Livestock Feed Resources in Ethiopia

Challenges, Opportunities and the Need for Transformation

Edited by

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Livestock

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USDA United States Department of Agriculture

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Abbreviations and Acronyms

ACDI/VOCA	Agricultural Cooperative Development International/ Volunteers in Overseas Cooperative Assistance
ADF	Acid detergent fiber
AFD	Action for Development
APDA	Afar Pastoralist Development Association
ARDU	Arsi Rural Development Unit
ASAL	Arid and semi-arid lands
BSG	Brewers spent grain
BSLF	Beyene-Sirgut-Lidet-Fitsum PLC
COOPI	Cooperazione Internazionale
CP	Crude protein
CSA	Central Statistical Agency
DM	Dry matter
E.C.	Ethiopian calendar
EAFIA	Ethiopian Animal Feed Industry Association
EARO	Ethiopian Agricultural Research Organization
EEA	Ethiopian Economic Association
EIAR	Ethiopian Institute of Agricultural Research
ERCA	Ethiopian Revenues and Customs Authority
ES	Ethiopian standards
ESA	Ethiopian Standards Agency
ESAP	Ethiopian Society of Animal Production
ESGPIP	Ethiopia Sheep and Goats Productivity Improvement Program
EVA	Ethiopian Veterinary Association
FAO	Food and Agriculture Organization (of the United Nations)
FEED	Feed Enhancement for Ethiopian Development
FLDP	Fourth Livestock Development Project
FTCs	Farmers Training Centers
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
GTZ	Gesselschaft fuer Technische Zussamenarbeit
HBA	Henok-Belay-Admassu PLC
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Instiutute
IPMS	Improving productivity and Market Success (of Ethiopian farmers)
IRC	International Rescue Committee

KA	Kebele Administration
l	liter
LEWS	Livestock Early Warning System
LPDA	Liben Pastoralist Development Association
Mcal	Mega calorie
ME	Metabolizable energy
MNB	Multi-nutrient block
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
MT	Metric tonne
NDF	Neutral detergent fiber
NGO	Non-governmental organization
NLDP	National Livestock Development Project
NRM	Natural Resources Management
OPADC	Oromia Pastoral Areas Development Commission
Oxfam-GB	Oxfam Great Britain
PADETES	Participatory Demonstration and Training Extension System
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
PLC	Private Limited Company
PPE	Poultry Production Enterprise
QSAE	Quality and Standards Authority of Ethiopia
Qt	Quintal
SC-UK	Save the Children UK
SC-US	Save the Children USA
SNNP	Southern Nations, Nationalities and Peoples
SNNPR	Southern Nations, Nationalities and Peoples Region
SPS-LMM	Ethiopia Sanitary & Phytosanitary Standards and Livestock & Meat Marketing Program
t	Tonne
TAES	Texas Agricultural Experiment Station
TMR	Total mixed ration
UN	United Nations
US	United States (of America)
VAT	Value added tax
WBISPP	Woody Biomass Inventory and Strategic Planning Project
WISP	World Initiative for Sustainable Development

Preface

The preparation of this book was initiated as a result of a consultative meeting organized by the Ethiopian Animal Feed Industry Association (EAFIA) in June 2008, which discussed the worsening situation of livestock feed supply in the country. The purpose was to review available information on livestock feeds and feeding; identify constraints, challenges, and opportunities in feed resources development as well as interventions needed to be made by different actors to address the problem. Accordingly, the book presents the status, trend, constraints, challenges, and opportunities for feed resources development in different livestock production systems prevailing in the country. It also describes issues related to feed marketing and quality and portrays institutional and policy support schemes needed to ensure feed security. This was based on reviewing of documents, using secondary data, questionnaire survey, and focused group discussions. The method used depended upon the type of information needed for different chapters of the paper.

The book is divided into eight chapters. Chapter 1 covers introductory aspects focusing on the need for transformation of the Ethiopian feed sector. Chapter 2 deals with feed resources availability and quality and briefly describes the major feed resources available in different production systems and the nutritional quality of the feeds. The third chapter highlights the influence of feed resources availability and quality on livestock productivity. The chapter asserts that the growth, production, and reproduction performance of Ethiopian livestock is much below the potential due mainly to nutritional constraints. Based on evidences from recent drought, chapter 4 deals with drought-induced livestock feed crises and emergency responses. It explains the extent and intensity of the crises focusing on the pastoral production system. The fifth chapter is about the compound feed industries and presents their status, challenges, and opportunities. Chapter 6 deals with feed marketing and quality issues. It highlights, among other things, the recent trends in the availability and price of feed ingredients and compound feeds. The seventh chapter deals with institutional and policy issues and particularly dwells on the policy support needed to ensure feed supply for enhancing the livestock sector. Chapter 8 presents the way forward or conclusions and recommendations.

Many institutions and individuals have contributed to the success of the work. The Ethiopia Sanitary & Phytosanitary Standards and Livestock & Meat Marketing Program (SPS-LMM), Ethiopia Sheep and Goats Productivity Improvement Program (ESGPIP), Food and Agriculture Organization (FAO), and Ethiopian Institute of Agricultural Research (EIAR) are duly acknowledged for allowing their respective staff member(s) to take part in the preparation of the book.

Financial support for publication of this document has been generously provided by the United States Agency for International Development (USAID) and United States Department of Agriculture (USDA) through SPS-LMM and Feed Enhancement for Ethiopian Development (FEED), respectively. We are very grateful to the managements of both SPS-LMM and FEED for their kind support. In addition, SPS-LMM hosted several meetings and a writeshop session, which allowed the authors to sit together for discussion and shaping the document. We are particularly very grateful to Dr Hank Fitzhugh and Mr. Belachew Hurrissa, Chief of Party and Deputy Chief of Party respectively of SPS-LMM Program, for their support and follow up.

