu	24
		FGD 2: Semi intensive and Intensive/sedentary	Improved	24
	Lushoto	FGD 1: Extensive/Sedentary	Zebu	24
		FGD 2: Semi intensive and Intensive/sedentary	Improved	24

All systems were therefore represented by at least 2 villages (3 groups of extensive/agro pastoral Zebu farmers; 3 groups of extensive/sedentary Zebu farmers and 2 groups of semi intensive and intensive improved breed farmers).

Farmers were randomly selected from a typical village community identified by the local government authority representing the site production system. Using the list of households (hh) available from the village leaders, farmers were randomly selected (using a table of random numbers). The random selections targeted only cattle-keeping households. In some villages, such as Kwang'wenda in Lushoto district, replacement was done after the selected participants postponed attending. To ensure gender balance, the first household picked was asked to send a man to the meeting, the second a woman, the third a man etc. Random replacement was done where, for example, a female representative was due for selection but the next randomly identified household was male-headed, and vice versa.

Key **input and service providers** were identified using information from the preceding farmer FGDs and key informants. The number of input suppliers interviewed depended on their availability, for instance in some villages such as Kabuku, only one supplier was interviewed, therefore a purposive selection was employed depending on the number of input suppliers available in the area. In general, input suppliers were individually interviewed.

Key **milk vendors and traders** were similarly identified. Again the number of milk vendors/traders depended on local availability. In some villages such as Kwampunda there was one trader buying milk from nearby villages and selling it fermented to Kwampunda communities. Similarly, there was a trader in Kwang'wenda village buying fresh milk from farmers within the village to make fermented milk. In Kilosa district, a good number of vendors were in Kimamba area collecting milk from Mbwade and Twatwatwa villages.

PRA process

The participatory rural appraisal (PRA) team was led by the gender analyst responsible for a gendered value chain assessment (VCA) in project sites. The team visited four districts of Kilosa and Mvomero in Morogoro Region, Handeni and Lushoto of Tanga Region. Two villages were randomly selected from each district to make a total of 8 villages. Three FGDs were concurrently run in each village.

In the morning session, the facilitator introduced the aim of the research, thereafter requested participants to select few representatives to draw up a village map. Mainly two men and two women (or three men and one woman in some areas where the number of women participants were few or came late) mapped out their village indicating natural resources, social and financial resources, infrastructures, social services and land use system within the village.

The remaining group was further divided into two sex-disaggregated groups of men and women. Participants were requested to explain their responsibilities from the time of waking up to when they go to sleep. Furthermore, participants were asked to indicate their decision making power between men and women on various aspects related to livestock keeping.

Livelihood analysis was also done in sex-disaggregated groups indicating the contribution of livestock to livelihood of men and women. Furthermore, participants identified important livelihood activities and income sources (on farm, off-farm, and non-farm) and trends. All livelihood sources both from within the area were listed and ranked. The main emphasis was to compare the role of livestock related activities to other activities. A short discussion was held with participants to assess if the importance of livelihood activities has changed in the past five years for men and women.

In the afternoon session, participants were divided into three separate groups each with a mix of men and women. One of the three groups handled the participatory epidemiology aiming at acquiring information on animal health, knowledge on public health related issues as well as milk-borne diseases and zoonotic. Participants were requested to list constraints to dairying including feed, disease, markets, improved breeds, low production, insecurity etc.

The second group discussed issues related to feeds mainly focusing on understanding the role of producers in the livestock value chain, with respect to feed availability in various seasons; feed use, conservation, and quality along the year and the technical support services affecting feed production. Some of the quantitative aspects arrived at through group consensus were recorded. Breeds and a breeding management tool were administered by this group mainly focusing on the breeding practices and management strategies.

The third group discussed issues related to the value chain with producers. The main emphasis was on the place of the producer in the milk value chain. An interactive diagram was drawn indicating actors buying from and selling to producers. Furthermore, marketing channels were identified and characterized. All the transactions and relations between buyers, sellers and other actors were described.

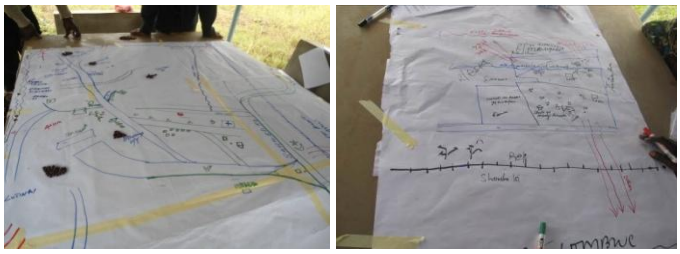
On the second day, a few representatives from the research team visited input and service providers.

Basic information on the communities

Community maps

Through FGD, participatory mapping for each village was conducted to indicate natural resources, infrastructures and social services available in the study area.

Rivers: The two rivers of Wami and Mgombelanga which serve as sources of drinking water for livestock in Mbwade village, Kilosa district were located on the map. The borehole located near the primary market is used as a source of water for domestic use and livestock (mainly calves and shoats) in Mbwade village. Twatwatwa village shares the Wami River with Mbwade village which is west of Twatwatwa village. The Mkata River is the northern boundary of Twatwatwa village which serves as a major source of water. Water flows diminish in both rivers in the dry season. Livestock migrate during dry seasons along the Mkata River in search of water. In addition, the Rugenge stream which originates and ends within Twatwatwa village serves as a watering source during the heavy rain season.

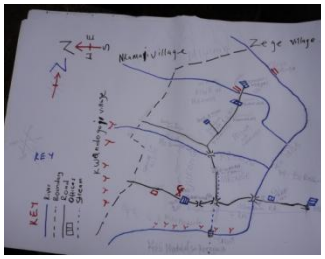


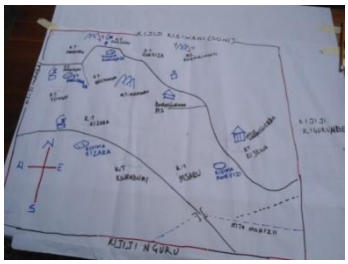
Village resource map for Twatwatwa and Mbwade villages

Kambala village in Mvomero district has three rivers which maintain water flow throughout the year, though water levels differ with seasons. The rivers are Wami, Mkindo and Wami which act as the eastern boundary of the village. The Manyinga village is endowed with the Kiongoya River which is the landmark that defines Manyinga. There is a stream in the northern part along the sugar cane plantation, the presence of Chaco dam around the settlement is a source of water for livestock.

Resource maps for Manyinga and Kambala villages

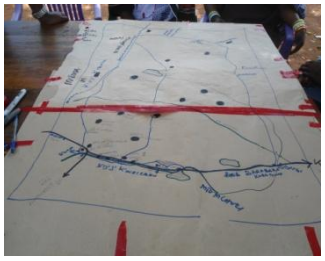
Sindeni village in Handeni district is endowed with seasonal rivers such as Mchonzi, Mnyuzi and Longwelo in the south, the Mnyuzi River traverses the village and provides water for livestock and domestic use. The village also has Tumbili Mountain and a forest within the mountain which is important for rainfall catchment.





Resource maps for Kwapunda and Kwang'wenda villages

In Kwang'wenda village, there is a river situated in the southern part of the village. The presence of hilly forest known as Kwemringoti facilitates better access to livestock feeds and rainfall catchment. Agricultural activities serve as source of crop residues for animals in the drought/feed shortage. The Mshizii River serves as a source of water for livestock. Similarly the rivers Zege, Mponde and Kwandogoi provide water for livestock in Kwampunda village. The village is also bordered with a mountain to the north which is important for rainfall catchment.




Resource maps for Kabuku and Sindeni villages

Table 3: Summary of resources available in the 8 villages

Village	Resources available	Comments
Mbwade	Rivers (Wami and Mgombelanga Borehole	• Sources of drinking water for livestock • Source of water for domestic use and livestock (shoats and calves)
Twatwatwa	Wami river Rugenge stream	• Source of water for domestic use and livestock • Watering source in heavy rain season
Kambala	Wami, Mkindo and Mgongola river	• Sources of water for livestock throughout the year
Manyinga	Kiongoya river Chaco dam	• Acts as landmark for Manyinga village • Sources of water for livestock
Sindeni	Mchonzi, Mnyuzi and Longwelo rivers Tumbili mountain and forest	• These rivers traverses the village and they are good sources of water for livestock and domestic use • Serve as rainfall catchment and source of pasture for livestock
Kwang'wenda	Mshizii river Kwemringoti forest	• Sources of water for livestock • Facilitate rainfall catchment • Sources of pasture for livestock
Kwapunda	Zege, Mponde and Kwandogoi rivers	• Sources of water for livestock

Infrastructure

The village maps also indicate social services such as schools, churches, mosques, hospitals, NGO offices and primary courts. For extensive system, the primary market serves as a place to sell livestock and purchase veterinary inputs. A cattle dip tank operated by the farmer's association in Sindeni is an indicator that these farmers are committed in fighting against tick-borne diseases and biting flies.

Almost all 8 villages had road networks except Kambala village which is only accessible in the dry season. Other villages such as Kabuku are at the highway from Dar es Salaam to Arusha which offers potential for milk marketing.

Most of the villages visited have electrical power except Mbwade and Kambala. Electricity provides an opportunity to install chilling plants where milk could be collected before transferring it for processing. Farmers in villages such as Twatwatwa, Manyinga, Kabuku, Sindeni, Kwang'wenda and Kwampunda have access to electricity and therefore have access to maize hurling and milling machines where they can buy maize bran as feed supplement to cattle.

Land use

The common economic activities revealed from the participatory mapping were livestock keeping and agriculture. Livestock keeping is dominant under the extensive/agro-pastoral system while agricultural activities dominated the semi-intensive system (Manyinga and Kwang'wenda villages).

Seasonal calendar

Three main seasons were identified: the dry season, long and short wet season. Livestock (cattle) keeping under the extensive production system (in Mbwade, Twatwatwa, Kambala and Sindeni) is characterized by migration of livestock during the dry season whereas crop production is carried out during the rainy seasons. The figures for rainfall distribution are indicated in Table 4. In almost all villages in Kilosa and Mvomero districts, rainfall reaches its maximum in March, April and May whereas the dry season runs from June to September. The short wet beginning in the last two weeks of September-January brings some relief in feeding of animals. Lushoto district mainly in Kwang'wenda village experience a different rainfall pattern with the dry season running from January to February and it is very short compared to other villages. The long (heavy) wet season runs March to June while the short wet also takes almost six months from June to December. This is an opportunity to grow pastures throughout the year.

Table 4: Annual rainfall distribution in the study areas

Village	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Kabuku	1	0	5	12	8	0	0	2	5	7	2	4
Sindeni	2	2	8	16	14	11	0	0	4	4	0	6
Kambala	2	3	21	30	11	5	1	0	0	0	3	10
Manyinga	7	7	6	4	4	5	3	3	2	2	2	7
Mbwade	6	4	18	19	12	11	4	2	2	3	7	7
Twatwatwa	9	4	25	39	4	3	0	2	0	2	4	4
Kwapunda	3	3	6	7	11	7	4	3	4	6	3	3
Kwang'wenda	1	4	10	12	9	6	2	3	3	9	5	6

Value chain mapping with producers, input supplier and milk vendors

Milk production in the eight villages

The quantity of milk produced in Twatwatwa village increases gradually from January to April, moderate production is experienced in May to June. High milk production was evident in March, April and May for Mbwade and Kambala villages of Mvomero district. Sindeni village in Handeni district experiences similar patterns with high milk production extending from March to June. Gradual milk production from March reaches its peak by June in Kabuku village. In Kwampunda village (Lushoto), milk production increases gradually from February reaching its peak in May thereafter gradually reducing in July to September.

For Manyinga village, the trend was different as the amount of milk produced reaches its peak between March and May and drops in August to October. However, the extent of the decline in milk production is not as high as it was in extensive systems. In Kwang'wenda village in Lushoto, more milk is available during July to October with less milk in the two months of January and February in the dry season. Milk production increases gradually from March reaching its peak in July. In September and October there is a constant milk production thereafter a gradual decrease beginning from December to February.

Milk selling channels

There were three milk selling channels in all the extensive production systems. Milk outlets such as selling at collection centres through vendors, individual households/neighbours and local restaurants for the villages of Mbwade, Twatwatwa and Kambala were mentioned. Previously, Sindeni villagers used to sell their milk to an agent for Tanga Fresh (collection tank) which is currently closed, therefore the village only has two outlets (individuals/neighbours and restaurants). Proportional pilling techniques was used to allocate the quantity of milk retained at home and the proportion of milk sold to outlet markets.

Table 5: Milk outlets for selected villages in Morogoro region

Village	Production System	Season	Milk outlet
Mbwade	Extensive	Long wet	1,2,3,4
		Short wet	1,2,3,4
		Dry	1,2,3,4
Twatwatwa	Extensive	Long wet	1,2,3,
		Short wet	1,2,3
		Dry	1,2
Kambala	Extensive and semi intensive	Long wet	1,2,3,4
		Short wet	1,2,3,4
		Dry	1,2,3,4
Manyinga	Intensive	Long wet	1,2,3
		Short wet	1,2,3
		Dry	1,2,3

Key: 1= Neighbours; 2=Restaurants; 3=Milk Vendors; 4 Collection Centres

Milk channels in extensive systems are mainly Tanga Fresh through agents and Tan Dairies collection centres. The second channel was restaurants and neighbours through

vendors in all seasons (table 6). Some of the producers were also vendors taking milk direct to collection centres. Almost 50% of milk is sold to restaurants in the dry season, because of the high price they offer for Mbwade and Twatwatwa villages. Other channels such as Tanga Fresh and Tan Dairies are supplied with small quantities of milk or drop out in the dry season. However, more milk is sold to collection centres in the long and short wet seasons where milk production is at its peak. Kambala village depends mainly on outlets available within the village, Turiani Township and beside the Dakawa highway between Dodoma and Dar-es-salaam). About 48 to 57% of milk produced in Kambala is retained for home consumption due to lack of markets in the long wet season.

Table 6: Milk outlets for selected villages in Tanga region

Village	Production System	Season	Milk outlet
Sindeni	Extensive	Long wet	1,2,3,4*
		Short wet	1,2,3,4*
		Dry	1,2,3*
Kabuku	Intensive/semi intensive	Long wet	1,2
		Short wet	1,2
		Dry	1,2
Kwapunda	Intensive/semi intensive	Long wet	1,2
		Short wet	1,2
		Dry	1,2
Kwang'wenda	Intensive	Long wet	1,2
		Short wet	1,2
		Dry	1,2

Key: 1= Neighbours; 2=Restaurants; 3=Milk Vendors; 4 Collection Centres
* Tanga Fresh Company Agent, currently not active

In Sindeni village nearly 78% of the Zigua ethnic group sell milk to vendors while most of the Maasai producers (56%) sell milk to local households and restaurants. The Maasai often reside in inaccessible areas which are not easily accessed by vendors. When the Tanga Fresh collection centre was operating, vendors used to take milk from the Maasai areas as well and only 7% of milk was sold to neighbours, 19% to local restaurants and 74% was sold to the Tanga Fresh agent. Following the absence of the Tanga Fresh agent, they depend on village consumers who can't consume more than 30% of the marketable milk. Milk producers in Kabuku said that 80% of milk produced is sold to neighbours within the village while 20% is sold to nearby restaurants. Participants reported that 1 to 2 litres is consumed each day at home to improve the nutritional status of the family.

Milk produced in the semi-intensive system is mainly sold to neighbours (Manyinga). During the wet season, farmers have to walk around selling milk within Turiani township. All the channels operate year-round. Small amounts of milk are channeled to restaurants through vendors, as indicated in the individual village reports. In Kwang'wenda village, a large proportion of the milk (55%) is supplied to restaurants, neighbours (25%) and the remainder (20%) is consumed at home, especially during the wet seasons.

Selling prices in each channel

More milk is supplied to restaurants because of the higher prices they offer, typically 500 to 600 TSh per litre compared to the fixed price offered by neighbours of 400 TSh per litre in Kwang'wenda village (table 7). The flow of milk is mainly rural-rural. Based on the fact that the dry season is only for two months, less milk is produced but still all the channels are maintained throughout the year.

For Manyinga village, the prices range from 600 to 800 TSh per litre. The highest price is also offered by restaurants and neighbours while the lowest price is offered by vendors. For extensive production systems in which plenty of milk is produced in the long wet season, the selling prices range from 250-400 TSh for Twatwatwa, Mbwade and Kambala villages, mainly selling to collection centres. Good prices are offered by restaurants and neighbours. Milk sold at restaurants and neighbours at Kabuku village offers the highest price (1000-1500 TSh for fermented milk). The only reason given was because of being close to the highway, there is high movement of people.

Table 7: Selling prices in each channel in the 8 villages

		Type of outlet and price in Tshs/litre			
Village	Season	Neighbours	Restaurants	Vendors	Collection centre
Mbwade	Long wet	500	500	300	350
	Short wet	500	500	400	450
	Dry	500	500	450	500
Twatwatwa	Long wet	400	500	250	350
	Short wet	500	500	400	450
	Dry	500	500	450	500
Kambala	Long wet	400	500	300	300
	Short wet	400	500	350	400
	Dry	400	500	400	450
Manyinga	Long wet	700	700	600	N/A
	Short wet	800	800	700	N/A
	Dry	800	800	700	N/A
Sindeni	Long wet	500	400	300	N/A
	Short wet	500	400	300	N/A
	Dry	500	400	300	N/A
Kabuku	Long wet	1000	1000	N/A	N/A
	Short wet	1000	1000	N/A	N/A
	Dry	1000	1000	N/A	N/A
Kwapunda	Long wet	600	1000	600	N/A
	Short wet	600	600	600	N/A
	Dry	600	600	600	N/A
Kwang'wenda	Long wet	400	600	600	N/A
	Short wet	400	600	600	N/A
	Dry	400	600	600	N/A

Payment modalities

Payments are through cash and bills. The bill system dominated in the extensive production system such as Mbwade, Twatwatwa and Kambala villages. It was rare to conduct a cash payment when selling to collection centres. For instance, Tanga Fresh and Tan-dairies collection centres take 10-12 days to pay for milk. Restaurants take 3-5 days and individual consumers take 15-30 days. Payments in Manyinga and Kwang'wenda were mainly cash and when check off are provided it takes just 7 days through verbal agreements.

