Assessment of animal feed resources in Tanzania

UHURU NA UMOJA

TANZANIA LIVESTOCK MASTER PLAN BACKGROUND PAPER

BILL & MELINDA GATES *foundation*

Assessment of animal feed resources in Tanzania

Nathaniel Mbwambo[1], Salim Nandonde[1], Conrad Ndomba[1], and Solomon Desta[2]

[1] Ministry of Agriculture, Livestock and Fisheries
[2] International Livestock Research Institute

May 2016

Editing, design and layout—ILRI Editorial and Publishing Services, Addis Ababa, Ethiopia.

Cover picture: ILRI/Elisabeth Kilian

ISBN: 92–9146–512-7

Citation: Mbwambo, N., Nandonde, S., Ndomba, C. and Desta, S. 2016. *Assessment of animal feed resources in Tanzania*. Nairobi, Kenya: Tanzania Ministry of Agriculture, Livestock and Fisheries and International Livestock Research Institute (ILRI).

Patron: Professor Peter C Doherty AC, FAA, FRS
Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

Box 30709, Nairobi 00100 Kenya
Phone +254 20 422 3000
Fax +254 20 422 3001
Email ilri-kenya@cgiar.org

ilri.org
better lives through livestock

ILRI is a CGIAR research centre

Box 5689, Addis Ababa, Ethiopia
Phone +251 11 617 2000
Fax +251 11 667 6923
Email ilri-ethiopia@cgiar.org

ILRI has offices in East Africa • South Asia • Southeast and East Asia • Southern Africa • West Africa

Contents

Tables

Acknowledgments

The authors would like to thank the office of the Regional Administrative Secretariat of Mwanza, the Department of Animal Science at Sokoine University of Agriculture, particularly to Germana Laswai and Ephraim Mtengeti, and lastly to NAFORMA project of the Ministry of Natural Resources, with a special thanks to Nurdin Chamuya.

The authors would also like to thank the Bill and Melinda Gate Foundation whose financial support made this project possible.

1. Introduction

Feed is one of the critical resources that determine the potential for growth in the livestock sector. Tanzania is endowed with abundant natural resources such as rangelands, grasslands, woodlands and bush and shrub lands in which a large resource base for animal feeds including natural forages and legumes are found. Additionally, the cultivated land is an important source of feeds in form of crop residues and later industrial by-products. The available feeds from these diverse sources support the country's livestock resource base estimated to be 28.9 million cattle, 16.7 million goats and 5.0 million sheep. Other livestock kept in the country include 1.9 million pigs, 72 million indigenous and commercial poultry, 0.6 million donkeys and 4.5 million ducks, guinea fowl, rabbits and other livestock species (National Bureau of Statistics 2012; Tanzania Livestock Sector Analysis 2016).

Utilization of grazing lands for sustainable livestock production is hampered by seasonal variations of quality and quantity of forage, uncontrolled burning, overgrazing, imperfect designation of grazing lands, tsetse fly and tick infestation. Weak pastoral and agro-pastoral organizations, inadequate livestock services, credit facilities and socio-economic services, and weak infrastructure also limit the utilization of poorly designated grazing lands (URT 2007).

The availability and use of feeds to a large extent depends on rainfall, temperature and humidity variations which in turn vary with agro-ecological zones and the livestock production system. The country has diverse agro-ecological zones namely highlands, humid to sub-humid; sub humid to semi-arid; and semi-arid based on altitude, precipitation pattern, length of growing period (LGP) and average water holding capacity of the soils and physiographic features. Crop and livestock production is the dominant economic sector providing livelihood, income and employment to over 80% of the population (MLFD 2012).

The livestock industry can broadly be categorized as traditional extensive and commercialized intensive production systems. The intensive or commercialized system, though limited in size, has been receiving more in investment and improvement because of its contribution to the market-oriented economy. But the traditional extensive system, which comprises agro-pastoralism and pastoralism, remains the dominant production system even though its reliance on seasonal availability of forage and water has resulted in unregulated (due to weakening of traditional pastoral institutions and shrinkage and loss of grazing lands to other non-pastoral uses) livestock mobility.

A third category, the semi-intensive production system which combines the intensive and extensive production systems and allows partial confinement of animals or free-ranging is also being practiced in areas where mixed livestock and crop farming is carried out. It is estimated that over 98% of Tanzania's ruminant population is kept under traditional systems of management using communal grazing practices mostly in natural pastures. However, natural pastures are characterized by low productivity due to the predominant year-round presence of coarse and early maturing grasses that have low feed value. Indigenous forage legumes, which have higher feed quality than grasses, are scarce and poorly distributed throughout the year, and are in short supply in the dry season. These factors result in low productivity of animals foraging on these pastures.

Only 4% of the country's ruminants are raised under the semi-intensive and intensive commercial production systems. The semi-intensive system of ruminants production is mostly in large-scale ranches and dairy farms while ruminants under the intensive commercial system are kept in feedlots (for beef cattle) or under zero grazing (dairy cattle).