We appreciate the support of the Ethiopian Animal Feed Industry Association (EAFIA) for its keen interest in the work and continued support. The cooperation of the Association members in providing needed information about the industry is duly appreciated. We thank the contribution of Brazemart International General Trading P.L.C. and Alema Koudijs Feed P.L.C. for covering the expenses related to a meeting organized to receive comments on the draft document from members of the Association. We also thank Eden Field Agri-Seed Enterprise for its contribution in hosting meeting of the authors.

While preparing this report we have referred to various published and unpublished sources of information and benefited from the comments of different individuals on the draft document. In this regard, we have benefited from the useful comments of Dr Carl Birkelo, Mr. Yacob Aklilu, Mr. Beruk Yemane, Mr. Abate Tedla, Mr. Abraha Hailemichael, and Dr William Thorpe. We thank them all for their very helpful comments.

Editors

Foreword

This book is written by a task force composed of renowned professionals in the field drawn from government, non-government, and private institutions based on the request from the Ethiopian Animal Feed industry Association (EAFIA). The EAFIA was established by feed processors, private dairy farmers and dairy cooperatives with the mission to improve the quality and quantity of livestock feed in Ethiopia. The team of professionals has presented a comprehensive review of the animal feed situation and the looming feed crisis in Ethiopia. The book, in addition to presenting the constraints and available opportunities, identifies intervention areas and forwards recommendations for action by pertinent parties.

The publication of the book could not have come at a better time than now when the feed problem is worsening from day to day and requiring urgent attention and action from all concerned in line with the growth and transformation plan (GTP) of the country.

The book is a useful manuscript for a multiplicity of users including policy makers that make decisions pertaining to solving the feed problem in Ethiopia, researchers to target solving real problems of livestock feeds and feeding, extension staff to focus on recommended solutions relevant to their particular situations. The book is also a comprehensive reference for instructors and students of animal feeds and nutrition, animal and range science or animal production who often have to rely on textbooks and references that do not effectively reflect the real situation in Ethiopia. The contents of the book analyze the real situation on the ground students are to face after graduation and prepare them better by presenting options for solving the real problems.

If Ethiopia is to produce more milk, eggs, and meat for its population, it must increase production per animal through provision of better quality feed in adequate quantities. As an association that is working towards solving feed related problems in Ethiopia, we are extremely happy for this important support tool being available to help us meet our objectives. We are convinced that implementation of the recommendations presented in the book provide the guide to achieve this.

The Ethiopia Animal Feed Industry association (EAFIA)

Chapter 1

The Need for Transforming the Ethiopian Feed Sector

Adugna Tolera, Alemayehu Mengistu, Diriba Geleti, Alemu Yami and Yirdaw Woldesemayat

ETHIOPIA HAS A LARGE LIVESTOCK POPULATION and diverse livestock genetic resources. Moreover, the country has diverse agro-ecologies suitable for different kinds of livestock production. There are three major livestock production systems in the country. These are smallholder mixed crop-livestock production, pastoral and agro-pastoral livestock production, and the urban and peri-urban livestock production systems. The mixed crop-livestock system is found in the high and mid altitude areas. The pastoral and agro-pastoral systems are found in the arid and semi-arid lowlands of Afar, Somali, Oromia, and SNNP Regions. The pastoral areas in the south and eastern parts of the country are the prime sources of animals for conditioning in feedlots for live animal and meat export. The urban and peri-urban production system is an emerging component of the livestock sector, which includes smallholder and commercial dairy, feedlot and poultry operations around the major towns.

Livestock resources have significant economic and social importance at household levels and make significant contributions to the national economy and foreign currency earnings of the country through export of live animals, meat as well as hides, skins and leather products. The livestock resource sustains and supports the livelihoods of an estimated 80% of the rural population (FAO, 2004) and it contributes 15 to17% of overall GDP and 35 to 49% of agricultural GDP, and 37 to 87% of the household incomes. Live animals and livestock products such as meat,

hides, and skins are the third major export items accounting for 11% of the export revenue (Hurrissa, 2009). However, the productivity and economic contribution of the livestock sector is much below the potential due to various technical and non-technical constraints. The main technical constraints include inadequate feed supply and inefficient feed management and utilization, widespread diseases and poor health and poor breeding practices. The non-technical constraints include low-level human, financial, and infrastructural resources; and inadequate policy support with respect to extension, marketing, and credit (EEA, 2006). Available evidences suggest a history of under-allocation of financial and human resources to livestock development. Moreover, responsibility for livestock development is diffuse within Ministry of Agriculture, and perhaps not fully coordinated. For example, over the last 30-40 years, the majority of livestock development projects have been donor-driven, with the associated constraints in design and content, and implemented by expatriate actors. Although the projects have delivered discrete value, the benefits have been rarely sustained, and domestic ownership was insufficient to motivate scaling up.

Among the technical constraints, shortage of feed supply in terms of both quantity and quality is the main constraint limiting the realization of exploitation the full potential of the livestock resources of the country. If animals are not properly fed, they cannot express their genetic potential for production and reproduction. They also become susceptible to a number of diseases and parasites. Prolonged shortage of feeds could lead to death of animals. Pastoralists lose a large number of their animals, sometimes the total herd, during prolonged dry season and drought mainly due to inadequate feed supply.

In mixed crop-livestock systems, livestock feed supply is mainly dependent on crop residues, natural pastures, and other agricultural by-products such as thinning and leaf stripping from crops such maize and sorghum, enset leaves and sweet potato vines depending upon the locality. However, the contribution of natural pastures to livestock feed is declining from time to time as most of the available land is cultivated for crop production. Cultivated forage and pasture crops may also be available to a limited extent in areas where there is strong livestock extension and where farms keep crossbred dairy cattle. The use of agro-industrial by-products is very limited due to predominance of subsistence-oriented production and scattered settlement of the farmers. Extensive grazing and browsing of range vegetation is the main source of

feed for pastoral herds and flocks. However, both the quantity and quality of the available forage is drastically low during the dry season. The problem is exacerbated by recurrence of drought at frequent intervals and the pastoralists' loss of key dry season and drought reserve grazing areas due to increasing population pressure, expansion of cultivation into pastoral areas and other development interventions. Almost all the urban and peri-urban livestock producers entirely depend on purchased feeds, as they do not have land for feed production or for grazing. Nearly all commercial dairy farms, feedlots, and poultry farms buy-in all their feed needs, be it roughage or concentrate.