Value chain mapping in extensive (Zebu dominated system)

Value chain mapping was done a day later after identification of vendors and traders during the focus group (FGD) session with producers. The sales outlets were milk vendors who purchase milk from producers and sell to milk collection centres namely Tan-Dairies/DESA and Tanga Fresh, households and restaurants in Kimamba, a small town located about 5 km from Mbwade and 20 km from Twatwatwa village (figure 3). Vendors said that only vendors with motorcycles manage to collect milk from Twatwatwa village due to long distances. A few women in Twatwatwa process milk into yoghurt and ghee which is sold within the village.

Milk vendors in Kambala village supply milk to Tan Dairies located in Dakawa highway and restaurants in Dakawa. Similarly, Kambala farmers used to sell milk to Shambani milk collection centre which is currently not operating. Other vendors sell milk at Turiani Township and to households in Kambala.

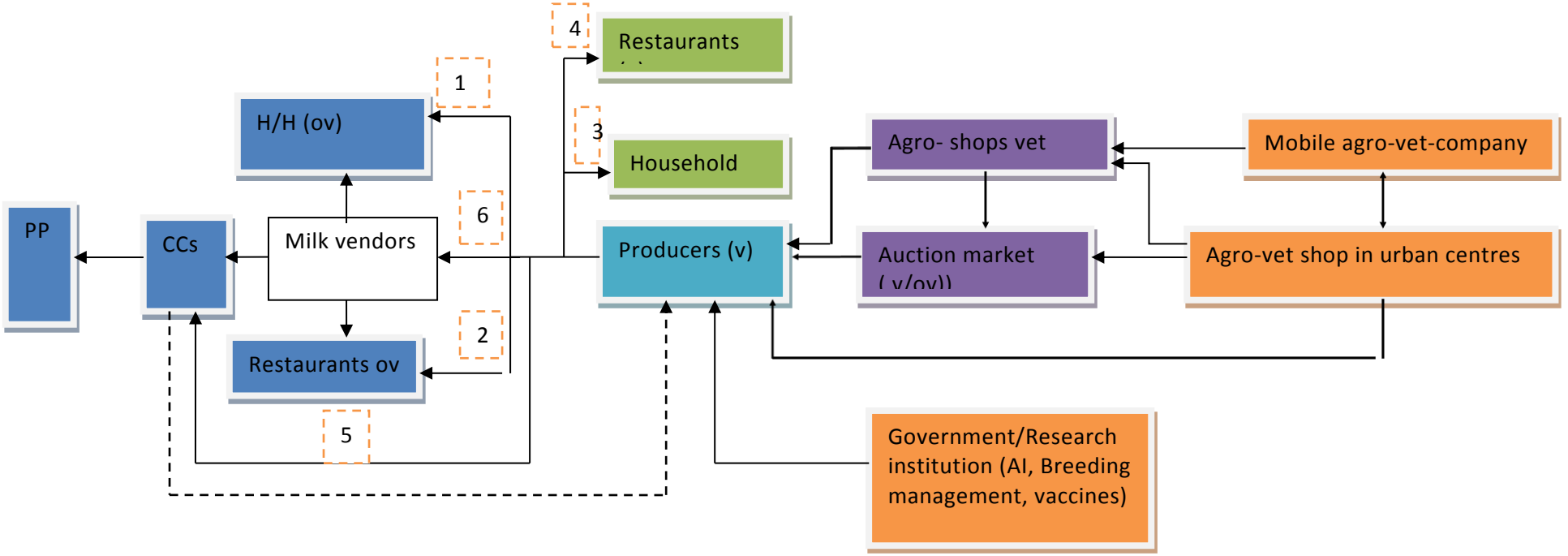


Figure 3: Value chain mapping in extensive system (Mbwade, Twatwatwa, Kambala and Sindeni villages

Notes:

v=within the producers village
Ov= other villages
Ccs = milk collection centres
PP = processors
Numbers 1-6 indicate channels preference by actors in the order of importance

Farmers obtain inputs (such as veterinary drugs) from the primary auction market and from veterinary shops located in Morogoro for Mbwade, Twatwatwa and Kambala villages. The milling machine available in Twatwatwa could be used as source of maize bran for livestock feeds. Provision of AI services is through local government authorities and vaccination services during disease outbreak were mentioned by livestock producers in the extensive system.

Vendors collecting milk from Mbwade, Twatwatwa and Kimamba continue selling to collection centres in the dry season when milk supplies are low as this ensures they can continue selling in the long wet season when milk production is higher than demand. Vendors collecting milk from Mbwade and Twatwatwa villages supply to Kimamba restaurants and individual households. Vendors collecting milk from Kambala supply milk to restaurants at Dakawa highway and other villages.

Milk retained at home in the extensive system is processed into products mainly fermented milk (figure 4). These are sold within the villages to neighbours and friends and are not a reliable business. The value chain map on milk products is therefore very short and the main actors are women. Participants say they rarely sell butter because most of it is stored for use in the dry season.

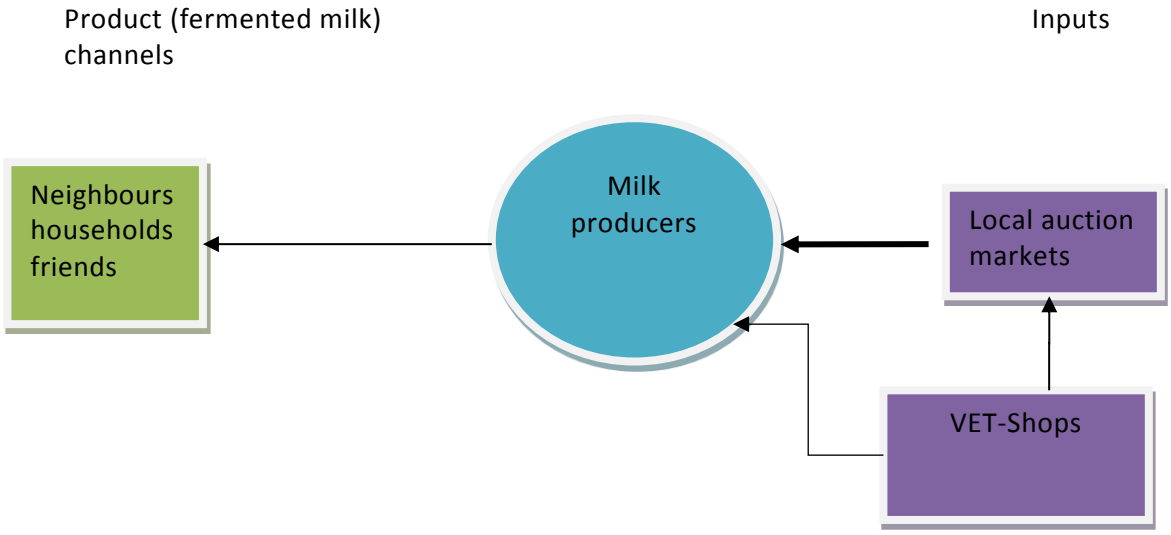


Figure 4: value chain map for fermented milk and ghee

Input suppliers in extensive systems

A local agro-veterinary shop and input suppliers for Sindeni village are located in Handeni where farmers travel long distance to purchase veterinary drugs. The government through the Ministry of Livestock and fisheries provide services via livestock officers who supply vaccination against ECF (East Coast fever).

Most farmers in Kambala village purchase inputs from Dakawa area. The representative for Tan-dairies collection centre located at Dakawa highway says that they sometimes sell a mineral leak commonly known as '*Jiwe lishe'* to producers in Kambala village. The Tan Dairies representative further said that they have a plan to provide motorcycles and veterinary drugs through credit. The Tan Dairies representative in Kimamba township collecting milk from Mbwade and Twatwatwa said that they were involved in a public health campaign with district officials to distribute motorcycles to milk vendors

on credit. Milk vendors collecting milk from Mbwade, Twatwatwa and Kambala said that they sometimes purchased veterinary drugs, medicine and some basic household requirements for producers in Kambala from Wami-Dakawa centre.

Value chain mapping in semi-intensive systems

Milk produced by farmers in the semi-intensive system in Manyinga, Kwang'wenda, Kwapunda and Kabuku villages is sold through three main channels, which are local sales to neighbours, restaurants and vendors (Figure 5). Prices offered by farmers in Kwang'wenda were lower compared to Manyinga in Mvomero (table 3). There is only one vendor in Kwang'wenda village purchasing fresh milk to process into fermented milk.

Input suppliers in semi-intensive systems include government veterinary officers in Kwang'wenda and Manyinga who provides veterinary drugs, advisory and Artificial Insemination (AI) services. Prices offered at Kwang'wenda village for AI service are higher (25,000 TSh) compared to Manyinga village (10,000 TSh). AI services in Kabuku are provided at (10,000 TSh) by an individual provider trained by Land'O'Lakes. Farmers complained about the use of AI for breeding purposes as conception rate was found to be very low. Some of the farmers said that they sometimes repeated insemination up to three times with no success. Based on this, farmers do not have much trust in AI. The government also supplies services such as vaccines against animal diseases and Boran bulls for breeding in some of the villages of Kambala, Kabuku and Manyinga villages.

Other inputs such as feed supplements such as maize bran and sunflower cake are available from the local mill at Turiani (mainly from Madizini area for Manyinga village). Farmers in Kwang'wenda purchase maize bran from mills at Soni Township and from Mombo area (30 km away). Molasses are available in Turiani and Kabuku area, though they are currently not used as feed for animals but rather used to make local brews.

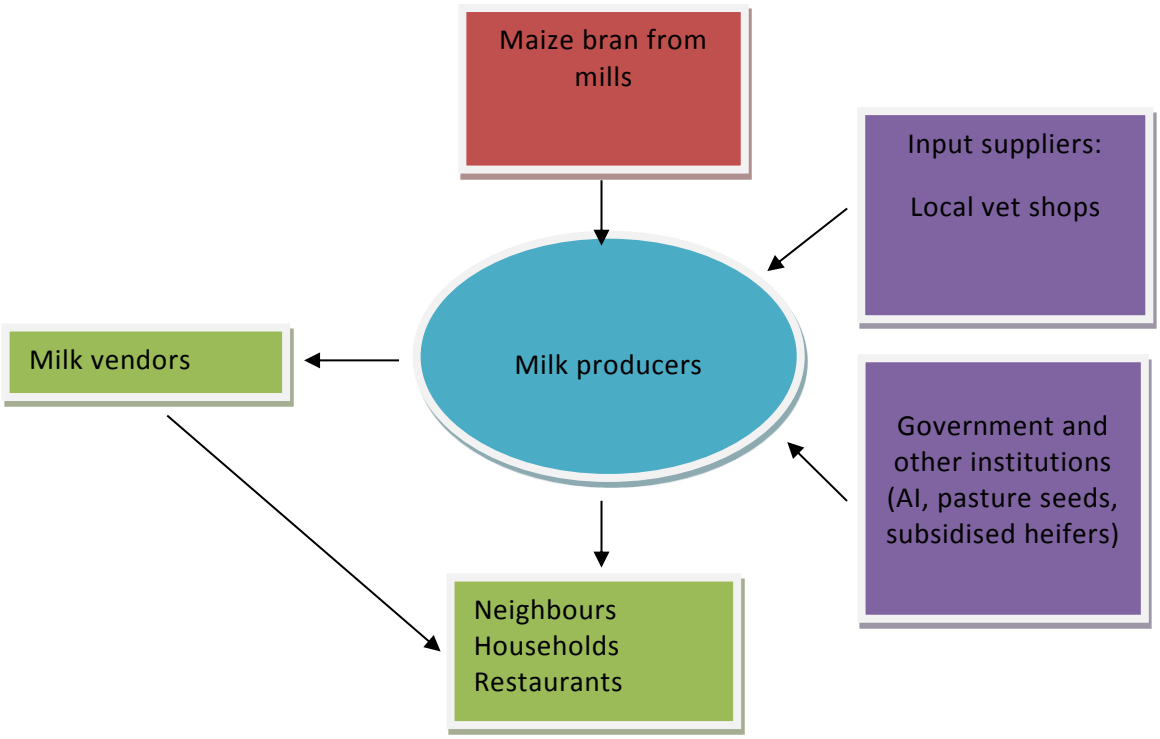


Figure 5: Input supply in intensive and semi-intensive systems

Price establishment

For extensive systems in which milk is sold at the collection centres, the Tan-Dairies purchase price is determined by the company's marketing officers based in Dar es Salaam. The collection centre is then given the indicative purchasing price per litre which is then announced to vendors and producers. Procedures are similar for Tanga Fresh whose prices are determined by the head office.

Price-setting for household/individual/neighbours and restaurants and vendors relies on verbal agreement based on market forces and prices offered by the companies. Price fluctuations were reported by both vendors and producers, with changed two to three times a year depending on milk availability as influenced by the season. In the semi-intensive system, prices are also set through verbal agreements with neighbours and local restaurants.

Milk testing

Tan-Dairies and Tanga Fresh collection centres test milk quality using various tools. Since some farmers use a certain tree locally known as *msisiro* to improve milk aroma, they also test for smell.

Milk vendors test milk quality using local means such as pouring some milk on the ground and observing viscosity. Others said that they pour a small amount of milk in a container and dip a nail (*ukucha wa kidole*) and a match box stick (*njiti ya keberiti)* to test for viscosity of milk. Milk with high viscosity is of good quality.

Constraints hindering improved milk production

Constraints in semi-intensive systems

- Inadequate markets for milk so producers waste time walking around looking for customers (Kwang'wenda and Manyinga).
- Lack of input suppliers within the village (Kwang'wenda).
- High prices for inputs for both extensive and intensive production systems.
- Lack of knowledge on diseases affecting cattle as farmers must wait for a livestock extension officer who serves many farmers and sometimes has no means of transport.
- Lack of knowledge on milk testing was also mentioned by vendors, especially in the dry season. There is a tendency for farmers to add water to the milk.

Constraints in extensive systems

- Unreliable markets for milk, especially in the long wet season.
- Few collection centres in all 8 villages visited.
- Price fluctuations at collection centres.
- High prices for inputs in all 8 villages.
- Lack of access to feeds (concentrates) as some villages have no electricity and therefore no mill where they can buy maize bran. In some areas molasses was used to make a local brew and not as feed for animals.
- Input suppliers mention lack of access to credit due to high interest charged by financial institutions as a challenge to expanding their business.
- Lack of strong associations for farmers to tackle some milk selling constraints such as price setting. An exception is Kambala village where there is a milk-selling association called Kikundi cha Wauza Maziwa Kambala (KIWAMAKA).

Constraints perceived by milk vendors

Constraints to milk purchase were mentioned by vendors (table 8):

Distance: vendors say they travel long distances from one producer to another and therefore take 1-2 hours to collect milk from farmers. Milk from producers is transported by bicycle to the collection centres at Kimamba township which is 3-20 km from Mbwade or Twatwatwa villages. Similarly, milk transported from Kambala to Dakawa travels 20 km by bicycle; sometimes the road is not passable especially during the rainy season. In addition, distance increase when cattle are moved to search for pastures in the dry season.

Bicycle breakdowns may also cause delays. Milk vendors are required to make all milk deliveries to collection centres by 10:00 am. Based on this, vendors prefer motorcycles because more milk can be collected at a time and less time is taken to collect and transport the milk. Vendors said that a motorcycle can also be used for other businesses after delivery of milk, for example to transport passengers.

Price offered at the selling points: Vendors say that the low prices offered by the collection centres do not give them high enough profit margins.

Lack of milk quality test equipment such as thermometers and lactometers was mentioned, especially to inspect and reject adulterated milk at the farm gate.

Table 8: Constraints to milk sales by vendors

Village	Constraint
Mbwade, Twatwatwa, Kambala	Use of plastic containers
	Lack of milk quality tests equipment
	Low price offered by collection centres
	price fluctuations
	Delay of payment as per arrangements
	Deterioration of milk quality leading to rejection by collection centres
	Long distance from producers to consumers
	Poor roads
	Poor means of milk transport
Sindeni	Lack of collection centre

Feed assessment

The main objective of the assessment was to understand seasonal feed availability, feed use, feed conservation and quality through the year and the technical and institutional support services affecting feed production.

Feed issues in extensive livestock production systems

The villages involved in the study under the extensive livestock production system were Twatwatwa, Mbwade and Kambala in Kilosa district and Sindeni in Handeni district. The systems are characterised by large herds of indigenous cattle and goats.

Common feeding systems

The main feeding systems used by farmers under the extensive livestock production were grazing on communal land in the wet season and pastoral transhumance (only the livestock are moved) in the dry season. Animals are moved because the available pastures in the village lands during the dry season cannot support the large herds. Only a few animals, normally ten lactating cows, young calves and one bull per family, are left behind to provide milk to the family. The animals remaining at home when others migrate are grazed on communal land within the village, where they largely survive on limited natural pastures, crop residues and tree branches, such as acacia species.