The non-ruminants, mainly poultry and pigs, are also divided into traditional extensive and commercial intensive production systems. The extensive or traditional system of poultry keeping is the largest, contributing over 50% of the flock and supplying most of the poultry meat and eggs consumed in rural areas and about 20% in urban areas. Intensive or commercial poultry and pig production is mostly practiced in urban and peri-urban areas and relies on compounded feeds or formula feeds, which are expensive because of competition between human and animal food needs for the raw materials used in making them—mainly maize, fish-meal and sardines.

It is important to estimate demand and potential supply of animal feed resources in order to accurately assess the growth potential of the livestock sector. Using the potential demand estimated for animal products in the livestock sector over the past 15 years and their competitiveness, the growth potential for the supply of animal products can be compared to the availability of feed resources for the animals, health constraints and genetic potential. Analysis of the feed demand and supply will provide the basis to generate empirical evidence on availability of feed that can support the current as well as projected livestock population using the feed analysis in the Livestock Sector Investment and Policy Toolkit (LSIPT). Thus results of these analyses will be used to support the case for the development of the livestock production sector at the national level and in different livestock production zones (typologies) of the country.

2. Current situation on animal feeds resources

The main animal feeds resources available in Tanzania mainland are classified into roughages and concentrates. The roughages include pastures (natural and planted), trees, shrubs, conserved forage, crop residues and agro-industrial by-products. Concentrates include cereal grains and related by-products, agro-industrial by products, brewer's waste, plant protein seeds, seed cake and animal proteins (fish and blood meal). These feed resources are abundantly available during the wet season but inadequate in the dry season of the year.

2.1 Roughages

Roughages are grouped into natural pasturelands or grasslands and established pastures. As mentioned previously, the main source of feeds for large ruminants in Tanzania is natural pastures in rangelands, which are abundant during rainy season and diminished in the dry season. Since most natural pastures are located far from homesteads, animals require long periods of grazing for body maintenance and production needs. Furthermore, an increase in human and livestock population has diminished the size of land holding consequently diminishing the size of pastureland and escalating cases of conflicts between farmers and livestock keepers leading to uncoordinated multiple uses of rangelands. In addition, it is estimated over 30% of total rangeland is still tsetse fly infested, making it unsuitable for human settlement and livestock production. However, most of the tsetse fly infested areas are found in protects forests and wildlife parks.

Natural pasturelands

Natural pasturelands are characterized by low and seasonal rainfall (usually 760 mm or less annually) and high evapotranspiration potential (over 1800 mm a year). *Themeda* and *Hypperhenia* grass species and meagre herbaceous forage legumes dominate pasturelands in the country (Thomas 1973).

A basic shortcoming of natural grasslands as a source of feed for ruminant livestock is their low production in terms of dry matter yield due to a combination of the negative effects of inadequate rainfall and the dearth of soil nitrogen on plant growth (Russell 1966; Wigg, Owen and Mukurasi 1973). The seasonality of plant growth, which reflects the annual rainfall distribution pattern, further restricts the availability of herbage for grazing animals to four or five months of the wet season over most of the natural grasslands.

Another shortcoming of the natural grassland is the low quality of the herbage. Results from an investigation in which Karue (1974) determined the nutritive values of grass species from similar grasslands in Kenya showed that, for most of the grasses, available energy and crude protein fell short of the animal's (Boran cattle) nutritional requirements during both the dry and wet seasons. In a review of the nutritional value of tropical grasses and fodders, French (1957) observed that: (i) irrespective of area in the tropics, or of grass species under consideration, the highest crude-protein values are recorded during the wet season; and (ii) tropical grasses often develop not only a high proportion of carbohydrates but also a high lignin content at an early vegetation stage and the lignin reduces the overall digestibility of the grasses.

Considering both their size and their role as the source of feed for most of the country's ruminant livestock population, national rangelands and grasslands are, nevertheless, an important resource in Tanzania. Their improvement through better management and utilization, bush and tsetse fly control, increasing the content of forage legumes (including suitable browse species), and providing adequate water supplies could, by themselves, considerably raise the production efficiency of ruminant livestock in the country.

Established pastures

The planted pastures in the country comprise a very small proportion of the total land area under cultivation. These pastures are found on dairy farms such as Kitulo (Iringa) and Sao Hill and Pasture Seed farms of Vikuge (Coast region) and Langwira (Mbeya region). There are also potential private pasture farms emerging in recent years across the country, and the trend is encouraging. Table 1 shows the various types of planted pastures and the plant species grown. Overall, they are much more productive than natural grasslands and form the basis of the non-traditional dairy industry in the country.

The temperate pastures deserve special mention because of their high potential for improving dairy production in the high-altitude areas. Presently only 5000 ha out of a total of 29,000 ha of available land in Kitulo is under planted pasture with a carrying capacity of 1 ha/livestock unit* yielding, on average, 8 kg milk per day (The Tanzania Industrial Studies and Consulting Organization 1983). The Tanzania Industrial Studies and Consulting Organization (TISCO) also estimated (1983) that with good management and utilization the same pastures could support 1 livestock unit/0.5 ha, yielding an average of 10 kg milk per day.

* 1 livestock unit = a mature Tanzania Shorthorn Zebu weighing 350 kg.