Feed cost accounts for 60 to 70% of the total cost of livestock production. As a result, shortage of feed and escalating price of feeds is adversely affecting the productivity and profitability of commercial livestock operations. The situation also has a far-reaching effect on the business and profitability of feed industries as their operations would become irregular with frequent disruption by shortage and escalating price of feed ingredients, which would raise their cost of production beyond what the livestock producers can afford to buy.

Drought induced shortage of feed in the pastoral areas exacerbates the problem of shortage and price hike of feeds in the highlands due to channeling of large quantities of feeds to the drought affected pastoral areas for emergency feeding. Accordingly, during the 2007/2008 drought, a substantial amount of concentrate and roughage feeds were purchased and mobilized by different governmental and non-governmental organizations to address the critical feed shortages in the drought affected pastoral areas. This situation coupled with the overall shortage and increased price of feed ingredients created a crisis in animal feed supply throughout the country, including the central highlands. As a result, dairy farms that could not sustain their operation sold their animals for meat while some of the poultry farms were closed. The few feed industries existing in the country were also forced to operate much below their capacity due to the shortage and sky rocketed price of feed ingredients. Despite the critical shortage, the demand for processed compound feeds decreased dramatically during that period as the price was beyond the reach of both smallholder and commercial livestock producers.

In general, the feed shortage problem is gradually moving to a crisis level. The agricultural production and productivity of the country is

affected directly or indirectly given the close inter-linkages of the farming systems in Ethiopia. The supply and quality of feed needs to be given serious attention if the planned targets in the Growth and Transformation Plan (GTP) of the country are to be realized. In order to produce more milk, eggs and meat, production per animal has to be increased through provision of better quality feed in adequate quantities. Without adequate supply of good quality feed, the productivity of both the livestock and crop agriculture would be at stake. The problem of feed shortage is a painful experience to all livestock producers ranging from extensive pastoralists to landless urban and peri-urban livestock producers, mixed crop-livestock producers and relatively large scale commercial livestock operations. Poorly fed animals cannot generate adequate draught power for traction and other farm operations. The solution to the problem requires a concerted effort from all those involved directly and/or indirectly ranging from policy makers, development agencies, livestock producers, pastoralists, NGOs, the public sector and private entrepreneurs. Thus, a complete transformation in livestock feed production and supply is necessary in order to realize the desired improvement in livestock production and productivity in the country.

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Chapter 2

Feed Resources Availability and Quality

Adugna Tolera, Getnet Assefa, Diriba Geleti, Lemma Gizachew and Alemayehu Mengistu

DIFFERENT TYPES OF FEED RESOURCES are available in Ethiopia. These are broadly grouped into concentrates and roughage feeds. The main sources of concentrate feeds are agro-industrial by-products, whereas the main sources of roughages are natural pastures, crop residues, and cultivated forage and pasture crops. The description of these major feed resources is given in the following sections.

Agro-industrial by-products

Agro-industrial by-products are the by-products of the primary processing of crops. They include flour mill by-products, oilseed cakes, brewery by-products, and molasses. These feed ingredients are the main constituents of concentrate feeds.

Milling by-products

Milling by-products include bran and related by-products such as wheat short, wheat middling, rice bran and screening. Wheat bran is the most common milling by-product used for livestock feeding in Ethiopia. The other minor by-product is wheat middling, which is finer than wheat bran with higher energy and lower fiber contents. Wheat screenings are broken or shrivelled kernels plus some foreign materials such as cheat and weeds.

Varela-Alvarez (2006) compiled the designated and actual annual production capacities of 190 flour mills found in different parts of the country and estimated the total annual production of wheat bran to be 269,238 tonnes. In recent years, there has been a significant increase in

the number of flour mills in different parts of the country. However, the actual production performance of the flour mills lies around 20-50% of their capacities due to shortage and high price of wheat among other factors. Some mills produce only wheat bran while others produce wheat middling and other products as well. Thus, considering the increased number of flour mills in different parts of the country and under capacity performance most mills, the current annual production of flour mill by-products is estimated to be 336,548 tonnes assuming an average increment of about 25% over the value reported by Varela-Alvarez (2006).

Wheat bran can be used a source of energy and protein. It contains easily digestible carbohydrates (α-linked polysaccharides), which are readily digested in the rumen with high energy yielding potential. Wheat bran contains 15-18% crude protein, which has relatively high digestibility of 75%. It is also a relatively good source of most of the water-soluble vitamins except niacin. The fiber and energy content of wheat bran may vary depending upon the quality of wheat being milled and the exact processing method used as these factors affect the overall blend of the bran components. When added to protein source feeds, wheat bran can improve feed intake, digestibility, and growth performance of animals.

Wheat middlings represent another by-product of the wheat milling industry containing a higher proportion of germ and flour than wheat bran. They include screenings, bran, germ and flour remnants. They are good sources of crude protein and supplemental energy. They have about 92% of the energy value of maize grain and contain more protein than maize. Wheat middlings contain nearly 40% NDF, which is highly digested in the rumen.

In areas where rice is produced and processed for food, rice bran, rice hulls, and broken rice grains are produced as by-products. Rice bran consists of the fibrous outer layer of the grain, some hulls and chipped grain. In general, rice mill by-products are characterized by high fiber and low energy content. It has a protein content of 9% and a fat content of 8%. Besides protein and oil, rice bran is an excellent source of vitamins B and E. The high oil content in rice bran increases its energy value. However, it may also cause rancidity under warm and humid climatic conditions thereby reducing palatability and increasing potential risk of toxicity.