Supplementation is rarely practiced; only a few farmers in Kambala said that they supplement maize bran to animals which are left at home in the dry season. This suggests a transition step for pastoralists, moving from traditional transhumance to sedentary production systems. In addition, the herders grow crops, implying that any attempts to reduce the existing effects of seasonal feed availability and increasing land sizes would shift the system towards sedentary semi-intensive systems. There is a possibility to intervene on the few cows that are left at home during the dry season by improving their productivity through proper feeding and where possible upgrading them through cross-breeding with exotic dairy breeds. This could bring some awareness to the pastoralists of the importance of investing in fewer animals to meet their needs.

Seasonal feed availability and milk yields

Results from the proportional pilling in all the four villages under extensive production systems indicate that there is normally plenty of pasture during the long and short wet seasons and feed scarcity is experienced only in the dry season.

The months with plenty of pastures and deficits differ between villages as summarized in Table 9. Generally, March to June has excess feed in all the villages under the extensive production system. During these months, animals graze in the communal village land and are placed in kraals at night.

Feed conservation is not commonly practiced in these areas. Further probing revealed that livestock keepers had no knowledge of feed conservation. Pastoralists could practice rotational grazing during these months in which animals graze in one area at a time and conserve standing hay or *`ngitiri`* as done in Shinyanga and other parts of Tanzania to be used during the dry season, normally August to October. However, land shortage in relation to herd size is another challenge in these villages.

Table 9: Monthly distribution of the feed availability and milk yield as perceived by participants in villages under extensive livestock production system

Village	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feed availability												
Mbwade	**	**	****	****	***	***	**	*	*	*	**	**
Twatwatwa	***	**	****	****	***	***	**	*	*	*	**	***
Kambala	**	**	****	****	***	***	**	*	*	*	*	*
Sindeni	*	*	***	****	****	***	*	*	*	*	***	*
Milk production												
Mbwade	ɵ	ɵɵ	ɵɵɵ	ɵɵɵɵ	ɵɵɵɵ	ɵɵɵ	ɵɵ	ɵ	ɵ	ɵ	ɵ	ɵ
Twatwatwa	ɵɵɵɵ	ɵɵɵ	ɵɵ	ɵɵ	ɵɵ	ɵɵ	ɵ	ɵ	ɵ	ɵ	ɵ	ɵ
Kambala	ɵ	ɵɵ	ɵɵɵɵ	ɵɵɵɵ	ɵɵɵ	ɵɵ	ɵɵ	ɵ	ɵ	ɵ	ɵ	ɵ
Sindeni	ɵ	ɵ	ɵɵɵ	ɵɵɵɵ	ɵɵɵɵ	ɵɵɵ	ɵɵ	ɵ	ɵ	ɵ	ɵ	ɵ

- Feed: **** Excess feed available, *** Adequate feed, ** Shortage, * Extreme shortage
- Milk: ɵ ɵ ɵ ɵ High milk production, ɵ ɵ ɵ Average milk, ɵ ɵ Low milk, ɵ Extremely low milk

Variation in milk yields match feed availability in all the villages and is lowest between August to January, except for Twatwatwa village where milk yield was highest in January. Milk production was peaks when pastures in the village communal areas were plentiful, during the long wet season from March to May. From late July when there is pasture scarcity in the villages, milk production declines until January. This is also associated with migration of the animals. The high milk yield in January for Twatwatwa is probably due to the short rains which increases pasture availability. The trend in milk yield was also related to calving periods. Cows normally produce high milk in the first two months after calving. In some villages, such as Twatwatwa and Kambala, the peak calving period was in December. In Kambala this period coincides with shortages of both water and pastures, resulting in low milk yields.

Contribution of feed to the diet of cattle under extensive production systems

In the extensive livestock production system it was observed that animals rely largely on natural pastures in the communal land, as well as crop residues. In Mbwade, Twatwatwa and Kambala villages, animals graze on communal village land from January to June and most animals are moved (transhumance) to other areas from July to December. Few animals remain in the village to feed on crop residues, mainly maize stover and tree branches. In Sindeni, the situation is slightly different, where in January and February there is a feed shortage and animals graze by the valleys and river basins. Some pastoralists move their cattle to another place called Mswaha, about 25 km from the village centre, where feeds and water are available, implying that they practice transhumance system, due to shortage of both pastures and water.

From March to June, cattle graze in the communal land within the village as there are plenty of pastures due to the rainy season. In July and August, animals are partly grazed in the communal village land and in the valleys and river basins. In September animals are grazed on the crop farms, where they obtain crop residues from maize, beans and cowpeas. Grazing also occurs in the valleys and river basins. Towards the end of October to November, short rains are expected, which enhance pasture growth in the fields whereby animals are mostly grazed in the communal village land.

The subject on feed quality was difficult for the respondents to comprehend. They indicated that selection of pastures for grazing was based on physical characteristics, rather than what pastures offer to the animals. Appropriate areas for grazing are chosen by observing an area where the sward has not been trampled by other animals.

They do not have knowledge on feeding and feed quality, thus they acknowledged the need for such knowledge. Respondents noted that they never have received advice from extension officers or any others about feeds and proper feeding of animals.

There was no feed conservation practiced in either of the villages under the extensive system. Participants indicated a lack of knowledge on feed conservation. Others were quoted whispering "*how can one conserve feed for such large herds of cattle?"* Generally participants indicated the need for training in relation to feed conservation. None of the pastoralists cultivated pastures or fodder plants.

Inventory of purchased feeds for animals

Farmers in villages under extensive production system rarely buy feeds for their cattle but sometime they buy some concentrates for chickens. There is minimal investment in feeding animals. Only one farmer in Twatwatwa claimed to buy maize bran to supplement animals which remain in the boma during the dry season. A few herders indicated that they buy crop residues from farmers for their animals.

Main constraints in feeding and possible solutions

The main feed related constraints facing the livestock farmers under the extensive system in the order of importance were lack of water and feeds in the dry season, land shortage, conflict between crop growers and livestock keepers, limited extension services and hence knowledge barriers.

Limited water and feeds during the dry season was mentioned as the major obstacle (table 10) and the major contributors to the problem of seasonal milk supply by the farmers. Only seasonal rivers and streams were available in these villages; they normally dry up during the dry season.

The problem of water supply both for humans and animals could be solved through rainwater harvesting or construction of bore holes. In some of the villages visited, rainwater harvesting was practiced mainly through construction of Chaco dams, which require institutional solutions due to the required high investment costs. However, some of these dams dry out during prolonged dry seasons.

Various other techniques could be used to solve the problem of feed shortage in the dry season. Feed conservation, through standing or harvested hay could be used. However, farmers have limited knowledge on feed conservation techniques. Farmers in in some villages, Sindeni and Kambala for example, indicated that they need knowledge on feed conservation to ensure feed availability in the dry season.

They perceived the need for feed conservation in the future because land for grazing is becoming smaller and smaller due to the influx of pastoralists from northern Tanzania and the increasing population of cattle in the villages. This trend has led to shortages of pasture, especially during the dry season, forcing herders to move animals to other places. There was an initiative to conserve standing hay, but they participants were unable to control animals grazing on their areas.

Some people in Sindeni had individually- demarcated farms, though grazing was communal. In such case, partitioning of the farms into paddocks and practicing rotational grazing could save some plots being grazed during the dry season, hence minimizing the problem of dry season feeding.

Table 10: Feed related problems and potential solution

Feed resource type	Problem/constraint	Solution/ opportunity	
		Technological	Institutional/Organisation
Planted fodders in valleys	• Lack of knowledge	• Screening of appropriate fodder plants	• Provision of knowledge • On farm demonstrations on planting fodder on the valleys
Conserved feeds (Hay, silage)	• Lack of knowledge • Damage by termites • Animals graze on standing hay	• Introduce methods of termite control • On farm demonstrations on padlocking	• Provision of education on conserving feeds. • Individual land demarcations exists
Grazing	• Lack of enough land for grazing which leads into conflict • Lack of water for animals • Selling of open spaces to pastoralists	• Introduce techniques for proper grazing land management	• Animals moved during dry season • Individual land demarcations exists • Construction of Chaco dams • Reserved areas for grazing • Consult relevant land policies
Feed supplements and additives	• Keeping big herds • Unable to afford supplementation	• Introduce proper herd management techniques	

Proper utilisation of crop residues could also alleviate the problem of feed shortages in the dry season. All villages visited cultivate crops such as maize, paddy, pulses, sorghum, sunflower, sesame and sweet potatoes. Some of the residues from these crops are grazed *in situ*, which result in much feed loss due to trampling. Other residues, such as paddy straw are rarely used because grazing animals are restricted from entering paddy fields in case they destroy the irrigation systems. These materials and other residues are normally burned by the farmers. The straw could be collected, conserved and treated to improve feed quality before being fed. The question is how one could harvest, store and treat enough feed for the large herds normally kept by pastoralists. In addition, the herders face conflicts with farmers, especially when animals graze in farmers' fields. The village councils in some villages have had to allocate areas for grazing animals to avoid conflicts between herders and farmers.

Some of the pastoralists in Kambala and Twatwatwa villages indicated that they negotiate with crop farmers and pay for stover before animals graze in the farms. Animals are only allowed to graze in crop farms after harvesting.

Problems of seasonal feed availability could also be minimized by establishing fodder banks in the valleys. Participants indicated a lack of knowledge on fodder planting and a lack of seeds. On-farm demonstrations of fodder planting in the valleys would improve dry season feed availability in some villages under the extensive system, for example Sindeni. The challenge remains to control fodder banks from being grazing by animals.

Another issues linked to the availability of feeds is shortage of land. This is due to various factors. The continuous influx of livestock from other communities to the villages significantly contributes to the land shortage. Lack of enough land for grazing was mentioned by participants in Sindeni, mainly the indigenous (Zigua) due to influx of migrants from Arusha (Waarusha and the Maasai). When asked about a solution, participants had no answer because the indigenous (Zigua) sold land to the migrants and they live in harmony. Reducing the numbers of stock per grazing area is one solution to the problem. This was not supported by Maasai women as one of them was quoted as saying "*Maasai hashibi ng'ombe"* which literally translated means "*Maasai will never ever have enough cattle".* Allocation of land to some private investors is also mentioned as reducing grazing land in Twatwatwa. This also led to conflicts between the investor and the herders to the extent that the investor sprays toxic substances on the pastures so prohibiting animals from grazing in his fields. In Kambala, which is close to Morogoro town, there is high influx of immigrants buying village land.

Weed and bush encroachment and termite destruction of the pastures also reduce pasture for animals. The herders were shown to have limited knowledge of controlling weeds, bush and termites in their grazing fields. Research is needed on appropriate ways to control termites in standing hay or harvested conserved feeds.

Lack of associations dealing with issues of feed availability also limits cattle productivity. Only in Kambala were farmers organised to solve feed problems in an association known as KIPOK (a Maasai word literally means "healing"). The group deals with the production of animal feeds, supervised by the Ward Executive Officer under the local government program known as District Agricultural Development Program (DADP).

In conclusion, there is seasonal feed availability in all the villages, with excess feed during the rainy season (March to May) and extreme scarcity during the dry season (August to October). This is linked to seasonal milk production, with high milk production in the rainy season and minimal production in the dry season. The main constrains to feed availability were centred on limited land and knowledge and minimal attention taken to solve some of the identified feed related problems.

Feed issues in semi-intensive and intensive systems

The villages under the semi-intensive and intensive livestock production systems were Manyinga in Mvomero district, Kabuku in Handeni district, Kwapunda and Kwang'wenda in Lushoto district. The system is characterised by smallholder production with small land sizes (1-5 ha) and small cattle herds (2-3 lactating cows) of improved or crossbred cattle. There were also some extensive systems being practiced in these villages. In all these villages, livestock is integrated with crops such as maize, pulses, paddy, banana, cassava, groundnuts, vegetables and sugarcane. Sisal is also cultivated in Kwapunda village.

Common feeding systems

In the semi-intensive system in Kabuku and Kwampunda villages, animals are grazed in the fields during the day and confined in barns during the night, where they are fed harvested chopped grasses in their feed troughs. In some cases, animals are tethered on a tree and allowed to feed on the grass grown underneath. Animals under the intensive system in Manyinga and Kwang'wenda villages are confined throughout the day in constructed animal structures in backyards. They are fed grass and other feeds. A few farmers practice preferential feeding, whereby pregnant cows 2-3 months before calving are given supplemental feeds, normally hominy feed/maize bran or rice bran mixed with mineral supplements. Other farmers supplement cows after calving. Calves were normally fed soft grass and supplemented with the same concentrate mixture as was fed to cows until they are 3 months of age. Leftovers from lactating cows and calves are given to the bull.

Seasonal feed availability and milk yields

Table 11 summarizes monthly feed availability and milk production in the study villages under the semi-intensive and intensive production system as perceived by the focus group participants. Low feed availability is experienced in the dry season, while abundant feed is available in the long and short wet seasons in all the villages. Except for Kwangwenda village, the seasonal patterns of feed availability are similar in all villages, experiencing critical feed scarcity in October and excess feed between March and May. A period of critical feed shortage in Kwang'wenda occurs from November to February; excess feed is available in July and August. This variation is due to differences in agro-ecological zones: Kwang'wenda is at a high altitude, the other three villages are in the lowlands.

Table 11: Monthly distribution of feed availability and milk production as perceived by participants in villages under semi-intensive and intensive livestock production systems

Village	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feed availability												
Manyinga	****	***	****	****	***	**	*	*	*	*	**	***
Kabuku	***	**	***	****	****	***	**	*	*	**	***	***
Kwapunda	**	**	***	****	***	**	**	**	**	*	**	**
Kwang'wenda	*	*	**	**	***	***	****	****	***	**	*	*
Milk production												
Manyinga	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ	ɵ ɵ	ɵ ɵ	ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ
Kabuku	ɵ ɵ	ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ	ɵ	ɵ ɵ	ɵ ɵ	ɵ ɵ ɵ
Kwapunda	ɵ ɵ	ɵ ɵ	ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ	ɵ	ɵ ɵ	ɵɵ
Kwang'wenda	ɵ	ɵ	ɵ ɵ	ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ ɵ	ɵ ɵ

Feed: **** Excess feed available, *** Adequate feed, ** Shortage, * Extreme shortage
Milk: ɵ ɵ ɵ ɵ High milk production, ɵ ɵ ɵ Average milk, ɵ ɵ Low milk, ɵ Extremely low milk

Despite the prolonged cropping season, the quality of feed resources in Kwang'wenda seemed not to decrease, thus milk yield increase from May to November. The weather in the village is cool, a typical temperate type of climate. It could be that the quality of forages matches those found in temperate climates. This however, needs to be investigated in another study.

Milk production follows a similar trend to pasture availability and depends on rainfall patterns in Manyinga and Kwang'wenda. In Manyinga, milk production slightly drops from July to October but not as severely as pasture availability. The probable reason is that during the dry season farmers go to the valleys far away to harvest forages and bring this to the animals. Participants say they go as far as 20 km with bicycles and it is normally a full day's work. Another reason is that farmers normally buy more concentrate and supplement animals during forage scarcity. One thing to note here is that farmers consider forages as the only feed for their cattle. Thus, the pattern indicated on Table 11 is mainly for the forage or pasture availability.

Farmers only feed crop residues when there is forage scarcity. One respondent narrated that farmers are not aware of the use of rice straw as animal feed. Most crop residues are plentiful in the fields and freely available in Manyinga village, in other villages, farmers purchase stover and bean straw from crop farmers.

Contribution of feeds to the diet of animals in semi-intensive and intensive systems

The types of feeds used by farmers under semi-intensive and intensive systems to feed their animals are more than those used in extensive system. They include natural pastures, crop residues, fodder crops, banana leaves and pseudo stems, conserved feeds, concentrate and mineral supplements.

The study revealed that the commonly used feed resource is forage from the natural grasses, harvested from owned farms or open lands. These are abundantly available during the rainy season. Another source are planted forages especially Guatemala and Pennisetum that are normally planted on terraces in farms and in some valleys. Tree leaves and branches and other forages also contribute significantly to the diet of the animals throughout the year.

Farmers in Kabuku, Manyinga and Kwang'wenda villages have planted multipurpose trees such as *Gliricidia sepium* and *Leucaena leucocephala* and other fodders, such as pennisetum, as these were some of the conditions for getting a dairy animal by the Heifer Project International. The contribution of banana leaves and pseudo stems is also considerable during the rainy season. Crop residues, mainly maize stover and bean straws and hauls contribute considerably to the diet of animals during the dry season.

Farmers in Kwapunda revealed that they graze on communal land in the mountainous areas, and in the sisal fields and crop farms after crop harvest. They do not have planted fodder. During the dry season, farmers normally move long distances and sometimes outside their villages to seek pastures. There is normally no conflict between farmers and crop producers, since forages are harvested from the communal land and there are good relations in terms of harvesting in ones cultivated farm. A few farmers conserve feeds, mainly crop residues, to use when there is feed scarcity. However, they said they have limited knowledge on feed conservation and are not knowledgeable in hay making. Participants insisted that feed storage requires a constructed barn; their main constraining factor was lack of capital for such construction. Another limitation with conserved feeds was revealed to be unacceptability by the animals. Some use various additives, such as soda ash, salt to sprinkle on the materials to enhance intake.

Other feeds used are weeds from the cultivated farms, banana pseudo stems, cassava, both leaves and tubers, and sugarcane tops. Maize bran, rice polishing, seed cakes and minerals were rarely used to supplement animals, mainly only during milking. Lack of capital was often mentioned as a limiting factor to supplement animals with concentrate. This indicates that farmers have limited knowledge on the commercial aspects of farming that needs investment to accrue profits. Nevertheless, there are limited credit facilities for farmers to draw on should they want to pursue more commercial paths.