Table 1. Types of planted pastures and plant species grown

Pasture type	**Grass species**		**Legume species**
Temperate pastures	*Perennial ryegrass*		White clove
	Lolium perenne		
	Dactylis glomerata		
	Festuca arundinacea		
	Avena sativa		
Sub-tropical pastures	Chloris gayana		Desmodium intorum
	Panicum maximum	Desmodium sandwicense	
	*Pennisetum purpureum	Neonotonia wightii	
	*Setaria splendida	*Medicago sativa	
	*Tripsacum laxum		
	*Zea mays		
Tropical pastures			
(a) Humid-sub-humid	*Chloris gayana*	*Pureraria phaseloides*	
	Setaria anceps	*Neonotonia wightii*	
	Panicum maximum	*Desmodium spp.*	
	**Pennisetum purpureum*		
	*Tripsacum laxum		
	*Zea mays		
	*Sorghum		
(b) Sub-humid to semi-humid	Chloris gayana	Stylosanthes gracilis	
	Cenchrus ciliaris	Centrosema pubescens	
	Cynodon plectostachus	Rynychosia sennarenis	

Sources: Madallali 1974; Mwakatundu et al.; TISCO 1983

2.2 Concentrates

Tanzania produces substantial amounts of cereals and root crops. Because of their high content of readily digestible carbohydrates, they are valuable feeds for livestock, especially the monogastrics. However, they are produced primarily for human consumption and some of them are in short supply in the country. In addition, some of them are used in the brewing industry and others (especially cassava) are used in manufacturing starch. Appreciable quantities of cereal grains are also exported to neighbouring countries.

Cereal and root crops are used to compound animal feeds to feed various livestock species in the intensive system of production. Significant feed compounding in Tanzania was started in 1971 by the National Milling Corporation (NMC) and later by the Tanzania Animal Feeds Company (TAFCO) which took over from the NMC. Both parastatals are now defunct. TAFCO used to produce 80% of the country's feed requirement. At that time, the private sector played a minimal role in the industry. When TAFCO collapsed in 1992, the feed industry also collapsed because the private sector was not ready to take over feed manufacturing. Starting in 1992, numerous small feed manufacturers emerged to fill the gap but were poorly equipped, lacked technology and rarely observed the required quality standards. However, they easily sold their products because compound feeds were in short supply. Lack of large-scale feed manufacturers made feed more expensive and as a result, backyard home mixing of poor-quality feeds mushroomed. For example, home mixing of feedstuffs has generated suspicion in the quality and safety of poultry products produced.

Despite these challenges, Tanzania's animal feed industry has grown and, currently, there are more than 80 compounded feed millers producing mainly poultry feeds. Some of them also produce pig and dairy meals though in limited quantities.

2.3 Effect of climate change

Climate change has significantly affected the availability of feeds resources. Extended dry seasons, frequent droughts, erratic rainfall manifested by shifts in onset and cessation of rain and increased temperatures have drastically reduced availability of both roughages and concentrates feeds. Decline in pasture and food crops because of the changing climate have also affected feed availability in terms of quantity and quality. Furthermore, because of climate change, pasture and water resources have diminished leading to overstocking and subsequent overgrazing in some areas of mainland Tanzania (Sangeda and Malole 2014). The movement of livestock keepers in search of pasture and water has also triggered resource use conflicts between livestock keepers and other land users across the country. Strategies must be put in place to assess the impacts of climate change on livestock and to manage these conflicts in order to boost livestock production and productivity.

2.4 Policy and strategies for animal feeds resources development

The private sector dominates the animal feed industry in Tanzania, particularly in compounded feeds production, distribution and marketing. Some feed manufacturers have also come together to establish the Tanzanian Feed Manufacturers Association (TAFMA) to address issues related to poor feed quality and advocate in favour of policy changes. The Tanzanian Bureau of Standards (TBS) established feed quality standards 20 years ago but these have not been adequately promoted in the feed industry. The Ministry of Agriculture, Livestock and Fisheries (MALF) has put in place the 'Grazing-land and Animal Feeds Resources Act. No. 13 of 2010' to regulate the feeds resource industry. So far, five regulations have been formulated for safeguarding grazing lands, registration and inspection of premises, storage and transport facilities. The Animal Feeds Advisory Council was subsequently established to oversee the industry but the Act is yet to be implemented fully due to inadequate human and financial resources. Some of the strategies to improve quality of animal feeds resources proposed in the Act include the following:

- The Ministry of Livestock Development and Fisheries and Tanzania Bureau of Standards (TBS) to enforce legislation and regulation of the feeds resources industry.
- To promote establishment of private pasture seeds farms and encourage forage businesses.
- To improve and extend Tanzanian laboratory testing facilities for concentrate feeds and pasture seed testing.
- Complete an inventory of all feeds commercially produced by manufacturers and analyse each feed.

The government also seeks to promote farming of various crops for use as raw materials for compounding feedstuffs and to support the establishment of animal feedstuffs associations and assure quality of locally-produced and imported animal feeds. Animal feeds industry regulation and development in Tanzania involves multiple stakeholders including TAFMA, TBS, Sokoine University of Agriculture (SUA), Tanzania Food and Drug Authority (TFDA) and MALF. It is important to engage every stakeholder in quality control, industry regulation and research development. Currently, research in animal feeds is done by the MALF and SUA and regulation is mainly done by MALF and TBS.