Oilseed cakes

Oilseed cakes are the residues or cakes that are produced as by-products during extraction of oil from oilseeds. They include noug cake, cottonseed cake, groundnut cake, linseed cake, sesame cake, sunflower cake and others. There are two methods of extracting oil from the oilseeds. These are mechanical (press) and solvent extraction methods. Most oil-processing plants, except Addis-Modjo Oil Factory, use the expeller (mechanical) method of extraction. The mechanical extraction employs the application of pressure to force out the oil from the oilseed, whereas the solvent extraction uses organic solvent, usually hexane, to dissolve the oil from the oilseed. The mechanical extraction is a less efficient method of extracting oil from oilseeds, which leaves a substantial amount of oil in the residue.

Most of the oil mills are operating at less than 50% of their capacity due to inadequate supply and high price of oilseeds as well as availability of cheaper imported oil in the market, which hampers competitiveness of local oil processing plants. These include commercial imports through regular trading channels, oil obtained in the form of food aid and through illegal trade, mainly in eastern and southern parts of the country. The supply and price of oilseeds is affected by competition from other uses such as export and direct use of the seeds locally. The high price of oilseeds is exacerbated by increased export of the seeds.

Table 1. Annual production and export of oilseeds from 2003/04 to 2005/06

Year	Produced (MT)*	Exported (MT)**	% exported
2003/04	312,863	109,732	35
2004/05	526,396	173,094	33
2005/06	486,355	263,251	54

Source: CSA (2006a; 2006b)
**Source: ERCA (2006)*

The quantity of oilseeds locally available for crushing depends on climatic and other factors that affect the quantity of oilseeds produced and behaviour of the international market that determines the quantity of the oilseeds exported. The share of oil seeds in total export of the country has increased from 15.6% in 2004/05 to 20.8% in the 2005/06 fiscal year.

Table 1 shows the quantity of oilseeds exported from 2003/04 to 2005/06 in comparison to the amount produced.

About 90% or more of the sesame produced in the country is exported or used for direct consumption. Thus, the amount available for oil extraction is only 10% of the annual production. On the other hand, 70% of noug, 80% linseed, 80% groundnut, 90% safflower, 95% rapeseed, and 90% cottonseed annually produced in the country may be used by oil processing plants for oil extraction. The efficiency of oil extraction from the different oilseeds is different. Using the percentage of oilseeds available for processing and the percentage of cake produced from the oilseeds processed, the annual production of the different oilseed cakes can be estimated as shown in Table 2 below.

Table 2. Estimated annual production of different oilseed cakes

Oilseed	Seed prod. (MT)*	% processed	Cake extraction rate (%)	Cake produced (MT)
Noug*	144,848	70	58	58,808
Linseed*	65,421	80	52	27,215
Groundnut**	14,478	80	44	4,991
Sunflower*	5,067	90	58	2,645
Sesame*	327,741	10	52	17,043
Rapeseed*	19,316	95	58	10,643
Cottonseed**	52,956	90	42	20,017
Total	**629,827**			**141,362**

**Estimated based on 2010/11 crop production data from CSA; ** Taken from Tolera (2007)*

The oilseed cakes are rich in protein, which may vary from 20 to 50% depending upon the type of oilseed and the method of extraction of oil—mechanical *vs* solvent. However, the protein content of most oilseed cakes such as noug and linseed cake lies within the range of 28-35%. Most oilseed cakes are low in the essential amino acids cystine and methionine and have variable and usually low lysine content. Depending upon the method of processing, some oilseed cakes may have high proportion of fiber bound nitrogen, which could reduce digestibility of the protein. Such incidence is higher in oilseed cakes obtained from small-scale press mills than from large-scale press mills and solvent extraction (Mogus, 1992). The application of high temperature and pressure during extraction using the press method may denature the protein and reduce the nutritive value by reducing its digestibility.

Oilseed cakes can also supply considerable amount of energy, depending upon the method of extraction of oil and the amount of residual oil remaining in the cake. The energy content varies from 2.03 to 3.7 Mcal ME/kg DM depending on processing method. Extraction of oil leaves a residue that may contain from nearly none to 12% fat depending upon the process and efficiency of extraction. Solvent extraction removes nearly all the oil from oilseeds leaving only about 1% or less in the residue. Oilseed cakes produced by mechanical extraction contain more fat and fiber and less protein than those produced by solvent extraction. Oilseed cakes have high phosphorus (0.75-1.31%), potassium and magnesium contents and low content of calcium (0.17-0.72%) and sodium (Mogus, 1992).

Brewery and winery by-products

There are breweries and wineries in the country that produce by-products of potential feed use, but which have not been fully utilized so far (Table 3).

Table 3. Annual by-products production capacities of breweries and wineries

Brewery/Winery	Location	By-product produced/year	Source or Remark
St. George Brewery	Addis Ababa	1,200 MT	Varela-Alvarez (2006)
Meta Brewery	Sebeta	4000 MT	Varela-Alvarez (2006)
Bedele Brewery–Spent grain	Bedele	88,000 HL	Bedele Brewery
Bedele Brewery–Brewers' yeast	Bedele	20,000 HL	Bedele Brewery
Harar Brewery	Harar	53,365 MT	Varela-Alvarez (2006)
Dashen Brewery–Spent malt	Gonder	730 MT ?	Tegegne and Assefa (2010)
BGI Brewery-Wet spent grain	Kombolcha	7474 MT*	Tegegne and Assefa (2010)
Awash Winery	Addis Ababa	100 MT	Varela-Alvarez (2006)

** 1868 MT dry brewery spent grain (Tegegne and Assefa, 2010)*

Brewery, distillery, and winery by-products could be important sources of supplementary feed in commercial livestock operations. This is particularly important for farmers residing in the proximity of commercial breweries, distilleries, and wineries. The by-products have

moderately high crude protein and metabolizable energy contents and digestibility.

Molasses and other by-products of sugar factories

Currently, four sugar factories produce sugar in the country. The factories produce significant quantities of by-products such as molasses, bagasse, and cane tops that could potentially be used as animal feed. Molasses contains high levels of sugars, which are readily digested in the rumen. It is also a good source of minerals such as calcium, potassium, sulphur and trace minerals, but deficient in nitrogen and phosphorus. Molasses is a concentrated source of energy that could be stored for a long period. Molasses is often used as a carrier for urea in molasses-urea blocks since it is palatable and provides a wide range of minerals.