Inventory of purchased feeds, prices and frequency of purchase

In all the villages under semi-intensive and intensive systems, purchased feeds are mainly used to formulate concentrate diets. Table 12 is an inventory of feeds purchased in Manyinga village. The major feeds purchased were hominy meal, rice polishing, sunflower seed cake and mineral supplements. Hominy meal was obtained from the grain mills. Most respondents in other villages said they get hominy feed when milling maize for their home use, implying that only a limited amount of it is used. Rice polishing was available in paddy de-hulling machines in Manyinga villages, where paddy is being cultivated. Sunflower cake was obtained from the oil processing plants in Manyinga and Kabuku. Other villages could get some of these inputs through traders.

Farmers in Kabuku village buy these feeds in large quantities when supply is plentiful and store it for use when there is scarcity. Farmers purchase minerals from farm input shops. There was no complete formulated dairy meal in any of the villages visited as it is rarely available in Tanzania. Molasses is available in sugar processing factories and could be a cheap energy supply to the animals during the dry season. However, it is not much used in feeding animals in all the villages.

Table 12: Inventory of purchased feeds, prices and frequency of trading in Manyinga village

Feed purchased	Season	Price/unit (TSh)	Local unit name	Frequency 1=very common 2=Sometimes 3=Rarely	Source of feed
Hominy feed	All	18000	bag	1	Mill
Sunflower seed cake	July-Aug	35000	bag	1	Oil processing factory
Rice polishing		24000	Roba	2	Rice mill
Molasses	July-Sept		Tanker	3	Mtibwa sugar factory
Limestone	All	35000	Bag	1	Farm input shops
Dicalcium Phosphate	All	1750	packet	2	Farm input shops
Maclick	All	15000	packet	1	Farm input shops
Salt	All	300	Packet	1	Shops

Farmers in Manyinga village, which is close to Mtibwa sugar factory, say they are not using molasses because it is sold in large quantities (tanks). It could be bought cheaper if farmers were in associations and purchased as a group. In all villages, the amount of concentrate feeds purchased and fed to animals was quite small as the farmers claim concentrates to be expensive and they have limited capital.

Trading of forages is done rarely. Some farmers in Kwapunda village buy plots of maize stover and sometimes bundles of forages. However, they indicated that people who cut and trade forages are poorly-respected by the community, hence discouraged.

Feed related services available for farmers

Extension services: Free extension services are available to farmers when requested.

Farmer training: Farmers who received dairy cows from Heifer Project International received some initial training on animal husbandry. Some farmers in Kabuku village received training from various institutions on feeds and feeding of cattle.

It was revealed that knowledge on feeds and feeding was low for farmers in all the visited villages. The extent that farmers understand the quality aspects of feeds and levels of feeding differs between among villages. Some farmers in Manyinga and Kabuku show some understanding of feed quality and feeding of animals, such as rationing, supplementation and also how to mix different grass types for nutrient balancing for animals. Farmers in Kwapunda and Kwang'wenda were shown to be less knowledgeable in all aspects. This could be due to differences in levels of education and location of the villages. Some respondents in Manyinga and Kabuku were well educated and were government workers and these villages are closer to sub towns and the highway, whereas Kwapunda and Kwang'wenda are in remote areas.

Feed supply: In most of the villages visited there were no specific shops for cattle feed supply, such shops are available in the nearby sub-towns.

Veterinary services: Animal treatments are provided on request. The costs of transport and treatment are paid by farmers. Artificial insemination (AI) services were available in all villages under semi-intensive and intensive systems, except Kwapunda village. These services were found to be expensive by the farmers. The high cost was due mainly to the distances travelled by the inseminator to follow the farmers. Most of the inseminators stay in the sub-towns near the villages. Another challenge with AI was revealed to be animals not conceiving after several inseminations. Limited services related to feeds and feeding is available in all the villages.

Credit services: In all villages visited, there was no indication of any institutions which could provide credit to the farmers. Only the Village Community Based Organisation (VICOBA) is available in some villages.

Farmer organisations

In some villages farmers were organised for solve various problems related to animal production. In Kabuku for example, there was a union for livestock farmers known as UWAKA (Umoja wa Wafugaji Kabuku). Membership is limited to livestock keepers residing in Kabuku and each pays a membership fee of 2,000 TSh and a subscription of 1,500 TSh per month. The group has a well-established constitution. Its activities include provision of livestock education to members, procuring improved breeds of cattle and improving the local breeds through cross breeding with exotic breeds.

Respondents in Kabuku also mentioned benefits like collective selling of milk, lending cattle to members, training on livestock keeping and receiving AI service for breeding purposes. They said that their relationships are improved through the association as they help each other in various aspects including social issues. This already established association could be used to transfer technologies on dairy cattle improvement to farmers.

In Manyinga, farmers are organised in a group known as KIWAMA. The association is engaged in agricultural activities and livestock keeping. It has a constitution. It aims to install two milk collection centres in Turiani and Madizini. It provides one cow to a member of an association and the first two calves or heifer have to be passed onto another person. They have a slogan in Kiswahili "*Kopa ng'ombe lipa ng'ombe''*. Some individual farmers were also members of VICOBA.

In other villages there was no farmer organisation dealing with livestock. Some farmers in Kwang'wenda village are members of VICOBA, which is not much involved with livestock improvement. Its main purpose is to build capital to provide small loans to members.

Feed constraints and solutions in semi-intensive and intensive systems

The feed-related problems and possible solutions in the semi-intensive and intensive systems are summarized in Table 13. The problems are grouped based on the feed type.

Feed-related constraints are linked to some production factors, that are land, labour, information and knowledge as well as other factors, such as capital, infrastructure and policy.

It is concluded that farmers in the four villages (Manyinga, Kabuku, Kwapunda and Kwang'wenda) under the semi-intensive and intensive livestock production system are smallholders with 1-5 crossbred dairy cows and small land holdings (1-3 ha). The animals are mainly stall-fed with forages and some concentrate supplementation. The sources of forages are open areas, crop farms and own lands. Planted fodder is limited to a few farmers. The constraints on feed availability are due to small land holdings, seasonal weather variations, small investments and limited knowledge on feed conservation and feeding.

Table 13: Feed related problems and their potential solutions in semi-intensive and intensive systems

Feed type/feeding practice	Problem/constraint	Village claiming as problem	Solution/ opportunity	
			Technological	Institutional
Natural grasses	Fire outbreaks in communal land	Kwang'wenda Kwapunda Kabuku	Introduce fire control barriers	Security from the village government
	Seasonal availability of pastures	All villages	Adopt feed conservation	Possibility of feed trading
	Animals graze on crops illegally	Kabuku Kwapunda	Proper grazing management	Separate land areas grazing and crop farms
Crop residues	Lack of storage facilities	All villages	Construct feed storage facilities (hay barns)	
	Knowledge gaps on feed storage	Kwang'wenda Manyinga	Training in feed storage	
	Lack of capital to invest in storage facilities	All villages		Access to credit institutions
	Crop farmers unwilling to sell residues; they are used as mulch	Kwapunda		Exchange manure with crop residues
	Low acceptability by animals	Manyinga	Apply treatments to improve quality	
Planted fodder	Knowledge gaps on planted fodder	Manyinga Kwang'enda Kabuku	Train on effective planting and management	
	Limited land acreage	Manyinga Kwang'wenda	Apply intensive production techniques	Strengthen existing and encourage new associations
	Lack fodder seeds/planting materials	All	Train on fodder planting and management	Create multiplication centre for fodder seeds
	Low fodder yields especially in dry seasons	Kwang'wenda Kabuku	Train on effective planting and storage Agronomic studies and variety screening	Possibility of irrigated fodder gardens
	Animals destroy fodder gardens in valleys	Kabuku	Adopt fodder management techniques	
Conserved feeds	Knowledge gaps on feed conservation	All villages	Train on feed conservation	
	Low acceptability of hay by animals	All villages	Improve low quality feeds e.g. use of magadi	
	Limited capital for investment			Possibility for credit

	Termites destruction of stored hay	Kabuku, Kwang'wenda	Apply termite control techniques	
Concentrate/ feed supplements	No dairy meal in the market	All villages	Develop and promote formulae for dairy meal for each village	
	Limited knowledge on dairy cow feeds and feeding	All villages	Train on dairy cattle management and feeding	Strengthen existing and encourage new associations
	Seasonal availability of ingredients	All villages		Buy large quantities and store in bulk
	No suppliers of ingredients in the village	Kwng'ewnda Kabuku Kwapunda		Purchase feeds jointly from towns and cities
	High costs of feeds	All villages	Impart knowledge on entrepreneurship	Access to credit
	Lack of strong associations	All villages	Impart knowledge on managing farmer associations	Strengthen existing and encourage new associations
	Limited capital to buy concentrates	All villages		Accessing credit
	Lack of credit services	All villages		Strengthen existing and encourage new associations
	Molasses in factory available in bulk	Manyinga	Construction of molasses storage tanks in the village	Organise to make group orders
Water	Water shortage in dry season	Kwang'wenda	Introduce rainwater harvesting	

Dairy cattle breeding management

Population and breeds of cattle

Livestock numbers and breeds is a good indicator of the potential of an area to attract investment in milk collection centres and animal health services provision.

Participants under both production systems enumerated their stock sizes and breeds. Thirty six participants indicated that they own a total number of 1,127 cattle. Of these, 1,095 were Zebu and 32 were cross-breeds. The extensive production system was dominated by the Tanzanian shorthorn Zebu (indigenous/Zebu) while the semi-intensive and intensive were dominated by exotic cross-breeds. In semi-intensive and intensive systems the total number of cattle was 134 (reported by 34 participants). Of these, 52 were Zebu and 82 were exotic or cross-breeds.

Breeds kept in extensive production systems

Focus group participants indicated that the main breeds kept under extensive systems in Twatwatwa, Mbwade, Kambala and Sindeni were indigenous breeds (see Table 14). Most (over 90%) farmers say they keep indigenous breeds; the remaining 10% said that they keep Zebu cross-breed with different levels of exotics such as Boran (for beef) Friesian, Jersey and Ayrshire (for dairy). When participants were required to indicate the main characteristics (both positive and negative) of the breeds mentioned, most indicated that the indigenous Zebu tolerates diseases and drought, and provides delicious meat and milk. On the other hand, this indigenous breed produces little milk compared to the improved breeds. Providing comparatively high milk and meat yield was the positive characteristic given to cross-breeds, however, the quality of milk and meat was said to be poor (table 14).

Table 14: Livestock types and their characteristics in the extensive system

Breed name	Important traits/ characteristics	Rank
Indigenous: Tanzania shorthorn Zebu (TSHZ) ≥90%	Tolerates disease and drought	1
	Provides delicious meat	
	Provides delicious milk but low quantity	2
	Is relatively cheap to rear	3
	Good quality butter	
	High butter fat	
Improved ≤10%	Provides high quantity meat	3
	High milk production but of low quality	2
	More money obtained on sale	1

Breeds in semi-intensive systems

Breeds kept in the semi-intensive system (Manyinga and Kwang'wenda) were mainly improved or cross-breed of dairy cattle. Mixed improved and Zebu breeds were found in Kabuku and Kwampunda. Participants suggested that improved breeds produce more milk, more meat, obtain a high price when selling live animals, are fast maturing, and docile (table 15).

Table 15: Livestock types and their characteristics in the semi-intensive system

Breed name	Important traits/ characteristics	Rank
Improved breeds	Provide a lot of meat	
	High milk production	1
	High growth rate	2
	More money obtained on sale	
	Short reproductive cycle	3
	Mature faster	
	Docile animals	
	Provide manure	
Exotic breeds	Produce a lot of meat	
	High milk production	1
	More money obtained on sale	2
	Mature faster	
	Docile animals	3
	Short reproductive cycle	
	High feed efficiency	
	Marketable with high price	
	Provide manure	

Mating methods and replacement options

Almost all farmers in the extensive system reported that they use natural method through bulls, a few farmers in the semi-intensive system said that they use Artificial Insemination (AI). Others combine AI and bulls (table 16). AI services are provided by government officials in Manyinga and Kwang'wenda villages, while in Kabuku village, the AI service was initially supported by Land O' Lakes through training of farmers. One of the trained technicians is currently delivering service by charging 10,000 TSH per straw.

The major challenge for farmers to adopt AI services is the low rate of conception. A cow can be inseminated three times without conceiving. This increases the cost, as each service the farmer has to pay the same amount (10,000 TSH or 25,000 TSH at Kwang'wenda village). This trend made farmers opt for natural mating method (bulls), which costs 5,000 TSH per service. Selection of bulls or use of AI is done in order to improve the breeds and introduce new blood to the herd.

Table 16: Methods used by farmers in mating of their cows

	Providers of service (e.g. Govt, Private sector, NGO, Village agents)	Challenges in getting the service from the different providers
AI	Private individual and government, not used by farmers in Kwampunda village	Accessing the service is difficult: One AI technician is trained but providing the service privately Low conception rates High costs due to repeat AI with each costing 10,000 to 25,000 TSH per straw (at Kwang'wenda)
Bulls (natural mating)	Natural	Lack of good breeding bulls The bulls are inadequate
Both AI and Bulls		

Methods to acquire new animals

Most participants of Manyinga and Kwang'wenda villages reported that they acquired improved animals from Heifer Project International (HPI) through a project known as '*Kopa ng'ombe lipa ng'ombe'* which literally means borrowing a cow and paying back by providing a cow to a neighbour (table 17). The project required that farmers receiving a cow pass on two calves to other farmers. Participants in Kabuku said that they bought new animals from a Catholic convent in Korogwe and at the Buhuri Livestock Training Institute (table 17).

Another source of animals was the primary auction market mainly used by farmers in the extensive system. Buying new animals from neighbours was mentioned by farmers from both extensive and intensive system.

Table 17: Getting new animals for both extensive and intensive system

Cattle type	Source of new animals	Constraints in accessing new animals
Indigenous/Local	Primary markets	N/A
Cross-breeds	HPI-Manyinga village, Korogwe Catholic Convent, Buhuri Institute and neighbours for Kabuku farmers	It takes one year to get animal from Korogwe Catholic Convent after placing order
Exotic animals	One farmer in Kwang'wenda village	Acquired an animal through church organisation from Zimbabwe

Sources of information and willingness to adopt change

Participants indicated that their main sources of information on breeding management were mass media and extension officers. They said they were willing to adopt changes such as keeping improved breeds; however lack of capital was a challenge. Participants in the extensive system were not willing to acquire exotic breeds because of the harsh environment.

Constraints to cattle breeding management

Participants said that lack of funds to access AI was a major challenge. One farmer in Kwang'wenda village lamented that "*paying 25000 TSh at once without any assurance as to whether the animal will conceive or not is risky. Why should I spend such money while my children have nothing to eat?"* Awareness creation among farmers is an important intervention to enable farmers to detect heat to avoid misconception of animals as well as changing people's attitude from using bulls to AI.

Participants were willing to make changes on the breed they are rearing as long they can get improved, better breeds with high milk yields. Respondents complained that the breeds of animals they have are not good for milk production. It is well known that both genetic and environmental factors have influence on the animal performance. Thus, the potential of the existing breeds of animals for milk production needs to be identified as well as the real causes (genetic versus environmental) for sub-optimal milk production.

The challenges facing farmers of not changing to better breeds were lack of capital due to high cost and difficulties in getting good breeds (table 18). Lack of improved bulls was also a challenge. Use of AI could be an easy means to improve breeds.

Farmers in extensive systems said that there is no controlled mating; bulls just move freely from one herd to another. One participant from Twatwatwa revealed that she got an improved breed just by chance as the improved bull from the neighbouring herd visited her herd. She was quoted as saying "*I am lucky because two weeks ago I got an improved female calf without incurring any cost*." Participant responses indicated that they lack knowledge about the effects of inbreeding.

In Kambala village, a farmer association aims to improve breeds through the use of exotic breeds. The association is known as "improved bulls" (*Madume Bora*). The bull is taken care of by one member; farmers take their cows for mating at a cost. Members under this group receive support in terms of advice from the District Agricultural Development Program (DADP).

Table 18: Constraints related to cattle breeding management

Problem	Land and water	Labour	Capital	Knowledge	Others
Access to AI	N/A	N/A	Lack of capital to get the desirable breed	Inadequate knowledge	N/A
High price of improved and pure exotic breeds	N/A	N/A	Lack of capital	N/A	N/A
Availability of improved bulls	NA	NA	Lack of capital	N/A	N/A
Low conception rate from bulls	NA	NA	NA	Inadequate knowledge	NA
Heat signs not easily detected	NA	NA	NA	Inadequate knowledge	
Problems during birth	NA	NA	NA	Inadequate knowledge	NA

Gender roles in cattle production and milk marketing

Participants were requested to explain their responsibilities from waking up to when they go to sleep. Livelihood analysis was done to indicate the contributions of livestock to the livelihoods of men and women. Income sources of men and women (on farm, off-farm, and non-farm) and their trends were elicited. The main emphasis was to compare the role of livestock related activities to other activities.

Gender activity profiles in extensive systems

Findings (table 19) indicate the gender roles as perceived by women in villages representing the extensive production system (Kambala, Mbwade, Twatwatwa and Sindeni). Women were asked to mention typical daily livestock-related activities in the villages and build a consensus on the same. Women had different timetables in the wet and dry seasons. Women wake up early in the wet season as compared to the dry season. They milk larger numbers of cattle than in the dry season. However, in villages such as Twatwatwa where water sources are located far from their residence, women wake up early in the morning, thus having a higher workload than men.