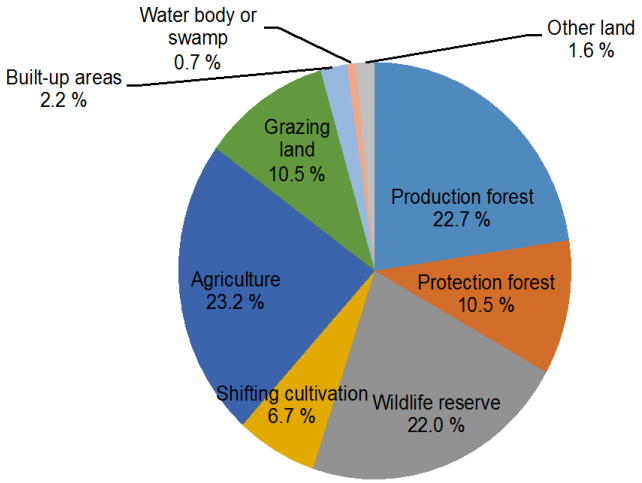
3. Challenges

Communally-owned natural pastures in rangelands are the mainstay of the traditional livestock production system in Tanzania. Generally, the communal semi-arid rangelands in Tanzania are constrained by several challenges including poor quality and availability of forage. The forage is characterized by seasonal variation in quantity and quality with high-quality forage only available in short periods during the wet season leaving livestock nutritionally stressed due to lignification of pasture in longer dry seasons (Kakengi et al. 2001; Kanuya et al. 2006).

Moreover, climate change has aggravated the problem of pasture and feed resources decline in terms of quantity and quality as have expansion of crop cultivation, increase in protected forestry and game areas, and growth of human settlements. Pastoral mobility in search of high-quality forage and water, which has been a drought coping strategy that historically helped many pastoralists to manage uncertainty and risk in arid lands, is under threat and land disputes resulting from pastoral mobility, rapid expansion of towns encroaching surrounding farming areas are now persistent in Tanzania.

Sources of land disputes include, among others, inadequate grazing land which is formally allocated to livestock farmers. According to the information available from the Ministry of Natural Resources and Tourism (2012), land available for grazing in Tanzania is only 10.5%. Other land users allocation include 22% wildlife, 10.5% protection forest, 22.7% production forest, 23.2% agriculture, 6.7% shifting cultivation and 4.5% to other uses. This information on land availability was collected by the Ministry of Natural Resources and Tourism after a forest inventory was done to establish a baseline. However, there is no official national land allocation for the various uses of land.

Figure 1: Land use distribution in Tanzania mainland



The fact that only 10.5% of land is allocated for grazing the millions of livestock in the country could be the main cause of conflict between livestock farmers and other land users especially during dry season when livestock are moved around in search of water and pastures.

Competition between human and animal feed millers for the same raw materials (maize, fish-meal and sardines) has made feeds and poultry products more expensive compared to other countries which use raw materials such as yellow maize, soya bean and by-products from meat processing and oil pressing industries for feed manufacturing. In Tanzania's case, inadequate crop production of mainly cereal grains, oil seed crops and animal feed sources such as sardines leads to scarcity in animal concentrate feeds and raises concerns about the quality of ingredients used in compounded feeds available to farmers.

According to TAFMA (2002), the use of sardines and fishmeal in poultry feed, which is common in the country, is associated with fish taint (taste and smell) in poultry products especially table eggs and chicken meat. Consequently, locally produced poultry products do not meet international standards and are not accepted by clients such as international hotels and the expatriate community who opt to import poultry products from Brazil, South Africa and other countries. Furthermore, there has been complaints from poultry stakeholders that sardines are easily contaminated by salmonella which causes fowl typhoid (salmonellosis), a vertically transmitted disease. Fowl typhoid has caused high mortality in chicken and led to the collapse of many parent stock and layers operations in Tanzania. As a result, today most hatcheries in Tanzania import over 80% of their hatching eggs (TAFMA 2002).

In this connection, a bean meal could be a good alternative for sardines in feed manufacturing because it contains a large quantity of high quality proteins. However, soya bean meal has not been used in a substantial amount because processing it is expensive and its low production in the country means supply is inadequate to meet feed requirements. The small quantity of soya bean production in Tanzania limits it utilization in poultry production. It is hoped that soya cake (or meal) will eventually replace, either totally or partially, the ground sardines that is currently the common protein source in locally manufactured feeds. Local users (and potential users) of soya meal are concerned about supply possibilities from internal sources and reducing imports which have been mainly from India.

Regarding quality control of animal feeds, the standards developed by TBS are supposed to be enforced by MALF and the animal feeds industry is regulated through the 'Grazing land and Animal Feeds Resources Act, No. 13 of 2010' which provides for inspection in the feeds storage and production premises, standards and safe guarding and management of grazing lands. Lack of important infrastructure such as laboratories and inadequate financial resources for inspectorate services has, however, affected the enforcement of these laws.

4. Objective

The objective of this assessment was to estimate the feed resources needs and potential supply of feed resources for animals in Tanzania. An understanding of the feed and feed resources needs will enable the establishment of feeds balance and an analysis of whether to increase animal production or to manage a deficit of resources in relation to the current herd.