However, because of competing alternative uses, the amount of bagasse and molasses used as animal feed is quite insignificant. Because of its bulky nature and difficulty of transport, most of the cane tops is either burned or just left in the field and used by any livestock producers living in the vicinity of the factories in the case of Wonji and Methara whereas in Finaca'a all the cane tops are burned in the field as there is no any animal production activity close to the factory. The bagasse is currently used as a source of fuel for boilers in the factories.

At Metahara Sugar Factory, currently the biggest factory, the annual molasses production estimate of the factory is about 44,000 MT. In 2006/07, 59% of the molasses produced at Metahara was exported while about 20% was sold locally (Table 4). However, the remaining 21% was not accounted for and that could be the amount dumped during the year. The highest export occurred during 2005/06 and 2006/07. However, the export has been stopped due mainly to interruption of rail transport to Djibouti and feed export ban.

Table 4. Amount (MT) of molasses produced and disposed in 2006/07 production year

Sugar factory	Production	Disposal		
		Export	Local sale	Ethanol production
Metahara	41,455	24,630	8,086	-
Wonji	8,987	-	8,987	-
Shewa	8,644	-	8,644	-
Fincha'a	24,376	-	-	24,376

** Local sale could used for alcohol production or for animal feed*

All the molasses produced by Fincha'a Sugar Factory is used for ethanol production, whereas nearly all the molasses produced by Wonji and Shewa Sugar Factories is sold to those who use it for alcohol production or as animal feed or to feed traders who resale it on retail basis for urban livestock producers.

All the existing sugar factories have a plan of expanding their capacity by three fold. In addition, a new factory with a much bigger capacity (25,000 t cane/day) is coming up in Tendaho. A big tract of land in Dhidhessa valley has also been allocated to a foreign investor for sugar cane plantation and establishment of sugar factory. These development plans would suggest that there would be a good potential for production of molasses and other by-products that could be used as animal feed. However, all the factories are planning to use all the molasses for production of power alcohol. Thus, all the current practices and the plans of all the sugar factories indicate that the possibility of using the by-products of these factories as animal feed is very unlikely.

Grain

Depending upon availability and price, cereal grains and grains damaged during processing could be used as sources of high-energy feeds. Substantial amount of screenings and damaged grains are produced during grain processing and seed cleaning. Grain represents a concentrated feed resource, which can be transported over a long distance with relatively less expense. Maize, wheat, barley, oats, sorghum and rice are usually highly digestible (80-85%), rich in energy and have a protein content of 8-12% of DM. Maize grain has a high potential in this respect because of its high-energy content, relative abundance and reasonable price most of the time. The annual production of maize grain from the smallholder farmers in 2005/06 was 3.9 million tonnes (Tolera, 2007). This amount does not include the grain produced by state farms and large-scale commercial farms. Cereal grains are low in calcium content and need to be supplemented with limestone to correct the deficiency. Screenings of barley and wheat have potentially high contribution to the diet of farm animals. Fourth grade barley screening has a crude protein content of about 12%, NDF and ADF contents of 21.5 and 7.8%, respectively and in vitro organic matter digestibility of about 83%.

Poultry Litter

Poultry litter is a product obtained where poultry are raised on floor. It contains poultry droppings, bedding material and spilled poultry feed. It may contain 15-35% CP depending upon the proportion and quality of the above constituents. It has high ash content with high levels of the minerals calcium, phosphorus, potassium, magnesium, sulphur, and copper. It can serve as a good source of fermentable nitrogen and essential minerals.

Commercial poultry farms have a potential of producing a significant amount of poultry litter that could be incorporated in the diet of ruminant animals. However, effective utilization of the litter as a component of ruminant rations depends on the location of the poultry farm.

Natural pastures

Natural pastures are naturally occurring grasses, legumes, herbs, shrubs and tree foliage that are used as animal feed. The intensity of cropping determines the area of land available for grazing and browsing. In the densely populated areas of the Ethiopian highlands, the better soils are used for cropping and the steep slopes and the seasonally waterlogged foothills are allocated for grazing. On the other hand, livestock grazing is the predominant form of land use in pastoral areas, which account for over 60% of Ethiopia's land cover and receive less than 600-700 mm annual rainfall (Coppock, 1994). Most of these rangelands are situated in the northeastern, eastern, and southern parts of the country with the remaining rangelands lying in the wetter Gambella and Benshangul-Gumuz regions. Largely, these environments, with the exception of the wetter western lowlands, are arid and semi-arid with characteristic high ambient temperatures, low and erratic rainfall regimes.

The rangelands are rich in plant species of high feeding and medicinal value, which varies in structure and composition. Largely, the rangeland vegetation structure is influenced by the utilization pressure, topography and the amount and distribution of rainfall. In the hot and dry northeastern and eastern arid rangelands, the sparse vegetation constitutes ephemerals, annual grasses, and dwarf shrubs suiting browsing camels and goats. The vegetation composition in the slightly better moisture regimes of the semi-arid areas of southern and eastern Oromia, southern

parts of SNNPR, and parts of Somali (southern and western sections) regions, is predominantly *Acacia commiphora* bush lands with understory perennial grass cover. The grass spp. are of good grazing value and includes *Cenchrus, Chloris, Chrysopogon* and *Themeda* spp. This environment is also rich in palatable forbs and browses, which include *Blepharis, Tribulus, Acacia, Balanites, Olea, Erythrina, Boswellia, Combrethem, Commiphora* and many other species. In the much wetter Gambella and Benshangul-Gumuz rangelands, woodlands and savannah grasses make up much of the plant communities. Forage from the rangeland is the principal source of feed for domestic and wild herbivores and availability of range forage shows considerable temporal and spatial variability.