Kambala, Kabuku and Kwampunda villages represent agro pastoralists in the extensive system. Crop production is also indicated on the activity profile (table 19). During the wet season men graze around the household in the morning locally known as (*Linga)* which has been nicknamed as cattle breakfast.

The number of hours spent by women in Kambala was 9 and a half hours working during the dry season and 11 and a half hours in the wet season dealing with activities related to cattle. Men spend 4 and a half hours working with cows in the dry season in Twatwatwa village. Both men and women are involved in livestock production with different and sometimes shared roles.

In Twatwatwa village, women escort animals to grazing as it needs some care to prevent cattle grazing near the private ranch. A woman in Twatwatwa village revealed that women are responsible for the daily management of calves, and if a calf is missing the woman will search until it is found. If it is still missing for a day, the husband may assist. If the calf is still missing, the woman will be beaten and asked to go to her parents or relatives and ask for a replacement of the lost animal.

Table 19: Women's activities in the wet and dry seasons in extensive system

Time	Activity (**wet season**)	Time	Activity (**dry season**)
04:00-08:00	Wake up, milk 20-40 cows	05:00-07:00	Wake up, milk animals; prepare food for a person going for grazing.
08:00-08:15	Milk packaging in containers.	07:00-09:00	Isolate calves from the main herd, general cleaning and prepare breakfast for family.
08:15-09:00	General cleaning.	09:00-10:00	Fetch water for domestic use.
09:00-11:00	Escort animals Prepare breakfast, food for a person taking cattle for grazing and isolation of calves.	10:00-10:30 10:00-12:00	Escort animals near the ranch (Twatwatwa). Send calves to drink water, prepare lunch and collect firewood.
11:00-12:30	Travel to the farm (Kambala and Kabuku villages). General cleaning such as washing clothes for children and husband and prepare meals.	12:30-13:00	Collect a special wood used for milk preservation and adding aroma in milk locally known as (*msisiro)*
12:30-16:00	Farming activities, Take lunch and wash dishes.	13:00–16:00	Make beads, pleat mats while resting.
16:00-18:00	Return home, receive the calves and goats which were grazing nearby.	16:00-17:00	Wash clothes for children, Searching for calves and goats from the field.
18:00-19:30	Milk cows.	17:00-18:00	Milk cows.
19:00-19:30	Isolate calves from the main herd.	18:00-18:30	Isolate calves from the main herd,
19:30-22:00	Prepare and eat dinner, clean dishes, then sleep.	18:30-21:00	Prepare dinner for the family then sleep,

Focus group discussants said that both men and women are responsible for separating animals (adult from young animals) and verifying the number and the health status of their animals. During the dry season, when livestock migrate to better pastures, men said that milking cows was part of their responsibility as women are left behind at home.

The findings (table 20) indicate the roles assigned to men in extensive system. It was observed that men are the overseer of all activities pertaining to livestock. Some of the activities claimed to be done by men were also done by women. For instance, opening the boma's is usually women's responsibility as they wake up early in the morning to do the milking. Similarly the role of receiving animals from the field is usually done by women as they prepare for milking. Generally men perform the regular guarding at night, specifically in the wet season when the cattle shed is full of mud. Apart from guarding in the night, men spend less time (5-6 hours) doing activities related to livestock in the day time compared to women.

Table 20: Activity profile/gender clock as perceived by men in an extensive system

Time	Activity
05:00-09:00	Open the herd(*Boma*) and livestock come out
	Check animal health
	Treat sick animals
	Check if there is missing animals
09:00-09:30	Take the animals to graze (young men)
09:30-10:00	Men take breakfast (stiff porridge *Ugali* and fermented milk)
10:00-18:00	Construct or repair the bomas if need arises
	Searching for areas to graze their livestock in dry season
05:00-18:00	Receive cattle from graze
05:00-19:00	Check the cattle if are all present
	Check their health and treating of sick animals
19:00-22:00	Rest and eat
22:00-04:00	Sleep, but wake up regularly and guard the herd
05:00	Wake up.

Gender activity profiles in semi-intensive systems

Women had different gender roles depending on the season in Kwang'wenda village. The dry season is also divided into two sub-sessions; women had two-three days in a week for fetching water for domestic use and cattle. Women wake up early in the morning (3:00am) up to 6:00am fetching water, thereafter; women do the milking and take milk to the market at Soni Township (table 21).

Looking at the number of hours women spend dealing with cattle related activities include fetching grass, milking and selling of milk, they spend five and a half hours in the dry season. Similarly women spend less time in the wet season because there is plenty of grass. Furthermore, unlike the gender roles in the extensive feeding system, women had time to rest. Men and women do the milking and fetching of water for domestic use and for the animals. Men in Kwang'wenda are willing to perform some of the activities believed to be performed by women in other societies. Similarly, men in Kwampunda village perform activities that are usually done by men in the extensive system, for instance milking. However, women in Kwampunda reported that they go for grazing, an activity done by men in the extensive system.

Men in Manyinga village spend morning hours fetching grass while women in both male and female headed households also fetch grass in addition to the domestic roles. Women discussants said that they usually perform crop growing activities in the wet season. Activities related to livestock production and marketing are carried out by both men and women at Manyinga village. This is due to the mutual contribution of the livestock keeping activities to their daily livelihood through selling live animals as well as milk. They tend to wake up and sleep at almost the same time. Milk selling and marketing was a task for each family member but women oversee sale of milk.

Women's roles in Kabuku differed from one household to another in different seasons. For instance in the long wet seasons, some women cultivate crops, while others are employed in various government institutions, NGOs and in the private sector. In view of this, it was difficult to establish a sequence of roles as indicated by one of the participants who was quoted "*I normally finish household chores at around 8.00am, cultivating crops and come back at 11.00am with a bundle of grass for livestock"* and another woman representing those employed said *"I usually come back from my office*

at 3.30pm, preparing food and do the milking" indicating that she was not involved in feeding animals as this is performed by someone else

Table 21: Gender roles as perceived by women in a semi-intensive system (Kwang'wenda)

Activity (Dry season)	Time	Activity (wet season)	Time
Wake up	03:00	Wake up	06:00
Fetch water, milking and selling milk at soni area	03:00-06:00	Prepare for milking, send milk to town and collect feed/grasses	06:00-09:00
General cleaning	06:00-06:30	Go to the farm come back with feed	10:00-14:00
Collect feeds/grasses	06:30-10:00	Prepare and take lunch	14:00
Take breakfast	10:00-11:00	Rest	14:00-15:00
Fetch water	11:00-12:00	Rest	15:00-16:00
Prepare and take lunch	12:00-13:00	Wash clothes, milking containers	16:00-17:00
Collect grasses	14:00-15:00	Prepare and take dinner, milking, take shower, socialise	18:00-21:00
Rest	14:00-15:00	Go to sleep	21:00
Wash clothes, vessels	15:00-16:00		
Collect grasses	16:00-17:00		
Prepare dinner, take shower, socialise	19:00-21:00		
Go to sleep	21:00		

Activity profiles in semi-intensive systems as perceived by men

Generally, it was difficult demarcate roles performed by men and women as far as livestock management is concerned in Manyinga village (table 22). Grazing is the main activity performed by boys besides milking stock in the extensive system. However, in the morning and evening, roles are well defined while in the day time men's roles are not well defined as some farmers are shop keepers or employed thus it is hard to come up with defined set of activities. In Kwang'wenda village, men and women perform similar activities i.e. milking, feeding, fetching grasses and selling of milk.

Table 22: Gender roles as perceived by men in a semi-intensive system (Manyinga)

Time	**Activity**
05:00-12:00	Fetch grass for livestock
12:00-17:00	Involved in other individual specific activities that generates income apart from livestock activities
17:00- 20.30	Supervision role at home
	Selling of milk
20:30-21:30	Rest and eat
21:30-05:00	Sleep
05:00	Wake up.

Household decision making in extensive production systems

Decision making at household level was elicited to gain understanding on who decides what in the household in relation to cattle production and milk marketing. Decisions on input supply and crop production are made by men in Mbwade, Twatwatwa and Kambala villages with the exception of Sindeni village where joint decisions are made. When asked the reason for this, women replied that men control resources used to buy inputs and hire tractors for cultivation in Mbwade and Twatwatwa villages. Men informed further that they predominantly make decision on input purchasing with slight involvement of women. The main reason was said to be that men are more exposed to latest information than women on, for instance, veterinary drugs, better crop seeds as well as better livestock market and animal breeds to purchase.

However, decision making on milk and milk products were made by women. Discussants from men revealed that decision making on crop production is done jointly because this is a new activity in Kambala village. Similarly, men in Sindeni village reported that decisions on which animal and animal products to sell is jointly done only if the wife is strong enough and has an interest in livestock activities.

Table 23: Decision making as perceived by women in Mbwade and Twatwatwa villages

Decisions	Male	Male and Female	Female	Comments
Inputs	✓			Currently there are no changes can be made.
• Who decides buying				
• How much labour to hire		✓		
Production:				Males decide because they own resources/capital.
• Who decides which food/cash to grow	✓			
• Who decides which livestock to keep				
• How much milk to be kept for consumption			✓	Females are entirely responsible for the milk sold and they retain the money.
Milk to sell			✓	

Household decision making in intensive production systems

Decision making for each variable is jointly made between women and men in Manyinga village. Cattle-keeping is one of the major sources of income to the household and hence not only the husband and the wife decide but even the rest of the family members, especially milk sales to neighbours or the nearby market. Most people here only consume milk following prescription from the health centres.

A similar trend was observed in Kwang'wenda village whereby participants through FGD reported that with the exception of widows, all decision making in relation to livestock management are made jointly. It was discovered that the community was a matrilineal society where women are culturally endowed with decision making power in various aspects at home. This was an opportunity for women to improve their livelihoods by engaging in various development activities as far as livestock production is concerned. Bearing in mind that activities related to value addition on milk are women related (i.e.

making butter, yoghurt and cheese) (Nombo and Sikira, 2011), women in Kwang'wenda had all the support from their husbands to process milk into other products such as cheese that could be sold within Lushoto district because the district is currently a tourism area. There was neither a milk collection centre nor cooperative where they could sell the excess milk.

Reasons to keep livestock

Keeping livestock in extensive production systems

Women in Kambala, Mbwade and Sindeni villages said they keep livestock as their major source of income. Men in Kambala say they keep livestock as their culture. Both men and women in Kambala, Sindeni and Mbwade villages indicated that livestock are kept as sources of food for the family and they ranked livestock highly. Similarly, men in Twatwatwa village revealed that livestock keeping is mainly a source of food. Almost all groups in Kambala, Sindeni, Mbwade and Twatwatwa added that cattle are used to pay dowries. Livestock is also a source of milk and other products such as butter which is also a source of income. Other products such as hides and skins are used as bedding materials for women. Milk is also used for medicinal purposes. Men in Kambala reported that livestock are used to pay fines.

Women in Kwampunda village reported that apart from being a source of income and food, livestock act as living bank, they are a form of savings. Livestock keeping for manure and as a source of biogas was mentioned by women in Kabuku village.

Keeping livestock in intensive production systems

In Kwang'wenda and Manyinga villages, the main reason for keeping cattle was given as being an important source of nutrition and ensuring food security. This was ranked number 1 by men. Livestock was also kept as a source of income from sales of milk, live animals and other products. Women in Kwang'wenda and men in Manyinga villages said that having livestock is just like having a living bank, "*Livestock keeping is a saving strategy*". Livestock are also important to pay dowries before marriage. Communities in Kwang'wenda and Manyinga villages are agro-pastoralists and see livestock as a good source of manure.

Indicators for success

Participants were asked to indicate how they measure success from keeping livestock. Women and men agreed that building good and modern houses was an indicator of success in Kambala, Sindeni, Twatwatwa, Kwampunda, Kabuku, Manyinga and Kwang'wenda villages. Participants in Kwampunda said that educating children in Uganda was considered as success. They further revealed that educating children in an English medium school and keeping money in the bank were also indicators for success. Possessing cars or motor bikes was an indicator of success given by both men and women in almost all villages.

Men in Kambala and Sindeni villages indicated measures for success based on herd size (1200-1500 cattle) and having improved cattle breeds (such as Boran). Owning a business or houses for rent were indicators given by women in Sindeni. Men in Kwampunda village reported that the ability to diversify to other investments such as shop keeping or acquiring land was an indicator of success. One group member revealed that he started with one animal, purchased six more, and eventually bought land and build a house. Participants (women) in Kabuku reported that having a water source for domestic and animal use and being connected to electricity were indicators of success. Men said that high quantity milk production and hiring labourers were indicators of success. Participants in Kwang'wenda reported that owning large farms and owning many improved/exotic dairy cattle were also indicators of success.

Livelihoods analysis

This analysis aimed to identify important livelihood sources on farm, off farm, and from non-farm sources. The group of women discussants in Kambala village indicated that milk sales contributes much on their livelihoods and as a source of cash income. Milk is seen as becoming more important than before, mainly due to the collection centre located at Dakawa. Income from sale of live animals is controlled by men although money from sales of animals is kept by women. Women discussants say that they keep this money in a similar way as it is kept in the Bank, a woman quoted *"if you attempt using even a single coin, the husband beats you."*

Both men and women in Twatwatwa, Mbwade and Sindeni village said that livestock keeping is the main source of livelihood followed by crop production. Men in Sindeni village said that crop production is the main source of income because one must start by cultivating crops and thereafter buy livestock *" from the genesis, land started before livestock and hence, those without livestock, they should start with crop cultivation followed by buying livestock if they were not lucky to inherit from their parents."*

Men and women in Kabuku, Manyinga, Kwang'wenda and Kwampunda mentioned crop production as their main source of livelihood, while livestock keeping was ranked number two. Both men and women regard livestock keeping as being very important in contributing to cash income. Men also indicated that livestock keeping is central to the livelihood of the communities as they were quoted in Kabuku village "*with dairy cows one has a continuous income flow almost throughout the year.''* They further said that livestock keeping provides a cash income on a daily basis, unlike crops. Participants in Kabuku, Sindeni and Kwang'wenda said that the trend for crop production is not changing while animal keeping and business are becoming more. Nevertheless, men in Manyinga reported that the trend for small businesses is increasing compared to crop production.

Other sources of income for men include carpentry and masonry in Kwang'wenda village and employment in sisal processing factories in Kwampunda village. Tailoring and employment in Kabuku was mentioned by women as sources of income.

Participatory epidemiology

Through brainstorming, groups identified the main constraints affecting livestock keeping in their respective villages in the order of their impact on livestock.

The **constraints** under extensive production systems in order of decreasing importance are indicated in the table below ranking from **1 to 8.** Lack of pastures apart from drought can be grouped together with lack of land due to high number of livestock owned by pastoralists. Diseases can be grouped together with less access to quality veterinary drugs.

Table 24: Ranking of constraints under extensive production systems

Constraints	1	2	3	4	Total	Rank
Lack of pastures	8	8	6	6	28	1
Lack of water	8	7	4	8	27	2
Lack of markets	6	6	-	7	19	3
Diseases	5	4	5	4	18	4
Theft	4	-	-	5	9	5
Access to drugs	-	5	-	-	5	8
Inadequate land	-	-	8	-	8	6
Bush burning	-	-	7	-	7	7

The constraints under semi intensive/intensive production systems in order of decreasing importance are indicated in table 26 ranking from **1 to 7**. The major constraint in livestock production was milk market as it was mentioned three times and hence ranked the first followed by dairy breeds, diseases and pastures the least. Market for the milk score higher because most of the society in Manyinga village does not have the culture of drinking milk and as well there is no cooperative for selling the milk produced by the livestock keepers.

Table 25: Ranking of constraints under semi intensive/intensive production system

Constraints	1	2	3	4	Total	Rank
Lack of milk market	7	4	-	4	15	3
Lack of good quality breeds	6	7	7	-	20	2
Livestock diseases	5	6	6	7	24	1
Inadequate feeds	4	-	5	6	15	3
Inadequate water	-	5	4	-	9	5
Inadequate land	-	3	-	-	3	7
Capital for cattle shelter	-	-	-	5	5	6

Lack of good breeds is the big constraint in Kabuku village because with good breed one will get enough milk. Animal diseases ranked second owing to high treatment cost and deaths. They all had a consensus that *given good breeds and improved animal health, you can focus then on markets, water and land for livestock feeds*. While in Kwampunda

village the major constraints in order of decreasing important were: the prevalence of livestock diseases, low potential of cattle breeds, lack of feed and water during drought. Lack of good cattle breeds was the leading constraints according to the participants. This was attributed to lack of high milk producing potential bulls and Artificial Insemination (AI) as most farmers have shorthorn Zebu which gives partly 3 litres per cow per day, incidences of inbreeding were said to be common as there are very few bulls.

Livestock diseases ranked first due to livestock mortalities and the high costs of treatment particularly the East Coast fever which was said to be endemic. Lack of feed and water ranked low as shortage is only experienced during dry seasons. On the other hand, in Kwangwa'nde village, the major constraints in order of decreasing importance were: prevalence of livestock diseases, lack of capital for cowsheds, lack of feed and lack of markets for milk and live animals. Most participants rear exotic cross-breeds which are prone to diseases which ranked as the first most significant constraint, particularly East Coast fever and anaplasmosis.

Cow sheds ranked as the second constraint to the farmers as they noted the capital required for construction, though it is essential for their dairy cattle.

Livestock feed is a problem mostly during long dry season when conserved feeds are in short supply. Lastly, the market for milk was mentioned but at the moment most of the milk produced is sold to neighbours and restaurants at Soni centre in Lushoto (rural to rural consumption).

Cattle health

Reasons for cattle exits from the community were explored from the participants. Simple ranking was applied to the proportions that exited for better analysis of the results whereby the main reason was found to be selling to meet household needs.