5. Methodology

Data and information was collected from various sources including key informants at the MALF, SUA and Tanzania Livestock Research Institute (TALIRI) in Iringa and Mwanza regions. Data on land use was collected from Tanzania Forestry Service (TFS) through the National Forest Resources Monitoring and Assessment (NAFORMA) project. Data on area and yield of food crops for retrieving animal feeds such as crop residues was collected from MALF. Review of literature and expert opinions on some feed aspects such as feed nutritive values, availability status; and feed requirements for different species and age groups was also done.

6. Livestock Sector Investment and Policy Toolkit (LSIPT)

The Livestock Sector Investment and Policy Toolkit (LSIPT) software was used to analyse data and information in this study. This information was input into an Excel spreadsheet in the LSIPT. The module 4 and sub-module 2 of the LSIPT proposes methods for estimating the potential for growth in the livestock sector based on the availability and the potential supply of forage, fodder and other feed resources. The toolkit was also used to estimate the total feed requirement by cattle in the traditional extensive and commercial intensive production systems for sheep, goats, poultry and pigs. The toolkit also enabled estimates of feed requirements for ruminants in three livestock production zones namely central (Cn), coast and lake (C&L) and highlands (Hi).

Estimations of requirement for the monogastrics (chicken and pigs) in this case, are based on cereal equivalent. The toolkit was used to estimate the supply of feeds using data gathered and analysed based on the three production zones (Cn, C&L and Hi), and the amount of forage crops and pastures, yields from grazing areas, from residues and agricultural by-products, and agro-industrial by-products supplied in the country. The yields from major crops such as grain cereals, pulses, and root and tuber crops were also calculated and the forage amount was estimated using crop yield indexes. Areas available for grazing in production zones were also calculated from information provided by the Department of Forestry Services (TFS).

7. Intermediate results

Since the LSIPT is not a data collecting toolkit, the data collected from various sources was first analysed in the Excel spreadsheet to get the intermediate results which were then fed into the LSIPT for final analysis of the livestock sector with regards to feed resources. The following intermediate results were observed.

7.1 Land use distribution

Table 2 shows the land distribution in three livestock production zones. The coast and lake zone had the largest proportion of land size.

Table 2: Land size distribution in Tanzania mainland by livestock production zones

Production zone	Size (km^2)	Percentage
Cn	228,768	26
C&L	351,950	40
Hi	299,158	34
	879,876	100

Source: Tanzania Livestock Master Plan (LMP)

Table 3 shows the percentage land use by various land users, including crop and livestock farmers. The proportion of land for grazing is only 10.5% for all ruminants in the country, while forestry and wildlife reserves occupy more than 50% of the land mass. Further assessment of distribution of land use size was done in the three livestock production zones showing a high proportion of grazing land in the central zone.

Table 3: Percentage distribution of land by land use in Tanzania mainland

	Production zone			
Type of land use	Cn	C&L	Hi	Overall
Production forestry	17	24	26	23
Protection forestry	10	9	1	10
Wildlife reserve	17	25	22	22
Shifting cultivation	6	7	7	7
Agriculture	29	23	19	23
Grazing land	17	7	10	10
Built-up areas	2	2	2	2
Inland water body or swamp	1	1	1	1
Other lands	1	2	2	2
	100	100	100	100

Source: Tanzania LMP

The distribution of crop residues in agricultural land in an average season (when weather is in average condition) is shown in Table 4. The crop residues proportion is lowest in the central zone.

Table 4: Percentage distribution of agriculture land producing major crop residues in different production zones in average weather year*

	Production zone		
	Cn	C&L	Hi
Rain-fed cereals (straw)	36	40	39
Rice (straw)	3	6	4
Groundnut (haulms)	4	2	3
Cotton (leaves, adventitious plants)	5	14	13
Tubers (haulms)	6	13	13
	54	75	72

* Major important crop residues for livestock
Source: Tanzania LMP

Table 5: Percentage distribution of agriculture land producing major crop residues in different production zones in bad weather year*

	Production zone		
	Cn	C&L	Hi
Rain-fed cereals (straw)	18	22	20
Rice (straw)	2	3	2
Groundnut (haulms)	2	1	2
Cotton (leaves, adventitious plants)	1	8	8
Tubers (haulms)	2	6	5
	25	40	37

Source: Tanzania LMP

Table 6: Percentage distribution of agricultural land producing major crop residues in different production zones in good weather year*

	Production zone		
	Cn	C&L	Hi
Rain-fed cereals (straw)	60	72	65
Rice (straw)	7	10	7
Groundnut (haulms)	7	4	5
Cotton (leaves, adventitious plants)	11	23	18
Tubers (haulms)	11	25	25
	97	134	121

* Major important crop residues for livestock
Source: Tanzania LMP

Forage productivity and availability

The average productivity in dry matter/square kilometre (DM/km2) of natural forage, crop residue and established forage is shown in Table 7. Trees and leguminous trees had the highest biomass while the lowest was found in rain-fed cereals straws.