Natural pastures are continually decreasing due to rapidly increasing human population and expansion of cropland. Hence, the contribution of natural pastures to the dietary needs of animals is substantially decreasing from time to time. The quantity and quality of feed obtainable from natural pastures particularly declines during the dry season. The protein content and digestibility of most grass species decline rapidly with advancing physiological maturity. In general, the productivity of natural pastures is very low and usually does not exceed 0.5 to 2 tonnes/ha dry matter per year in the arid and semi-arid areas. Extensive grazing areas are communally used, which does not encourage individual farmers to invest in pasture productivity improvement.

Utilization

Natural pasture could be utilized through either direct grazing or zero grazing or the combination of grazing and zero grazing by harvesting and conserving as hay or silage. The application of these practices depends on the level of intensification of the production system, the environmental situation, topography, soil conditions, productivity, and management of the pasture. The most efficient way of using natural pastures could be a combination of grazing during the unproductive dry season and resting and harvesting the pasture during productive months of the year. Hay making is appropriate and cheaper means of conserving forage. However, haymaking is not a common practice in Ethiopia, except in few peri-urban farms near Addis Ababa.

Improved management

Various management practices have been tested and recommended to improve productivity and utilization of natural grasslands in different agro-ecologies. These include resting of pasture from grazing during rainy seasons of July to October; especially in waterlogged grazing lands, application of nitrogen, phosphorus, and manure in well-drained pastures during resting. As a strategy of pasture improvement, oversowing of selected forage species such as *Desmodium* and *Stylosanthes* spp. for increasing species composition, quality and productivity of native pasture in mid-altitudes have been verified by the Fourth Livestock Development Project (FLDP) (Mengistu, 2005). In the highlands, manure coated vetch over-sowing is suitable for improving the legume content of native pasture.

Challenges

The pastoral areas are faced with complex challenges constituting recurrent drought, population pressure, continued loss of prime grazing lands, the weakening of customary institutions and pervasive rangeland degradation threats (Coppock, 1994; Yemane and Mesfin, 2000; Kamara *et al.*, 2003; and Melesse *et al.*, 2006). The extent varies but almost all rangelands are under serious threats of vegetation and soil loss, and concomitant state of ecological decline. Compared to the highlands, the livestock feed insecurity is higher in the lowland parts of the country. Depletion of livestock asset through cyclic droughts has driven hundreds and thousands of pastoralists into absolute destitution making them dependents on relief food aid. The causes of rangeland degradation and the corresponding growing livestock feed insecurity are many and complex. The most notable ones are indicated below.

Prolonged and excessive rangeland use: The growing population pressure, restricted mobility, and indiscriminate stock water development schemes have led to prolonged and heavy grazing/browsing pressure of the range resources (Coppock, 1994; Yemane and Mesfin, 2000; Gizachew, 2009). The intensity of forage use particularly becomes severe and detrimental where herbaceous forages are grazed close to the growing points, and browses are heavily defoliated and debarked. In most of the rangelands, heavy grazing pressure has resulted in the disappearance of the most productive and palatable grasses and their replacement by unpalatable and undesirable species like *Aristida* and *Sporobolus* spp. as well as poisonous plant species. Excessive lopping of

trees and shrubs particularly at times of drought for survival feeding, and the cutting of trees to meet the growing demand for fuel wood and construction materials have resulted in similar undesirable consequences such as transformation of many of the rangeland micro-habitats into vegetation devoid desert. This is very evident in most pastoral areas but much more pronounced in the Afar Region.

Recurrent drought: In the arid and semi-arid environments, frequent and extended droughts are depleting soil-seed bank and exhausting natural resource base. The continued loss of vegetation cover is increasing soil erosion and undermining the regeneration capacity of the rangelands with ultimate negative consequence upon livestock feed security. The other damaging negative impact of the drought is the loss of rangeland biodiversity. Although not documented systematically, the recurrent and severe droughts have contributed to substantial loss of forage species of high medicinal and feeding values.

Inefficient use of local available resources: *In situ* utilization is the common form of rangeland use in pastoral and agro-pastoral environments. Livestock keepers rarely conserve pasture and/or crop residues at times of relative plenty. The same applies for agro-industrial by-products such as molasses, brewers' dry grain, cottonseeds, and various types of oil seed cakes. Efficient management and utilization of the above local feeds is tremendously important to extend the period of modest feed availability with reasonable nutritional quality.

Restricted livestock mobility: For generations, pastoralists have dealt with the seasonal fluctuation in supply of forage and water by adopting free mobility across the landscapes varying in the temporal availability of the grazing resources (Coppock, 1994; Kamara *et al.*, 2003; Gizachew, 2009). The global arguments justifying the ecological suitability of mobile livestock keeping to the arid and semi-arid environments are building momentum (WISP, 2008). Unfortunately, in most of the arid and semi-arid environments of Ethiopia such periodic mobility of people and livestock are restricted due to the growing population density and the accompanying proliferation of settlements, change in land use and ever-growing resource use conflicts. In many of the rangeland ecosystems, scarce resources are often the source of conflict as periodically migrating pastoralists converge on areas where there is abundant pasture and water supply. Due to livestock raiding and insecurity, large expanses of buffer zones with substantial grazing

reserves have been left unutilized along the inter-ethnic territories even at times of severe droughts. The cases in point are the Alaydege plains, the El-Gof grazing reserve, and the pastureland along the Sagan River.

Invasive species encroachment: The rapid spread and proliferation of invasive plant species is posing a daunting challenge to the rangelands of all regions (Coppock, 1994; Yemane and Mesfin, 2000; Gizachew, 2009). Most of these invasive species are indigenous. The exotic invasive species with serious threat to the rangelands are the toxic annual herb *Parthenium hysterohorus* and the woody species *Prosopis juliflora*. The most negative impacts of these woody invaders are that they make thick tickets, which obstruct mobility of people and livestock and suppress the growth of under-storey herbaceous grass. Causative agents for spread of invasive species are complex and include recurrent droughts, grazing pressure, and fire ban.