The main reasons for cattle exit in extensive system include sales, paying dowry and exit due to predators. Diseases were also mentioned as one of the reasons for cattle exit.

The main reasons for cattle exit under semi intensive/intensive production system in decreasing order are sales, dowry, DRC, accidents, theft, ceremonies, burial and drought.

Animal diseases occurrences and mortalities as well as specific disease impacts were assessed through a key informant interview covering the past one year. The main livestock diseases mentioned as well as the relative morbidity (MB), mortality rate (MR) as well as case fatalities (CF) are listed in Tables 26 and 27.

Health issues in extensive production systems

Table 26: Relative morbidity, mortality and case fatalities

Disease	Mbwade			Twatwatwa		
	MB%	MR%	CF%	MB%	MR%	CF%
CBPP	15	8	53.33	10	5	50
LSD	7	4	57.14	-	-	-
Trypanosomiasis	5	1	20	14	4	28.5
ECF	5	3	60	15	7	46.7
Anthrax	-	-	-	9	3	33.3
FMD	EP	EP	EP	8	2	25
Others	6	2	33.33	7	4	66.7

EP= epidemic, FMD out breaks has been coming once in a year but this year there has been three outbreaks in the last six month making it a big epidemics with associated with High mortalities in calves.

From the table it is evident that the case fatality from ECF is very high followed closely by LSD and CBPP. This could be due to lesser access to veterinary services in the area in terms of the high cost of treating ECF and no proper dipping facilities. The high case fatalities from LSD and CBPP could be due to farmers having less access to the vaccines and the CCBPP being endemic in the area.

Table 35 shows from the individual herd that, the most prevalent disease is ECF closely followed by trypanosomiasis and CBPP. Other diseases all together have high case fatalities followed by CBPP, ECF, anthrax, trypanosomiasis, and FMD in decreasing order.

From table 36, it is evident that morbidity from FMD is very high followed by ECF, CBPP, babesiosis and LSD. Similarly, FMD causes high mortality compared to other diseases in the area; however, babesiosis leads to high case fatality followed by CBPP. High mortality from FMD was explained to be the sudden death in calves.

Table 36 shows from the individual herd that the most prevalent disease is ECF closely followed by CBPP with anthrax being the third. Anthrax though with low morbidity, upon outbreak, results into high mortalities (7) compared to ECF (4) CBPP (5) as well as

case fatalities 58.3%, 14.3% and 19% respectively. This is attributed to the fact that, there is no routine vaccination against anthrax while the disease occurs as an outbreak associated with sudden death. This is contrary to CBPP and ECF which, upon manifestation of clinical signs, farmers can treat themselves or look for advice, reducing case mortalities and fatalities (table 28)

Table 27: Herd relative morbidity, mortality and case fatalities

	Kambala			Sindeni		
Disease	MB%	MR%	CF%			
CBPP	12	5	42	27	5	19
LSD	4	1	25	-	-	-
FMD	32	8	25	-	-	-
Babesiosis	7	3	43	-	-	-
Anthrax	-	-	-	12	7	58.3
ECF	19	5	26.3	28	4	14.3
Others	4	1	25	-	-	-

Health issues in semi-intensive/intensive production systems

The interviewed participant from Manyinga village mentioned the main livestock diseases that affected his herd. It was noticed that he practices most routine/required management to his cattle herd (6 dairy cows), including spraying against ticks and biting flies, deworming and vaccinations. He was also knowledgeable in treating trypanosomiasis using trypanocidal formulations.

In view of the above, as for the past one year there were no cases of sick animals in his herd. Following these findings, the disease relative mortality, morbidity as well as case fatalities were not calculated. The semi intensive system is said to be mainly affected by mastitis but it was not mentioned. This could be due to the effective management measures and the smaller numbers of livestock kept. Trypanosomiasis ranked comparatively lower. However, the low impact of trypanosomiasis may be due to the spraying of cattle against the biting flies. Anaplasmosis has high case fatality due to farmers having less knowledge of early detection. Mastitis was said to have high morbidity rate. However, recovery was found to be 100% and hence no mortalities. Though there may have been indirect negative effects in terms of reduction in milk production.

The participant was also interviewed about his livestock herd health for the past one year. He mentioned only two livestock disease cases that affected his herd namely ECF and worms. No case fatality derived from his herd as all cases were managed and recovered thus no mortality was experienced. In Kwang'wenda village, the individual(s) were interviewed about their livestock herd health for the past one year. From the FGD, the number of cattle reared by each farmer was small hence to get representative morbidity and mortality would need more herds. There was no mortality reported by all the four farmers interviewed individually. This could be due to the production system (intensive) and the availability of veterinary services from the Livestock Field Officer based in Soni ward close to Kwangw'enda village.

Table: 28: main livestock diseases under extensive production systems

Local name	Symptoms	Probable diagnosis	Management measure
Orkipei/Lipis	Coughing, difficulty in breathing and adhesion of lungs to the ribs	CBPP	Tylosin® (advised that the vaccine is available)
Oltikana	Enlarged prescapular lymph node and difficult breathing	ECF	Butalex® and oxytetracycline (advised that the vaccine is available)
Ormilo	Animal move in circles(*kisungu sungu*) and tears	Heart water	No treatment (advised use of oxytetracycline 30% in the early stages) and dipping
Orkipepedoi	Presence of wounds under the skin, the hide is of poor quality(can't stretch)	LSD	No treatment (advised that the vaccine is available)
Orkuluk	Sudden death in calves, wounds in the mouth and hooves, difficulty in walking. Adults develop heat intolerant syndrome (afraid of sun, isolate and stay under the tree or stand in water	FMD	Advised to use broad spectrum antibiotics against secondary infections and wounds (ulcers)
Olodokulak	Presence of red urine and yellow meat if it dies.	Babesiosis	Oxytetracycline (advised use of imisole and dipping animals)
	Emaciation, lack of appetite, strange bellowing like a dog, blindness and death	Rabies	No treatment (advised vaccine is available and avoiding contact with stray dogs) report cases to the authorities
Emburuo, emburas or estonyii	Sudden death, presence of blood clots in the heart, swelling of the limbs and around neck region, trembling, black quarter upon post mortem.	Black quarter and or Anthrax	No treatment (advised to treat using combination of penicillin and streptomycin and that vaccination is available for both black quarter and Anthrax
Emonywa	Sunken eyes, emaciation, off feed, dry faeces with stain ed blood and weakness	Anaplasmosis	Use herbal plant muarubaine (advised to use oxytetracycline 10% and laxatives)
Endorobo	Decreased milk production, emaciation, swollen lymph node, cutting of the tail	Trypanosomiasis	Trypanocidal drugs (also advised proper livestock dipping against biting flies and ticks).
Emburas	Swollen neck, dies suddenly, kills fatty animals and sometimes blood oozes from nose and ears	Anthrax	Enjani eboru (white injectable drug): Penstrept (advised on yearly vaccination and reporting outbreaks to authorities)

Table: 29: main livestock diseases under semi intensive/Intensive production systems

Local name	Symptoms	Probable Diagnosis	Management measure
Kiwele	Enlarged udder, milk with blood and clots, sometimes leads to abscess	Mastitis	Use intra-mammary infusion, ensure more hygienic milk practices
Ndigana kali	Enlarged prescapular lymph node, fever, faecal material with blood	ECF	Most call the LFO, a few use oxytetracyclines to treat (advised the use of available vaccine and proper spraying against ticks)
Vipele	Presence of wounds under the skin, Initially several swollen areas under the skin	LSD	No treatment (advised the use of available vaccine)
Midomo na miguu	Salivation, wounds in the mouth and hooves, difficulty in walking, anorexia	FMD	No treatment (advised to use broad spectrum antibiotics against secondary infections and wounds as well as management through LFO
Minyoo	Decrease in appetite, animal becomes emaciated with rough hair coats.	Helminthiasis	Anthelmintic drugs by LFO
Ndigana baridi	Anorexia, emaciation, dry faeces and weakness	Anaplasmosis	Consult LFO and use of Berenil
Ndorobo	Decreased milk production, emaciation, cutting of the tail	Trypanosomiasis	Consult LFO
Mapafu	Coughing, difficulty in breathing and adhesion of lungs to the ribs	CBPP	Tylosin® (advised that the vaccine is available)
Ugonjwawa siafu	Wound between hooves, difficulty in walking and sometimes overgrown hooves mainly during rainy season	Foot rot	No treatment (advised the use of antibiotic spray, good bedding)
Kutoka kizazi	Uterus or vagina coming out just after birth, death in cows	Prolapse (uteral, cervical or vaginal)	Bury cow since it is considered a bad omen (advised about the use of feed supplements)
Kulala chini	Animal fail to rise from sleeping position, mainly in milking cows, wounds develop in the lower side of the body and front limb	Hypocalcaemia	No treatment (advised the use of feed supplements especially during gestation period)
Kono/cham bavu	Swollen and stiff shoulder and back , difficulty in walking NB: endemic in the area	Black quarter	Put a hot iron rod/panga on the affected feet and back and give herbs (advised to communicate with the LFO and vaccinate yearly*)*

Disease identification

The participants in each production systems were crosschecked on their understanding on disease, symptoms and management measures in their village. Under extensive production systems (table 28) producers were able to identify livestock diseases and they had significantly good knowledge about the symptoms and the causal reasons. For intensive and semi-intensive systems, producers had less knowledge (table 29) and depended more on livestock field officers (LFO). Following cross checking their understanding, participants were taken through each mentioned disease/condition briefly for them to at least understand the key symptoms and management measures as well as the advisory services to be considered during treatment.

Apart from knowing that ECF is spread by ticks, farmers also beloved that the disease was associated with certain pastures. Through probing, it was revealed that ECF cases occur when livestock are migrated to better pastures during the dry season to places where animals do not have access to dipping facilities against ticks. As for trypanosomiasis, participants explained this was due to grazing livestock along the river where there are shrubs and long grasses as well as the biting flies.

Following cross checking their understanding, participants were taken through each disease or condition for them to at least understand the key symptoms and management measures as well as the advisory services to be considered. To understand the negative impacts of the diseases on livelihoods, participants were asked to list and score the benefits of cattle, then to distribute the benefits to each disease using disease impact matrix score as follows.

Table 30 Disease impact matrix scores for Mwade village

Benefit	Score	ECF	LSD	FMD	CBPP	Heart water
Cash	42	5	9	13	4	8
Milk	19	-	-	12	7	-
Meat	10	-	7	-	3	-
Hides	5	-	3	-	2	-
Blood	7	All	All	All	All	All
Ruminal content	8	All	All	All	All	All
Fat (from beef)	9	-	6	-	3	-
Score	100	7	27	27	21	10

NB: All=All livestock diseases affect it because blood is only taken from ***visual clinically healthy*** cattle

In Mwade village (table 30), the livestock diseases with the highest impact on the benefits according to the participants were LSD and FMD with equal scores, followed by CBPP, heart water, and ECF and for any disease related intervention the action priority should be based upon the disease impact matrix score above. Four of them, CBPP, LSD, FMD and ECF were as well noted by the ***Leigwanani*** during individual herd proportional pilling for morbidity and mortality.

The farmers said that nobody will accept an animal with FMD. Even if it is given as a gift, it will be rejected as the disease spreads fast and brings high mortalities to calves.

In Twatwatwa village (table 31), CBPP has bigger negative effect to the benefits derived from cattle and hence affects the household livelihood followed closely by FMD and LSD. Anthrax and trypanosomiasis seemed to have less impact on the benefits. This could be due to occurrences of anthrax as outbreaks in foci and the endemic nature of trypanosomiasis in the area. For livelihood improvement, diseases to be addressed first are CBPP, FMD and LSD. However, trypanosomiasis may be carrying higher impacts than others due to hidden costs as well as less production from cattle (milk and meat) that is overlooked by farmers.

Table 31: Disease impact matrix scores for Twatwatwa village

		Losses associated with top five diseases of significance to pastoralists.				
Benefit	Benefits Score	CBPP	LSD	FMD	Anthrax	Trypanosomiasis
Milk	31	12	4	8	4	3
Money	16	4	3	5	2	2
Meat	13	3	5	2	2	1
Dowry	11	5	3	1	1	1
Ghee	8	3	1	3	1	0
Fat	7	0	0	2	0	5
Hide	7	0	7	0	0	0
Manure	4	1	1	1	1	1
Gifts	3	0		3	0	0
Total	100	28	24	25	11	12

In Kambala village (table 32), CBPP is the disease most affecting the livelihood benefits derived from cattle in the village. For cash income and milk production improvement, CBPP control needs to be first addressed followed by LSD, FMD, ECF, babesiosis, black quarter and trypanosomiasis in decreasing order for livelihood improvement.

Table 32: Disease impact matrix scores for Kambala village

Benefit	Score	CBPP	ECF	FMD	LSD	Babesiosis	Trypanosomiasis	Black quarter
Cash	18	5	2	4	3	2	1	1
Milk	30	8	3	7	7	3	1	2
Meat	7	2	1	1	2	1	0	0
Ghee	11	3	2	3	1	1	0	1
Blood	4	1	1	0	1	1	0	0
Dowry	15	3	3	3	3	2	0	1
Fat (from beef)	12	4	2	1	3	1	1	0
Penalty	3	1	1	0	0	1	0	0
Total	100	26	15	19	20	12	3	5

In Sindeni village (table 33), CBPP was found to be the livestock disease most affecting the household livelihood of the livestock keepers followed by ECF, anaplasmosis, FMD and babesiosis. CBPP was explained to be endemic in the area, ECF treatment and the vaccine are very expensive, anaplasmosis is treatable but difficult to be diagnosed in the early stages, FMD comes in the form of outbreaks with high mortalities in calves associated with reduced milk production and lastly was babesiosis with less occurrence frequencies and easily to be treated.

Table 33: Disease impact matrix scores for Sindeni village

Benefits	Benefits Scores	CBPP	ECF	Anaplasmosis	FMD	Babesiosis
Food	28	9	9	4	4	2
Cash	17	7	4	2	2	2
Manure	16	5	4	4	2	1
Dowry	12	6	3	2	1	0
Drought power	13	6	4	1	1	1
Hides	6	3	2	1	0	0
Fat from meat	8	5	2	1	0	0
Total	100	41	28	15	10	6

Table 34: Disease impact matrix scores for Manyinga Village

Benefit	Score	ECF	Anaplasmosis	Trypanosomiasis	Helminthiasis	Mastitis
Cash	28	10	9	4	2	3
Milk	40	12	12	6	5	5
Manure	12	4	3	1	2	2
Education	14	4	4	2	2	2
Agriculture	6	2	2	0	1	1
Total	100	32	30	13	12	13

In Manyinga village (table 34), the most challenging disease affecting the benefits derived from keeping cattle is ECF followed by anaplasmosis, trypanosomiasis, mastitis and helminthiasis.

Table 35: Disease impact matrix scores for Kwampunda village

Benefits	Benefits score	Anaplasmosis	ECF	Worms	Foot rot
Food	35	15	11	5	4
Cash	40	17	14	5	4
Manure	10	4	4	1	1
Dowry	15	4	6	3	2
Total	100	40	35	14	11

In Kwampunda village (table 35), anaplasmosis is the disease most affecting the benefits (food and cash income) and thus the disease to be first addressed to improve the livelihoods. This is associated with inadequate knowledge for early detection and reporting. The ECF is highly weighted due to its high treatment cost. Both conditions are spread by ticks and it was mentioned that the village dip tank was not working, which could be the main reason for the importance of these tick-borne diseases.

Table 36: Disease impact matrix scores for Kwangwénda village

Benefit	Score	Anaplasmosis	ECF	Black quarter	Mastitis	Prolapsed
Milk	31	12	8	6	3	2
Meat	16	3	9	2	1	1
Manure	32	8	11	5	0	8
Hide	13	0	10	1	0	
Dowry	8	0	2	4	1	1
Total	100	23	40	18	5	14

In Kwangwénda village (table 36), cash benefits from the sale of milk and fermented milk scored high at 31% for live cattle and meat at 16% in the form of slaughtered animals. Together with manure which they sell and use in their crops at 32% these are the leading benefits from cattle. Hides and dowry were ranked 13% and 8% respectively. Dowry is losing value as most people do not pay cattle immediately but instead they sell cattle and pay dowries in cash, so they will also retain some of the money earned from the sale. Dowry ranked last because they said paying dowry is not a must and it can take long before one pays. The high ranking of manure is because most of the farmers grow horticultural crops and need manure for their farms. The current price of manure is 50-100 TSh per bucket.

The diseases most affecting livelihood benefits from cattle are tick-borne anaplasmosis and ECF followed by black quarter. Participants mentioned that ECF and anaplasmosis are common leading to declines in production and loss of livestock. Anaplasmosis can be treated if detected early while ECF treatment is always difficult. The effect of ECF on hides was that, when a cow dies of ECF they bury the animal and the hide hence there is a total loss. This also applied to animals that died from prolapse as they consider it a bad omen. Tick-borne diseases are major challenges as participants lacked knowledge on tick control. Tick control is therefore an important intervention.

Table 37: Disease impact matrix scores for Kabuku village

Benefit	Score extensive	Anaplasmosis	Trypanosomiasis	Helminthiasis	ECF	CBPP
Food security	25	13	6	3	2	1
Manure	6	2	1	1	1	1
Income	55	20	16	11	5	3
Animal power	14	5	4	2	2	1
Total	100	40	27	17	10	6

In Kabuku village (table 37, participants practiced both production systems. Animal health is a constraint in cattle production within the village particularly for extensive farmers. The semi-intensive system suffers mainly from mastitis, reduced milk production from stress, and helminths due to poor hygiene, close animal contacts and small herd sizes. The costs of managing diseases was said to be high in both systems.