Table 7: Average productivity of natural forage, crop residues and established forages (tonnes DM/km2)

	Cn	C&L	Hi
Natural forage	250	300	290
Rain-fed cereals (straw)	84	81	104
Rice (straw)	161	197	272
Groundnut (haulms)	103	129	147
Cotton (leaves, adventitious plants)	393	407	595
Tubers (haulms)	178	183	165
Established pastures			
Established grasses	800	1000	1000
Legumes	500	700	800
Trees/leguminous trees	1000	1500	1600

Source: Tanzania LMP

Table 8: Productivity of natural forage, crop residues and established forages in a bad weather year (tonnes DM/km2)

	Cn	C&L	Hi
Natural forage	200	250	240
Rain-fed cereals (straw)	81	74	100
Rice (straw)	146	178	272
Groundnut (haulms)	105	119	124
Cotton (leaves, adventitious plants)	274	379	467
Tubers (haulms)	87	111	124
Established forage			
Grasses	500	700	700
Legumes	300	350	350
Trees/leguminous trees	700	800	800

Source: Tanzania LMP

Table 9: Productivity of natural forage, crop residues and established forages in a good weather year (DM/km2)

	Cn	C&L	Hi
Natural forage	280	350	300
Rain-fed cereals (straw)	94	83	114
Rice (straw)	151	212	357
Groundnut (haulms)	125	144	150
Cotton (leaves, adventitious plants)	405	427	659
Tubers (haulms)	188	190	198
Established forage			
Grasses	1000	1300	1300
Legumes	800	1000	1100
Trees/leguminous trees	1500	2000	2100

Source: Tanzania LMP

Table 10: Average availability of natural forage, crop residues and established forages (%)

	Cn	C&L	Hi
Natural forage	40	40	40
Rain-fed cereals (straw)	50	50	50
Rice (straw)	50	50	50
Groundnut (haulms)	50	50	50
Cotton (leaves, adventitious plants)	50	50	50
Tubers (haulms)	50	50	50
Established forage			
Grasses	50	50	50
Legumes	40	40	40
Trees/leguminous trees	40	40	40

Source: Tanzania LMP

Table 11: Availability of natural forage, crop residues and established forages in a bad weather year (%)

	Cn	C&L	Hi
Natural forage	30	35	35
Rain-fed cereals (straw)	50	50	50
Rice (straw)	50	50	50
Groundnut (haulms)	50	50	50
Cotton (leaves, adventitious plants)	50	50	50
Tubers (haulms)	50	50	50
Established forage			
Grasses	50	50	50
Legumes	40	40	40
Trees/leguminous trees	40	40	40

Source: Tanzania LMP

Table 12: Availability of natural forage, crop residues and established forages in a good weather year (%)

	Cn	C&L	Hi
Natural forage	85	85	85
Rain-fed cereals (straw)	80	55	55
Rice (straw)	75	38	35
Groundnut (haulms)	85	63	85
Cotton (leaves, adventitious plants)	90	50	75
Tubers (haulms)	85	25	35
Established forage			
Grasses	50	50	50
Legumes	40	40	40
Trees/leguminous trees	40	40	40

Source: Tanzania LMP

Concentrates production

Concentrates in tonnes of DM for the three production zones in average year is shown in Table 13. Cotton and sunflower seed cakes are produced in high amount in the central zone while cereal bran production is highest in coast and lake zone. Cereal bran production was calculated based on human population which explains the large quantity in coast and lake zone (430,000 tonnes) as compared to other zones.

Table 13: The average amount of concentrates by production zone (tonnes DM)

Type of concentrates	Cn	C&L	Hi
Cotton seedcake	47,000.00	22,000.00	-
Sunflower seedcakes	194,000.00	45,000.00	544,000.00
Cereal brans	162,000.00	430,000.00	226,000.00
Molasses	-	56,827.00	24,494.00
Fishmeal (sardines)	-	13,000.00	-

Source: Tanzania LMP

Table 14: The average amount of concentrates by production zone in bad weather year (tonnes DM)

Type of concentrates	Cn	C&L	Hi
Cotton seedcake	19,000.00	10,000.00	-
Sunflower seedcakes	64,000.00	19,000.00	421,000.00
Cereal brans	109,000.00	297,000.00	151,000.00
Molasses	-	39,762.00	24,494.00
Fishmeal	-	13,000.00	-

Source: Tanzania LMP

Table 15: The average amount of concentrates by production zone in good weather year (tonnes)

Type of concentrates	Cn	C&L	Hi
Cotton seedcake	94,000.00	41,000.00	-
Sunflower seedcakes	535,000.00	56,000.00	845,000.00
Cereal brans	225,000.00	557,000.00	353,000.00
Molasses	-	68,545.00	30,853.00
Fishmeal	-	13,000.00	-

Source: Tanzania LMP

7.2 Estimates of feeds requirements

Performance data was calculated based on various animal categories such as body maintenance, growth rates and productivity to estimate feed requirements. The following was the data fed into the LSIPT.

Livestock performance

Performance data for cattle at various ages was fed to the LSIPT for extensive and semi-intensive system of production for a livestock herd. Live weights and growth rates were higher in the intensive than in the extensive system of production. Also, performance data for sheep and goats were available for LSIPT.

Grain equivalent and monogastrics production

The toolkit was used to estimate the cereal equivalent of maize, millet and sorghum in percentage in relation to poultry and pigs (monogastrics) meat production as shown in the Table 16. The cereal equivalent was 14%.