Land use change: Due to the adoption of crop cultivation by pastoralists and expansion of private agri-businesses, the land uses of the rangelands are continually evolving (Coppock, 1994; Yemane and Mesfin, 2000; Kamara *et al.*, 2003; and Melesse *et al.*, 2006). Population pressure and livestock asset depletion are the major drivers of the land use change. Participatory landscape level land use planning is crucial to align the evolving change with the agro-ecological potential of the environment. Local administration and the customary institutions have an important role in guiding and monitoring the change in manner that communities generate sustainable livelihood and income from the fragile environment.

Weakening customary institutions: Customary institutions and pastoral land use practices have largely become dysfunctional. A number of factors have contributed to the weakening of the customary institutions. Chief amongst these are the influences of parallel formal structures, the population growth and drought induced ecologically unsustainable livelihoods; for example, crop farming, unplanned water development schemes, and haphazard settlements patterns (Coppock, 1994; Kamara *et al.*, 2003).

Lack of sustained investment in rangeland improvement: In the late 1960s, 1970s and 1980s Ethiopian government piloted rangeland improvement projects in the selected areas of the country. Most of these rangeland improvement initiatives recorded little success due to limited

grassroots participation and an overly alignment of the scheme to the western ranching model. Since then investments for improvement and rehabilitation of the rangelands have been negligible or at best sporadic.

Opportunities

Diversification of livelihood and income: The increasing trends of natural shocks and disasters have forced many pastoralists into destitution and adoption of livelihoods unsuitable to fragile arid and semi-arid environments such as crop farming and charcoal making. With the fast population growth, degradation of natural resources and increasing incidences of climatic change induced threat the proportion of the population seeking relief assistance will likely grow. To avoid humanitarian crisis and release the pressure on the natural resources, supporting alternative livelihoods with promise to generate more sustainable income and little threat to the ecology are crucial. To this end, potential alternative livelihoods such as apiculture; handcrafts; community-based forage seed and fodder production along the perennial rivers; value addition and marketing of feed, livestock, livestock-by-products, and other range products, for example, gum and incense need to be considered.

Livestock mobility: All pastoral communities practices some form of herd mobility to match livestock needs with the forage and water availability. Essentially, the mobility of livestock across the heterogeneous landscapes is the most important adaptive strategy of pastoralists to the risks and the uncertainties they frequently encounter in these harsh environments. Such indigenous knowledge of relieving grazing lands for a season or two will give rangelands the chance to rest and recover. Properly planned and jointly agreed livestock mobility help to even out periodic feed deficits, and efficiently exploit forage resources in dry-season grazing areas and buffer zones. .

Rich biodiversity and socio-cultural heritage: The rangeland ecosystem is endowed with a wealth of plant and animal genetic resources. The plant and animal biodiversity encompass plants of forage and medicinal—ethno-veterinary medicine—importance, endemic birds and game animals, and diverse domestic animal species well adapted to the harsh environment. The rangelands are also home to 29 ethnic groups with mosaic socio-cultural heritage. All these endowments if tapped

properly can be turned into a range of environmental friendly livelihoods alternatives such as livestock production, game farming, eco-tourism, etc, warranting dignified life for the local communities.

Exemplary local innovations: In response to the growing environmental challenges, some pastoral communities are engaging in practices new to the system. Women are particularly keen in adapting to these new realities. To this end, the haymaking by Borana women, forage seed marketing by Afar women and marketing of green forage by Somali women groups are encouraging developments that are worth scaling up.

Conserved forage

The objectives of forage conservation is to preserve forage resource for the dry season in order to ensure continuous and regular supply of feed for livestock, either to sustain growth, fattening or milk production, or to continue production in difficult periods. The different forage conservation techniques include haymaking, silage making and urea molasses or effective microorganisms (EM) treatment of crop residues or other low quality roughages.

Silage making is a fermentation process aimed at preserving forage in its wet state under anaerobic condition (away from air). The aim is to minimize loss of dry matter and nutritive value and to avoid creating products toxic to the animals. To obtain good quality silage, it is necessary to use airtight silos that can create total anaerobic condition. Effective microorganism (EM) is also used in the preparation of silage from crop residues. It can also be applied through drinking water to enrich livestock feeds and improve palatability.

Hay is a product obtained by cutting and proper drying of forage of high moisture content (65 to 80%) to moisture content of less than 20%. The aim of haymaking is to produce a stable product of medium nutritive value with a minimum wastage and loss and at a reasonable capital and labor cost. Hay can be made from sufficiently well managed natural pastures (meadowlands) that are well maintained for this purpose or from cultivated forage crops such as Rhodes grass, oats and vetch that are grown under intensive management. It can be made from grasses, and tall and erect legumes such as alfalfa or from a combination of grasses and

legumes. The legumes increase the nutrient content, digestibility, and intake of the hay. However, grasses alone can make good hay if they are cut at the beginning of flowering. If the grasses are combined with legumes such as alfalfa and vetch, they make excellent quality hay. The hay produced from grazing land has a relatively lower nutritive value as it is usually harvested after the plants reach maturity stage. Such hay may not support high level of production. But it would be very useful to bridge the dry season feed gap as it may support the basic maintenance needs of animals and in some cases may even support marginal production of milk and meat during periods of critical feed shortage.

Fodder conservation as hay or silage is not a common practice in many parts of Ethiopia with the exception of the central highlands around Addis Ababa. There is a long established practice of commercial hay production from natural pastures or meadow grass in parts of North and West Shewa zones of Oromia National Regional State. A more efficient system of harvesting grass using a scythe—locally known as *falch*—has been a common practice in these areas although in other parts of the country the sickle is the only tool available for cutting grass. Medium and big private and government run livestock farms do also make silage from a variety of forage sources during wet season. Locally produced native hay and silage can serve as useful source of roughage in commercial livestock operations. However, the nutritive value of the hay and silage could be very variable depending upon botanical composition or species of the forage crop, stage of maturity at the time of harvesting as well as harvesting, drying/ensilage and storage conditions.