For the extensive system, due to movement when animals search grazing pasture, there is high contact with ticks and biting flies which leads to a higher incidence of diseases such as anaplasmosis and trypanosomiasis. These were followed in importance by helminths, ECF and CBPP. Anaplasmosis is always detected late, leading to high mortalities.

Animal health services

Animal health services were assessed under each production system to evaluate how often and how easily farmers can access veterinary services, the sources of drugs, treatment, vaccinations and information for animal health improvement.

Health services in extensive production systems

Mbwade village gets animal health services from Morogoro town, primary cattle markets in Kilosa district (Mbwade, Parakuyo, Ngaiti and Kivungu) and from Melela cattle market in Mvomero district. The services are provided by drug seller (cattle keepers with experience in treating their own livestock though without formal training in livestock treatment) and the distance generally ranges from 1 to 58 kilometres.

Respondents said that there is no health service provider in Twatwatwa village. Animal health services are accessed from primary markets (Parakuyo kibaoni - 35 km away and Mwade - 25 km away) and from Morogoro town. The main sources of information on animal health aspects are radio, newspapers, workshops and sometimes researchers. Vaccination services are provided by government in which the pastoralists are asked to prepare the cattle holding ground and pay some charges like transportation for the vaccinators.

Farmers in Sindeni village get animal health services like drugs, advisory services and treatment from the local animal health officer and local agro vets within the area. The local animal health officer is easily accessed by phone and comes to each area on a weekly basis. News on animal health issues are sometimes obtained through radio.

Elsewhere, such services are also obtained from the village livestock officer who lives and work in the village. Livestock keepers asserted that each of them is an expert in livestock health for his livestock herd (**'***kila mtu ni daktari wa mifugo yake'***)** as the art of treating animals is passed from father to son. Farmers also get veterinary services from agro vets located in Morogoro town and the primary livestock markets (Mkongeni cattle market).

Health services in semi-intensive and intensive production systems

In Manyinga village, veterinary services are available and accessible both from the local agro vet shops and from the village livestock extension/field officer. They have the village livestock field officer's phone number who responds promptly when called upon and has a vaccination and de-worming schedule for the area. The most common channels of getting news on livestock health are seminars and Sokoine University researchers who come once in a year. Person to person information exchange is also common.

Farmers in Kabuku village get animal health services from the local animal health officer and local agro vets within the area. The local animal health officer is easily accessed through phone and comes to each area on a weekly basis. News on animal health issues is sometimes provided via the radio. Similarly, participants in Kwampunda village get all

animal health services from the village auxiliary livestock officer and ward livestock field officer, who attends the sick animals on call and sometimes offers free services. They do not have an agro vet in the area to source livestock drugs and thus the animal health officer buys drugs and treats livestock himself. It is worth noting that farmers rely fully on him for all type of animal health support.

In Kwang'wenda village, animal health services are provided by ward and district livestock health officers, who attend sick animals on call. They access information on animal health via the radio and from livestock field officers

Public health

The focus group discussions also assessed the presence of common human clinical signs or symptoms (fever, anorexia, diarrhoea, vomiting, headache, etc.) that could be associated with consumption or improper milk handling. These signs may occur within 2 to 6 hours or more following milk consumption.

Public health issues in extensive production systems

Participants mentioned the following symptoms in the community, in descending order: fever 2) vomiting 3) diarrhoea 4) coughing.

They also identified milk-borne diseases (tuberculosis, brucellosis, Rift valley fever and typhoid fever) and zoonotic diseases (rabies, tuberculosis, anthrax, Rift valley fever and brucellosis). The general symptoms they mentioned for milk and waterborne diseases were abdominal pain, diarrhoea, vomiting, fever, malaise and coughing. They associated climatic change to the upsurge in many diseases.

Other diseases mentioned were malaria, HIV/AIDS and *sure* (measles). Malaria and fever were hard to distinguish among them so they generally referred to fever as malaria. It is possible that fever may include brucellosis, malaria, FMD and typhoid fever. There is some occurrence of carbuncles in humans which could also be associated with anthrax.

In Twatwatwa village, the disease symptoms in humans in order of prevalence were: fever, painful joints, change in voice, headache, difficulty in breathing and warm breathing, nausea and vomiting. They further mentioned severe fevers, TB, FMD, brucellosis, rabies and anthrax. Participants noted that pregnant women aren't allowed to drink milk from animals suffering from FMD, as it causes abortion and fever. There are no vaccination services for dogs because dogs are strays, without owners. They have good knowledge of TB and the way it is spread from animals to humans and humans to humans. There is general lack of boiling or filtering of milk in the community. Those who sieve milk presume that it is safe to consume.

In Kambala village, except for one person, all participants said it is impossible to spread diseases from animals to people and vice versa**.** The exception mentioned tuberculosis that can be got through milk consumption. Common human conditions mentioned by respondents were malaria, asthma, flu, coughing, TB, fever, diarrhoea, vomiting and weakness. These were ranked decreasing order of occurrence as: fever, malaria, diarrhoea, TB, vomiting, flue, coughing, asthma and weakness. Fever was ranked first because every condition they mentioned starts with fever.

In Sindeni village, the human diseases and symptoms in order of frequency occurrence were: fever, headache, coughing, malaise, malaria, loss of appetite, diarrhoea, amoebic dysentery, typhoid, yellow fever, and nausea and vomiting.

They considered fever as the first symptom of any disease which develops into a headache. Without treatment they said that headaches develop into coughs and malaise. If the above symptoms persist, malaria will develop leading to loss of appetite and diarrhoea. Amoebic dysentery and typhoid fever infection is from drinking unsafe water, particularly during the dry season, causing nausea and vomiting and stomach ache.

It was difficult for participants to distinguish diseases from symptoms hence the two are mixed in the ranking. Coughing is associated with TB, while loss of appetite and diarrhoea are associated with both typhoid and malaria.

Public health issues in semi-intensive and intensive production systems

In Manyinga village, participants said that diseases that can be transferred from animals to humans include tuberculosis, rabies, rift valley fever (RVF) and typhoid fever. They mentioned the following symptoms as common in the community, in descending order: body weakness, colds, coughs, fever, vomiting, and diarrhoea. The ranking was based on the view that the hard work they do means that everyone wakes up weak; colds are common because of climatic change and these lead to chest problems and coughs and fevers which result in vomiting and diarrhoea. Fevers, vomiting and diarrhoea may be associated with salmonellosis, campylobacteriosis and pathogenic E.coli.

In Kabuku village, the most common diseases and symptoms in descending prevalence were: malaria, typhoid fever, vomiting and diarrhoea, cholera (occurs yearly during the dry season), bloody diarrhoea (amoeba), and tuberculosis. They said that nearly everyone suffers from malaria each year, followed by typhoid because of poor hygiene and lack of clean drinking water. Diarrhoea and vomiting were associated with drinking unsafe milk and water, bloody diarrhoea associated with amoebic dysentery linked to lack of safe drinking water. Bloody persistent diarrhoea was said to be common, and TB was ranked low due to its prevalence only in groups who do not follow good milk hygiene practices and lack awareness on how it spreads.

In Kwampunda village, the disease symptoms in order of prevalence were: fever, malaria, abdominal pain, malaise, coughs, tuberculosis, diarrhoea, and vomiting. They identified fever as the most common symptom, developing into to malaria. Malaria will generally manifest symptoms like abdominal pain and malaise. Coughs were also very common and sometimes lead to TB. Diarrhoea and vomiting were mentioned as common due to changing climatic condition. While abdominal pain and fever were year-round, diarrhoea and vomiting are common during the dry season when clean water is scarce. It was hard for participants to distinguish diseases from symptoms hence the two are mixed in the ranking.

In Kwang'wenda village, the disease symptoms in order of prevalence were: body weakness, fever, malaria, typhoid, coughs, abdominal pain, diarrhoea, and vomiting. They said that almost everyone suffers from body weakness and fever; then they go to hospital they are usually diagnosed with either malaria or typhoid, owing to lack of safe drinking water. Diarrhoea was also associated with bad food, dirty water and typhoid, while vomiting and coughing were linked to fever and changing climatic conditions.

Since most food-borne and zoonotic disease are associated with frequently-ocurring symptoms like fever, diarrhoea, vomiting, abdominal pain and malaise, it is worth investigating the presence and prevalence of *Campylobacter spp, Brucella spp, enterotoxin E.coli spp, Listeria monocytogenes, Mycobacterium tuberculosis/bovis Salmonella spp(non-typhoid)* and *Toxoplasma gondii* to establish any links between these symptoms and the causative agents.

Milk-borne diseases and zoonoses

Discussions in the focus groups also assessed farmer understanding of zoonotic diseases and whether these could be linked to milk consumption. The focus was on milk and milk products consumption (milking, sources, transportation and storage).

Milk-borne diseases and zoonoses in extensive production systems

Most people consume raw milk and raw milk products like *mtindi*. They also consume rumenal juice and drink raw blood. These practices increase the risk of infection with pathogens and the spread of zoonoses, especially if consumed from sick animals.

Anthrax cases were reported and normally experienced in healthy cattle leading to sudden deaths. Participants also mentioned close contact with animals which equally increases the risk of TB. High levels of ***E.coli*** in rumenal content may be normal in cattle but not in humans. There is a belief among cattle keepers that due to the hard work they do, they will suffer from malaria, TB and other fevers. Through probing, this mortality could be associated with presence of anthrax foci in the area.

The culture to eat dead cattle without knowing the cause of death and the habit of pastoralists to undercook meat may predispose them to contract zoonotic diseases. Consumption of rumenal content juice as a treatment for malaria and to induce vomiting in sick people may be associated with typhoid and or other infections like diarrhoea and vomiting in the population. Some farmers drink fresh milk from their own herd as well as from others herds, increasing the risk of milk-borne diseases.

It was noted in Twatwatwa village that fermented milk prepared in calabashes from fresh milk takes 2 days during the wet season and one day during the dry season. The livestock keepers consume unpasteurized fermented and fresh milk. It was further established that they drink fresh blood from cattle by looking at the animal's health without considering the possibility of subclinical cases. This translates in a knowledge gap of subclinical cases which can result in transmission of diseases from animals to humans. Brucellosis is said to be common following occurrences of abortion in the third trimesters and severe fevers in human. This is always associated with witchcraft. Some people had no knowledge of the possibility of transmission of zoonosis while some eat meat from dead animals without knowing the cause of death, while others typically undercook meat. Farmers had no knowledge of the withdrawal period of drugs and they consume livestock products from animals under medication.

Participants in Kambala village mentioned that many people consume raw milk, ruminal juice (*emoyoo*), raw milk products, and fresh blood from live animals. Most of the community does not boil milk as they said they have been using it for many years without casualties. To avoid getting diseases like TB, a few of them filter the milk followed by boiling; though some believe filtering is enough.

In Sindeni village, participants were aware of zoonoses by mentioning diseases like TB, FMD, brucellosis, rabies and anthrax. They said that FMD leads to sores on lips and mouths, while tuberculosis causes persistent coughing. The TB mortality rate is very high and patients (mainly children) get admitted for 60 days for treatment in a referral hospital in Kilimanjaro region. Furthermore, they said that anthrax causes severe diarrhoea and vomiting and all who participate in eating the meat will be affected. One participant and his 4 in-laws had suffered from anthrax after eating meat from a dead carcass. It seems they have good knowledge of TB and the way it is spread from animals to humans and humans to humans. The proportion of those who boil milk among

participants was 4 from 11. This implies that most people consume raw milk which exposes them to zoonotic and milk-borne pathogens.

Most participants consume fermented milk (*mtindi)* from raw milk. One woman explained a typical way of milk consumption, in which she said "as you milk early in the morning, children always cry for milk as they are hungry which necessitate giving them fresh raw milk so that she can continue milking other cows". It was not strange to get a comment from one male participant that he knew TB as a disease of children. Fresh milk takes 2 days to ferment during the wet season while only 24 hours during the dry season. There is a general lack of boiling or sieving of milk in the community. Those who sieve milk presume that it is safe enough.

Consumption of raw and fresh blood from subclinical cattle may predispose livestock keepers, especially those lacking routine vaccination against diseases like anthrax, to zoonosis infection. It was noted that the fore stomach of goats is used to plaster and bandage patients suffering from an anthrax wound and that the bandage is then given to women to eat. Bandage consumption by women may predispose them to anthrax infection from bacteria or spores.

The farmers do not observe a withdrawal period after treating their livestock which may lead to microbial residues above maximum residue limit and consequent antimicrobial resistance. Consuming dead animals and half-roasting meat may increase the risk of food-borne illnesses to humans.

Milk-borne diseases and zoonoses in semi-intensive and intensive systems

Most people consume boiled milk in Manyinga village. Every farmer insisted on practicing hygienic milking practice, with only cats and dogs fed on milk from cows under treatment till the end of the withdrawal period. In Kabuku village, participants were aware of zoonoses and identified rabies, tuberculosis, anthrax, Rift valley fever, avian and swine flu. One farmer said his nephew was diagnosed with anthrax after eating meat, but was treated and recovered.

Tuberculosis was said to be associated with the consumption of raw milk, undercooked meat from infected cattle and lack of milk sieving. Milk sieving is seemingly believed to reduce pathogens in milk. One participant said that "some people consume raw unpasteurized milk alleging that it is a medicine".

Participants in Kwampunda village were knowledgeable on hygiene milking practices and the need to observe the drug withdrawal period in lactating cows. Participants had little knowledge of zoonoses although high TB incidence was mentioned with participant family members suffering and the disease attributed to consumption of raw milk and milk products. TB was the only known zoonotic disease, with only one participant aware that TB is transmitted by inhaling breathing droplets of infected cattle when one share house with cattle.

They generally believed that raw milk is safe after filtering and could not link raw milk consumption to any diseases. Participants had no knowledge of other zoonotic diseases like anthrax, brucellosis, rift valley fever or salmonellosis. Participants generally don't boil milk unless it is for tea or porridge. Milk for *mtindi* making is sieved then poured into a fermentation container without heat treatment. They allege that milk can only make *mtindi* when not boiled and that boiling gives a bad flavour. The increased time in fermenting milk is due to reduced fermenting microbial population during boiling.

Milk consumption by villagers is relatively less as children are mostly fed on porridge with milk and the main milk product consumed by the general household members is *mtindi* – fermented milk. Participants mentioned that nearly everyone share houses with cattle for security reasons. This practice was observed as a possible exposure route to TB through pulmonary route, and other GIT pathogens like pathogenic *Campylobacter jejuni*, *E.coli* and salmonellosis from cow dung.

In Kwang'wenda village, participants were aware of the presence of TB and its spread via aerosols from infected cattle breath. Many participants have had TB patients in their homes and they mentioned how difficult it is to treat the disease. Currently TB was mentioned to be prevalent in the village. The participants generally don't boil milk with the perception that sieving milk takes away all the germs. Milk for *mtindi* making is sieved then poured into a fermentation container without heat treatment. They allege that milk can only make *mtindi* when not boiled and that boiling gives a bad flavour.

Participants had no knowledge of other zoonotic diseases like anthrax, brucellosis, rift valley fever or salmonellosis.

From the discussions, it seems that the zoonosis knowledge gap is so large that there is a need for training on food and milk handling hygiene to reduce exposure.

Discussion and conclusions

Focus group discussants greatly depend on livestock and livestock's products for their livelihoods in the study area. Cattle kept are the Tanzania shorthorn Zebu and exotic cross-breeds under extensive and semi-intensive and intensive systems. The Zebu produces less milk, though numbers kept are high compared to the cross-breeds which are kept in smaller numbers but with relatively higher production. Under each system, several constraints were elicited which affect production or have an impact on the benefits farmers derive from cattle keeping – issues mainly linked to pastures and feeds, diseases, breeding, markets and animal health services.

Natural resources in the 8 villages

All villages included in the study are endowed with natural resources such as rivers and forests which offer potential for agriculture and are sources of feed and water for livestock. From the forests, farmers get better access to livestock feeds while agriculture serves as a source of crop residues for animals, especially during droughts or periods of feed shortage. Some villages such as Manyinga, Kambala, Sindeni, Kwang'wenda and Kwampunda are situated near basins that could serve as sources of water for irrigation to cultivate green forages like elephant grass. These are potential as entry point for interventions for livestock feed and hub formation projects.

With the exception of Kambala and Kwang'wenda villages, all the villages have electrical power supply that could also facilitate the availability of milling machines for maize bran. This is also an opportunity for livestock feed improvement to enhance production and installation of chill plants or collection centres for boiled milk. Roads are important for transportation of milk from producers to consumers and collection centres.

Land use management is regarded as a solution to the free movement of livestock. Handeni district was a pilot area under the government program on property and business formalisation commonly known as *MKURABITA* in which resources such as land was well allocated and demarcated to individual farmers. It was anticipated that this would reduce some of the conflicts between livestock keepers and crop producers as well as reduce opportunities for livestock movement searching for pasture. However, farmers lack control of the demarcated land. Formulation of by-laws to protect land and other formalized resources is recommended.

Value chain mapping with producers

Milk production varied with the season. Production was high in the rainy season while almost all villages experience low milk production during the dry season beginning from the last week of July to October. High milk availability in the long wet season under the extensive system allows installation of chill plants in areas such as Twatwatwa, which could be shared by neighbouring villages of Mbwade and others not included in the study.