Table 16: Calculation of grain equivalent for the monogastric production

Type of production		Cereal equivalent (T)		Production (T)		
		T	1.37	Maize	Sorghum	Millet
Meat						
	Poultry (T)	200,000	274,000			
	Pig (T)	120,000	164,400			
Eggs (T)		232,000	317,840			
Total			756,240	4,378,069	777,340	103,423
	Percentage of the estimate of cereal equivalent in relation to the production of maize, millet and sorghum (%)		14			

Source: Tanzania LMP

8. Feed resources availability and balance

Feed resources availability, requirement and balance for ruminants were determined by the LSIPT in average, bad and good weather conditions. A negative feed balance was found in all years i.e. average, bad and good years as shown in Tables 17, 18 and 19, respectively. Table 17 shows that resources available for ruminants feeding in an average year are 26% while the projected balance for 15 years under current investment scenario is 15%.

Table 17: Average feed balance assessment

		TDM	% resources available
Current	Resources	20,964,780	
Current	Requirements	80,557,716	
Current	Feed balance	-59,592,936	26
Projected	Requirements	139,409,651	
Projected	Feed balance	-118,444,871	15

Source Tanzania LMP

Table 18 shows that feeds resources available for ruminants feeding in a bad weather year are 13% with a projected 15 years balance of 8% under current investment scenario.

Table 18: Feed balance in a bad weather year

		TDM	% resources available
Current	Feed available	10,656,474	
Current	Feed requirement	80,557,716	
Current	Feed balance	-69,901,242	13
Projected	Requirements	139,409,651	
Projected	Feed balance	-128,753,177	8

Source Tanzania LMP

Table 19 shows that feeds resources available for ruminants feeding in a good weather year are 44% and a projected feed balance of 25% in 15 years.

Table 19: Feed balance in a good weather year

		TDM	% resources available
Current	Feed available	35,069,029	
Current	Feed requirements	80,557,716	
Current	Feed balance	-45,488,687	44
Projected	Feed requirements	139,409,651	
Projected	Feed balance	-104,340,623	25

Source: Tanzania LMP

Table 20 shows the feed balance in the three typologies at different weather conditions i.e. average, bad and good weather years. The current feed balance is very small in central zone and is higher in the highlands. Also, the same trend was observed in projected feed balance. However, the projected feed balance is smaller than the current.

Table 20: Feed balance in the three livestock production zones

	Cn	C&L	Hi
Current feed balance			
Average year	18	27	51
Bad weather year	9	15	21
Good weather year	31	44	87
Projected feed balance, 15 years			
Average year	11	16	20
Bad weather year	5	9	8
Good weather year	18	27	34

Source: LMP Tanzania

9. Assessment of the current scenario on feed needs and availability

Most ruminant feeds resources in the country are found in rangelands. The feed resources available to livestock nationally is 26%, 13% and 44% of the feed required in an average weather year, bad weather year and good weather year, respectively. The lower percentage of feed resources available versus the demand implies a negative feed balance showing that available feed is insufficient. The observed feed insufficiency might result in poor animal nutritional health thereby high mortality rates. However, the mortality rate, particularly that of ruminants, in the country is normal indicating that animals are probably grazing beyond the 10% of land 'allocated' for grazing (URT 2013; TFS 2015). Animals graze almost everywhere including some prohibited areas such as protected and production forests, wildlife parks and even in agricultural/crop land, which might be the main cause of the increased land use conflicts. Feed balance is relatively good in the highlands and dairying performs better in such typology compared to the central areas of the country where traditional livestock keeping (extensive system) is mostly practiced.

The feed balance projection in the next 15 years under the current investment scenario is worse compared to the current situation. As shown in Tables 18, 19 and 20, the projected feed resources balance is 15%, 8% and 25% in average, bad and good weather years, respectively. The projected feed balance in three different typologies for the same period is smaller compared to current findings. Urgent technology and policy interventions are needed to address the project feeds resources deficiency especially in the central zone. One tropical livestock unit (TLU) requires an average of three ha per year, a requirement which is far above the current available land for grazing and future (15 years' projection) needs. Interventions towards providing adequate feed resources should focus on improving pasture productivity in the grazing lands, reducing the ruminant livestock population and increasing their productivity.

10. Proposed policy and technology interventions

The negative balance of livestock feed resources, which has been the main cause of land use conflicts in the country, calls for policy and technological interventions to ensure sustainable livestock production.

10.1 Policy interventions

The main cause of deficiency of livestock feeds resources is relatively small land available for grazing land taking into consideration the high population of ruminants in the country. The importance of land reserves for forest and game need not to be overemphasized. However, there is a need for government ministries, including the Ministry of Land Housing and Urban Development; MALF, Ministry of Natural Resources and Tourism, the Prime Minister's Office and Regional Administration and Local Government, which are the main stakeholders of land in the country, to conduct dialogue on proper use of land and to explore possibilities of using forages available in the production forests and shifting cultivation areas. It is also suggested to consider the possibility of land reallocation to avail more land for grazing.

Currently, the Forest Act (Number 14 of 2002) allows the Minister for Natural Resources and Tourism to allow grazing access in forest reserves in times of severe drought, though livestock keepers require a special permit, often at a fee, to enter these areas. Such an approach might also be used in highlands where, in times of fodder scarcity, intensive (home-based) dairy farmers could be allowed to access forage for 'cut and carry' from some forest reserves.

It is imperative for the MALF to formalize the area allocated for grazing through the Grazing land and Animal Feed Resources Act (Number13 of 2010). After a formal land registration, then policy for ownership of grazing areas according to carrying capacity should be pursued.

10.2 Technological interventions

It is evident that the stocking rate for ruminants is very high particularly in grazing areas. Two approaches that can be used to boost sustainable livestock production include increasing carrying capacity of the grazing lands, and improving livestock productivity coupled with reduction of local herds so that farmers and livestock keepers can increase incomes from smaller herds. Technologies such as over sowing with high-quality forage seeds including legumes, reducing bush encroachment in the grazing lands and promoting the establishment of private pasture and pasture seed farms can also be used to improve quality of pastures in order to increase carrying capacity of grazing lands.

Livestock productivity can be increased by selection of the best animals from the herd, cross-breeding with high-producing exotic breeds and use of breeding technologies such as artificial insemination, multiple ovulation and embryo transfer. Intensive livestock production should also be encouraged. Generally, given the existing negative

feed balance, there should be a 'Marshall Plan' to reduce the number of ruminant livestock by encouraging livestock keepers to sell their animals in good weather years, when they can fetch premium prices, and breeders to come up with more efficient breeds of livestock.

Given the current pressure on natural resources, attention should also be focused on increasing the use of crop residues, by-products from the agro-industrial processes and other locally-available non-conventional feed resources. Technologies for crop residues treatment that increase the digestibility of current feed resources and production of non-conventional animal feeds such as soya beans, yellow maize, etc. should also be encouraged.

11. Conclusion

Animal feeds resources in Tanzania are not sufficient for both ruminants and non-ruminants even in good years of forage production. There is need for interventions to improve rangelands carrying capacity, fodder conservation and application of technologies in livestock herds to increase production and decrease the livestock population. Overall, a strategy should be put in place to improve intensification in feeding programs along with pursuing breeding programs to increase livestock genetic potential thereby ensuring higher productivity of animals. In addition, the Tanzania Livestock Master Plan 5–15 year projection on feed resources will need to ensure access to feeds from some forest reserves during drought and bad weather years so as to align with the 2002 Forest Act and the Ministry for Natural Resources and Tourism (2016).

References

Calo, L.L. 1976. Supplementary feeding. In: P*roceedings of the Third Scientific Conference of the Tanzania Society of Animal Production*, Nay 1976.

French, M.H. 1957. Nutritional value of tropical grasses and fodders. *Herbage Abstracts* 27:1–9.

French, M.H. 1943. Feeding value of tropical grasses and bulrush millet. *East African Agricultural and Forestry Journal* 9:88–89.

National Bureau of Statistics (Tanzania). 2012. *Human Population Census 2011*. Dar es Salaam, Tanzania: National Bureau of Statistics (Tanzania)

Kakengi, A.M., Shem, M.N., Mtengeti, E.P. and Otsyina, R. 2001. Leucaena leucocephala leaf meal as supplements to diet of grazing dairy cattle in semi-arid western Tanzania. *Agro-forestry system* 52:305–314.

Kanuya, N.L., Matiko, M.K., Nkya, R., Bittegeko, S.B.P., Mgasa, M.N., Reksen, O. and Ropstad, E. 2006. Seasonal changes in nutritional status and reproductive performance of Zebu cows kept under a traditional agro-pastoral system in Tanzania. *Tropical Animal Health and Production* 38(6):511–519.

Madallali, S.A. 1974. A review of pasture research in Tanzania. In: *Proceedings of the First Scientific Conference of the Tanzania Society of Animal Production*.

Ministry of Livestock and Fisheries Development. 2016. *Mtazamo wa Wizara kuhusu Kupunguzwa kwa Maeneo ya Hifadhi Nchini kwa ajili ya Kupisha Shughuli za kibinadamu.* Dar es Salaam, Tanzania: Ministry of Livestock and Fisheries Development.

Ministry of Natural Resources and Tourism. 2012. *Forest Act 2002*. Dar es Salaam, Tanzania: government of Tanzania.

Russell, E.W. 1966. Soils and fertility. In: Davies, W. and Skimore, C.L. (eds.). *Tropical Pastures.* London, UK: Faber and Faber.

Sangeda, A.Z. and Malole J.L. 2014. Tanzanian rangelands in a changing climate: Impacts, adaptations and mitigation. *Net Journal of Agricultural Science* 2(1):1–10.

TISCO (Tanzania Industrial Studies and Consulting Organization). 1983. *Dairy Development for Tanzania Livestock Development Authority* (main report). Dar es Salaam, Tanzania: TISCO.

ISBN:92–9146–512-7

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

The International Livestock Research Institute (ILRI) works to improve food security and reduce poverty in developing countries through research for better and more sustainable use of livestock. ILRI is a CGIAR research centre. It works through a network of regional and country offices and projects in East, South and Southeast Asia, Central, East, Southern and West Africa, and in Central America. ilri.org

CGIAR

CGIAR is a global agricultural research partnership for a food-secure future. Its research is carried out by 15 research centres in collaboration with hundreds of partner organizations. cgiar.org