Kwang'wenda village in Lushoto district had different trends as milk production is low in January and February. In Manyinga village for instance, during the long wet season less milk is produced because despite the abundance of pastures, these pastures are lush, with low dry matter content, hence low dry matter intake. Farmers are also highly engaged in crop farming activities, hence they have less time available to feed and care for their animals. During the short wet season there is nutritive pasture, farmers spend less time in their gardens and more attention is given to the cattle, hence more milk is

produced and sold. Milk vendors in Kambala village supply milk to Tan Dairies located in Dakawa highway and restaurants in Dakawa. Similarly, Kambala farmers used to sell milk to Shambani milk collection centre which is currently not operating. Other vendors sell milk within Kambala village and at Turiani town.

The price offered by the collection centres is low compared to restaurants and individual households. Based on this, some farmers, mainly from extensive production systems like Kambala village sell milk at Turiani (Madizini Town) which is 30-40 km away. While Madizini area is a potential market for Manyinga farmers (semi-intensive) the Kambala farmers flood the market by selling at relatively low prices. Formulating a milk marketing hub would allow dialogue between the collection centres and producers especially in price setting, allowing producers to cover their production costs. This is especially important for farmers in semi-intensive systems where production costs are higher.

Vendors revealed that most of the milk is sold to collection centres namely Tan-Dairies/DESA and Tanga Fresh, households and restaurants. Among other challenges faced by vendors is a lack of transport. Most use bicycles and therefore vendors cannot collect milk from distant farmers. Using plastic containers to collect and transport milk from producers to collection centres increases the chances for contamination and sometimes the milk fermenting, hence the rejection rates at collection centres. Formulating marketing hubs could improve all value chain nodes, including equipment and working tools for vendors.

Payment is mainly through bills whereby vendors supply milk at the collection centre and payment is done after two weeks. This was partly accepted by some of the vendors and producers as they receive a lump sum rather than daily cash. However, some farmers and vendors preferred cash so they could meet their daily requirements. Nonetheless, some collection centres such as the Tanga Fresh agent in Sindeni village closed the centre without paying money they owed to farmers. This is a big challenge to both farmers and vendors requiring that farmers have a strong association, formally registered, that can enter into formal agreements with collection centres before delivering milk at the centre. Farmers in semi-intensive systems sell milk on a cash basis; however, sometimes they provide check off for 7 days or less.

Gender roles, decision making and livelihood analysis in livestock production

Gender roles are specific and well-demarcated between men and women in extensive systems in Mbwade, Twatwatwa, Sindeni and Kambla villages. All important decisions are made by men and control of income from sale of live animals is done by men. However, decisions related to milk and milk products are made by women. Similarly control of income accrued from sale of milk is done by women; however it was apparent that commercialisation of milk sales leads to men getting integrated in the decisions as more money is earned. Traditionally milk sale is purely a women's role and they could use sales to buy cattle or sheep and goats, which belong to women, but men will still have control of all the cattle or sheep and goats in the household.

In the intensive and semi-intensive systems, gender roles are shared between men and women (Kabuku, Manyinga, and Kwang'wenda and Kwampunda villages). Decision making in intensive production system is done by both men and women. This is an opportunity for women to process milk into other products. Furthermore, communities in Kwampunda and Kwang'wenda villages are matrilineal society where women are

culturally endowed with power in various aspects at home. Women have the support from husbands to make butter, yoghurt and cheese that could be sold within Lushoto district because the district is currently a tourism area. Despite milk availability, there is neither milk collection centre nor cooperative where they could sell the excess milk.

Breed management

Most participants wished to keep pure exotic breeds of animals because the current improved breeds are not producing more milk as expected. However, looking at the management practices offered to the animals, less milk production was due to poor feeding. Furthermore, use of one bull in some of the villages such as Manyinga and Kwampunda increased the chances for inbreeding.

Maasai people were not willing to change their local (Zebu) breeds to improved ones because of a reluctance to reduce the size of the herd. They also believe that milk from indigenous breeds is better than from improved/exotic breeds. However, most were willing to keep Boran type of breeds because of their high growth rates and higher market prices.

AT challenges such as low conception rates could be solved at the national level, but sources of bulls and probably storage of semen is a challenge. Lack of a reliable supply of liquid nitrogen to maintain the required conditions in semen storage containers might be a reason for low conception. Low knowledge of farmers in detecting when a animal is in heat, especially in the rainy season when agro pastoralist are busy with farming activities might be another reason for low conception.

Feed availability

Participants in Kwampunda, Manyinga and Kwang'wenda and Kabuku villages revealed that their cattle do not eat dry grasses. However, some participants said that they mix dry feeds with salt and water so as to make the feeds more palatable. This indicates a lack of knowledge on feed availability and quality. Furthermore, farmers consider forages as the only feed for cattle. This was noted in all villages visited whereby farmers only feed crop residues when other feed is not available, for instance in the dry season.

Epidemiology

Animal health should be the first priority as part of a one health philosophy which will minimize human risks associated with keeping cattle as well as consumption of products derived from cattle like zoonotic diseases. The identified lack of animal health services as well as the public health risks put farmers and the public at large at risk of milk-borne and other zoonotic diseases. The likelihood of unsafe food consumption, especially from cattle products (milk and meat), is high due to lower quality animal health services.

Symptoms of illnesses caused by various bacteria commonly found in raw milk include vomiting, diarrhoea, abdominal pain, fever, headaches and body aches - which were all identified by participants during the interviews. Producing and consuming safer food, especially from animal products, requires education focusing on animal health and management husbandry, zoonotic diseases, meat consumption, milk consumption and handling. This could be done through establishment of decentralised animal health systems, vaccination programs, farmers groups and further studies to confirm the study findings on public health. Last but not least, it is critical to look at hygienic milking procedures, consumption habits (milk, blood and dead carcass), milk storage (for home use and for selling) and milk transportation.

Findings

Value chain mapping with producers in extensive system

- Livestock keeping is the most important source of livelihood in the extensive system among the farmers (Twatwatwa, Mbwade, Kambala and Sindeni villages), contributing to cash income and food security.
- Milk marketing is highly seasonal and the downstream marketing system cannot accommodate seasonal peaks. This interferes with orderly marketing, affecting breed and feed scheduling decisions. Low milk production in the dry season is partly caused by shifting cattle from the village to areas with pastures and water (transhumance system), hence strategies to collect milk from areas outside the village (following transhumance routes) would maintain milk availability to the collection centres and other channels.
- Most farmers sell milk to neighbours and restaurants due to the high prices offered by these channels.
- Some non-transparency exists among (the very few) value chain actors, which contributes to variability and unreliability of prices and sales channels. This increases uncertainty for producers, as well as vendors and market actors.
- Presence of electricity in 7 villages (except Kambala) is an opportunity to install chilling plants before milk is taken to established markets.
- Low prices offered at collection centres (Tanga Fresh and Tan Dairies) and unpredictable price fluctuations are problems to vendors and producers.
- Milk purchase and sale by vendors can provide employment for many young men in Mbwade and Twatwatwa villages.

Availability of organisation of farmers

- A livestock producer's group (KIWASI) is active and its activities can be improved under a hub approach in Sindeni village.
- The livestock keeper's association (UWAKA) is an opportunity for awareness creation to increase producers' bargaining power in Kabuku village.
- A farmers' association in Kambala village would be an opportunity to improve many challenges facing farmers in the area. Some existing associations seem to be inactive.

Value addition

- Only one woman is fermenting milk and selling it at a high cost compared to fresh milk. This is an opportunity for other producers to add value on fresh milk thus acquiring more income especially in the long wet season.
- There are many women processors of fermented milk in Sindeni

Value chain mapping with input suppliers

- Inadequate or absence of input suppliers in some of the village (Sindeni and Kabuku) creates high demand for inputs such as veterinary drugs.
- The high price of veterinary drugs and other important inputs is a stumbling block to livestock development.

Feed availability

- Both calving periods and milk production are seasonal and are largely controlled by feed availability. Calving is high during the months of October to December and milk production in the months of January to March.
- Land scarcity and marketing of milk were mentioned to be the major constraints to livestock production in Twatwatwa village.
- Seasonal feed availability was noted whereby farmers conserve maize crop residues. Knowledge is lacking on how to conserve and use the abundant feed available in the long wet season in almost all villages.
- Land demarcated in Sindeni village is seen as an opportunity; however, there is also free grazing. Fencing farms and practicing rotational grazing through padlocking could help conserve pastures and minimise the problem of feed scarcity in the dry season.
- The availability of molasses in Kabuku and Manyinga villages is an opportunity that could be utilised to improve intake of conserved grasses and hence nutrient intake by animals.
- Knowledge on how to feed dry grasses is required in Kabuku, Manyinga, Kwang'wenda and Kwampunda.
- Participants said they have no knowledge on many feeding practices and breeding aspects. In most cases they mentioned the need for assistance in terms of capital to buy seeds for growing green fodder crops (Kwampunda village).
- There is a general lack of knowledge on feed conservation and feed quality among farmers.

Breeding management

- The need for change in breeds from improved to pure exotic breeds was noted because of low milk production. However, management practices such as poor feeding and general management was assumed to be the reasons for low production.
- The unwillingness of Maasai communities to change their indigenous breeds was voiced in Sindeni, Mbwade, Twatwatwa and Kambala villages, however, they are willing to keep Boran breeds.
- Low conception rate when using Artificial Insemination (AI) was reported by participants in Kabuku, Manyinga and Kwang'wenda villages, probably due to lack of awareness of what's needed for successful AI.
- Lack of knowledge to control inbreeding was observed in Kambala, Mbwade, Twatwatwa, Sindeni and Kwampunda villages.

Gender roles, decision making and livelihood analysis

- There is a clear division of gender roles between men and women in extensive systems in which women spend many hours managing livestock (Mbwade, Twatwatwa, Kambala and Sindeni villages). In semi-intensive and intensive systems, gender roles related to livestock management are shared by both men and women.
- Decision making power on various issues related to livestock is entirely with men in the extensive system. This includes decisions on inputs, production activities (livestock and crops) as well as marketing of outputs. Decisions are made jointly in semi-intensive and intensive systems.
- Income acquired after selling of milk is controlled by women in both systems.

Participatory epidemiology

- Under extensive production systems, pastoralists have a relatively good knowledge of animal diseases. This could be because the reported diseases are endemic. Diseases reported included viral (FMD and LSD), bacterial (black quarter and anthrax) tick-borne (ECF, anaplasmosis, heart water and babesiosis), trypanosomiasis and CBPP. Villagers ranked disease impacts on livestock benefits between 25 and 57%, mainly from CBPP, ECF and LSD.
- Under semi-intensive and intensive production systems, farmers had less knowledge on disease causation. However they benefit from closer proximity to livestock field officers who help diagnose and treat diseases. Frequently reports diseases and conditions included tick-borne disease, mastitis and worms. Villagers ranked disease impacts on livestock benefits up to 40%, mainly from tick-borne diseases in particular ECF and anaplasmosis.
- Under extensive systems, farmers have existing veterinary knowledge inherited from earlier generations. Since they are completely dependent on livestock for their livelihoods they know a lot about diseases and their animals. However, they have less knowledge to distinguish between diseases and the clinical signs, mixing symptoms with illnesses. Since they do most diagnosis themselves, the treatments are likely to be more based on symptomatic assumptions or trial and error, probably leading to drugs misuse.
- Under extensive systems, most of the drugs used, apart from trypanocides, are broad-spectrum antibiotics covering a range of bacterial infections. Viral, mycoplasma and tick-borne diseases thus tend to remain the major problem in these areas. By contrast, producers in semi-intensive and intensive systems have less knowledge of disease causation but can call on trained advice. Their main problems are more to do with the high cost of treating livestock and the high impact from anaplasmosis due to late recognition of the disease.
- Generally, there are few proper animal health services available to farmers in extensive production systems. Livestock keepers source drugs from informal drug sellers and primary livestock markets. In some areas, there are no livestock field officers, no vaccination programs, and inadequate dipping facilities. Under semi-intensive and intensive systems, the situation is better. Producers are closer to livestock field officers, the can access formal agro vets shop, some have vaccination programs and because they keep fewer cattle, these can be sprayed against ticks and biting flies (instead of being dipped).
- Animal source human health problems and risks identified included human tuberculosis, anthrax and typhoid which could be associated with consumption of livestock products especially milk and meat. Inadequate knowledge about zoonoses, especially in extensive production systems, increases the possibility of infection from livestock to humans.
- Some risky practices and beliefs were: Raw and unpasteurized milk was said to be medicinal, most people do not pasteurize milk, children are given raw and unpasteurized milk early in the morning, TB was said to be a disease of children, milk for fermentation need not be pasteurised as it loses flavour and taste, filtering and sieving milk makes milk safe from harmful bacteria, no human can be infected from the same diseases affecting livestock, hard work leads to TB occurrence in humans, and fresh blood from cattle is highly nutritious (generally true, unless the animal is sick).

Recommendations

Genetic improvement

- Establish the potential of existing breeds of animals for milk production and identify the real causes (genetic versus environmental) for the sub-optimal milk production.
- Strengthen farmer groups to increase their awareness on using AI instead of natural breeding.
- Provide affordable AI services to all farmers.
- Change the attitude of farmers towards the use of AI, through awareness and training on early heat detection and proper storage of semen, to increase conception rates of animals when using AI.
- Decentralise liquid nitrogen to allow easy availability of AI services. ie. Establish small AI units in regions to serve the dairy sector.

Collective action

- Raise awareness among producers on the benefits of collective action to attract buyers of milk and sellers of services and inputs, particularly credit.
- Join up with existing initiatives, such as in Kambala village where the program known as DADPS introduces improved bulls and helps create a farmers' association dealing with feeds.
- Form or strengthen farmers associations in all villages. The association would be used to form community-based market hubs. Concerted effort in the management of a farmer-based hub is required in collaboration with the local government and private sector to ensure sustainability. Farmer-based associations should be linked to the umbrella farmers association known as MVIWATA.
- Form womens' groups for them to acquire knowledge on issues related to hygienic milk handling for improved markets. Milk processing is another important intervention to increase the shelf life of milk and provide income for improved livelihoods. Women development groups can deliver empowerment skills, especially in the extensive systems.
- Bring these take home messages to farmers: hygienic milking procedures, good consumption habits (milk, blood and dead carcass); safe milk storage (for home use and for selling) and suitable milk transportation.

Feed availability

- Provide training on how to conserve feeds and the importance of using feed concentrates such as molasses.
- Organise on-farm demonstrations on planting, screening of appropriate fodder plants for the area and managing fodder plants. Screen for high producing fodder species for the area.
- Educate livestock keepers on hay making and how to use it as feed.
- Formulate by-laws in areas where land is formalised (Handeni District) to avoid free movement of cattle.
- Influence the government to improve and increase the number of extension staff delivering quality services to farmers on issues related to alternative feed sources and feed conservation practices.

Market development

- Establish market centres for selling milk in some villages (Kabuku is beside the highway where it could easily transfer milk to other areas).
- Develop hubs that provides inputs and services, knowledge on breeds, feeds animal health, milk quality, management, financial services) for increased productivity.
- Link up with Tan-Dairies in hub formation. They also have a veterinary section which could be used as source for veterinary inputs suppliers.
- Promote the use of stainless steel equipment to store and transport milk.
- Introduce Boran bulls to attract men to participate in the hub.
- Introduce mobile milk collection chilling tanks and trucks to enable constant supply of milk during dry season, especially following the transhumance route in the extensive production system.

Animal health services

- Activate the animal health system at village level through Community Based Animal Health Workers (CAHW's) scheme linking government livestock officers with livestock keepers.
- Select, train, certify and equip the CAHW's and connect them with formal drug stores as a reliable source of veterinary drugs as well as a continual learning centre.
- Establish farmer-managed dips for tick control (as is done in Sindeni).
- Under semi-intensive and intensive systems, the animal health services are easily accessible and mainly provided by both government officers and the private veterinary suppliers. Greater emphasis should be in the quality services, advice on breeding, feeding and good husbandry management systems.

Compulsory animal vaccination

- Diseases, mainly CBPP, LSD, FMD and ECF, need extra attention.
- In collaboration with the respective authorities, contribute to the compulsory fight against CBPP and LSD to ensure that farmers do vaccinate their animals. Assess the available cold chain and use trained CAHW's to mobilize farmers and carry out vaccination at least for 2 consecutive years.
- For ECF, use the trained CAHW's to mobilize farmers to vaccinate using the currently recognized vaccine. Lobby for funds to subsidize the vaccine price (cost sharing with farmers).
- Introduce vaccination against anthrax, black quarter and rabies found to be endemic in these villages.
- Raise farmers' awareness about ECF and about the vaccine availability; train one ECF vaccinator in each village, equip them and connect them to the supplier.
- For diseases control, especially tick borne diseases (babesiosis, anaplasmosis and heart water) as well as trypanosomiasis, given the herd sizes owned, rehabilitate existing dip tank(s) and commercially run by the farmers group(s).

References

Covarrubias, K., Nsiima, L. and Zezza, A. 2012. Livestock and Livelihoods in Tanzania. A descriptive analysis of the 2009 National Panel Survey. A joint paper of the World Bank, FAO, AU-IBAR, ILRI and Tanzania Ministry of Livestock and Fisheries Development. LSMA-ISA Integrated Survey on Agriculture.

Lyimo, H.L. N., Mtenga, L. A., Kimambo, A. E., Hvelplund, T., Laswai, G.H. and Weisbjerg, M.R. 2004. A survey on calf feeding systems, problems and improvement options available for the smallholder dairy farmers of Turiani in Tanzania. Livestock Research for Rural Development. http://lrrd.org/lrrd16/4/lyim16023.htm

Njombe, A.P and Masanga, Y.N. 2009. Livestock and Dairy Industry Development in Tanzania.

Nombo C.I and Sikira, A.N. In Press. Gender issues in dairy and beef value chains in Tanzania.