Crop residues

Availability

Crop residues are becoming increasingly important as sources of roughage feeds for ruminants. These include cereal straws like tef, wheat, barley, maize, and sorghum, grain legume haulms, such as haricot beans, field peas, chickpeas, lentils, and groundnut. Sweet potato and cassava tops and vines, sugarcane tops and *enset* by-products are also becoming very important in small-scale livestock production systems. However, the principal crop residues used for animal feeding are the straws of cereals and pulses. Based on crop production data of Central Statistical Agency (CSA), the annual production of cereal and pulse crop residues in 2009/10 was estimated to be around 29.9 million tonnes (Table 5).

However, the actual quantities of crop residues available for livestock feeding is reduced by the costs of collection, transport, storage and processing, seasonal availability, other alternative uses and wastage.

Table 5. Estimated total amount of residues produced annually from the major crops

Crop	Residue production (thousand MT)			
	2007/08	2008/09	2009/10	2010/11
Tef	4489.4	4542.0	4769.1	5225.2
Barley	2032.2	2279.1	2625.7	2555.0
Wheat	3471.7	3806.5	4613.5	4283.5
Maize	8249.5	8651.6	8573.8	10969.5
Sorghum	6647.8	7010.9	7428.2	9899.7
Finger millet	1076.0	1120.6	1048.4	1269.7
Oats	62.2	72.7	56.1	80.9
Rice	92.7	92.8	134.1	117.5
Pulses	2139.3	2357.6	2269.0	2343.8
Total	28260.8	29933.8	31517.7	36744.8

Source: CSA, 2009

Feeding Value

The nutritive value of crop residues is variable depending upon the species and variety of the crops, time of harvest, handling and storage conditions and other factors. Cereal straws and stovers are generally characterized by relatively low nutrient content, high fiber content, low digestibility, and low voluntary intake (limited consumption) by animals. The nutrient supply of many cereal straws such as tef, barley and oat straws is closer to the nutrient supply of medium quality native grass hay. Thus, good quality straw can be regarded as a good roughage source for ruminants next to native grass hay. Most cereal straws and stovers have lower nutritive value than the haulms from grain legumes and/or vines from root crops such as sweet potato. The haulms of pulse crops represent medium quality roughage with a CP content of 5-12%. Most roughage feeds are bulky and of low nutrient density, which makes the transportation cost very expensive relative to the nutritive value of the feeds especially when they are transported over a long distance. Thus,

provision of such feeds should be planned based on ease of accessibility of source of supply.

Without supplementation, crop residues cannot satisfy even maintenance requirements of animals primarily because of low N, high cell wall and slow digestion leading to a negative N balance and loss of body weight and productivity and death of the animal in critical cases. Post harvest management technologies, such as efficient collection and conservation are crucially important. Though not widely practised, chopping increases intake and digestibility of straws. Urea treatment of cereal straws remarkably increases crude protein content, intake, and digestibility.

Improved Forages and Pastures

Improved forage crop production has diversified advantages. The primary benefits are to produce high amount of quality forage to be used as feed for farm animals. On the other hand, they complement crop production through maintaining soil fertility by fixing nitrogen or when used as mulch. In addition, forage crops could be grown as a component in integrated natural resource management to prevent soil erosion and to control weeds, and pests and diseases. Generally improved forage crop production could provide useful nutrients especially in the rural areas where availability and accessibility to agro-industrial by-products is a problem. Highlights of the status of improved forage production, available technologies, the major challenges, and opportunities for development are described in the paragraphs to follow.

Production of improved forages should focus on those species that have high biomass yield potential such as Napier grass (*Pennisetum purpureum*), Rhodes grass (*Chloris gayana*), Guinea grass (*Panicum maximum*), Buffel grass (*Cenchrus ciliaris*), Sudan grass (*Sorghum Sudanese)* and Colombus grass *(Sorghum almum*). The leguminous forages are important as sources of nitrogen, fermentable organic matter and minerals in crop residues and poor quality natural pasture based diets. Most adaptive and productive forage legumes include Leucaena (*Leuceana spp*), Pigeon pea (*Cajanus cajan*), Sesbania (*Sesbania sesban*), Calliadra (*Calliandra calothyrsus*), Tree Lucerne (*Chamaecytisus palmensis*), Alfalfa (*Medicago sativa*), Stylos (*Stylosanthes spp*), Green leaf Desmodium (*Desmodium intortum*), Silver

leaf Desmodium (*Desmodium unicinatum*), Vetch (*Vicia dasycarpa*), Lablab (*Lablab purpureus*), etc.

Among the grass species, Napier grass is known for its high biomass production. However, its productivity could vary from one area to another depending upon climatic conditions and fertility of the soil. Nitrogen fertilizer or manure application influences the DM yield and CP content of the grass. The grass can be harvested at frequent intervals for cut-and-carry green feeding.

Improved forage production

Thousands of forage species and accessions have been tested and a number of them recommended for wider adoption in different agro-ecologies and production systems during the last five decades. Appropriate agronomic practices have also been developed for selected species. Though Ethiopia is the center of diversity for many forage species, most of the tested forages are of exotic origin (Table 6). Even though they are not officially released due to the absence of variety releasing procedures for forage crops, nine forage species/varieties have been registered in the crop variety register of the Ministry of Agriculture. In evaluation of forage crops, ease of establishment, biomass production, flower setting and seed production potential, persistency for prolonged time, resistance to diseases and pests, forage quality as animal feed, and other complementary benefits such as soil fertility improvement, ability to protect soil erosion, ability to grow on marginal lands and climatic conditions are mainly considered as selection criteria.

Forage development strategies

Various forage development strategies have been assessed and proven successful under Ethiopian condition. These strategies address the needs of both smallholder farmers and specialised large-scale forage producers. For smallholder farmers with problems of land shortage, options like integration of food and forage crops are highly suitable. In areas with problems of soil fertility and soil degradation, forage crops can suitably be planted on soil bands, soil conservation structures, as hedge and alley crops.

Table 6. List of recommended forage species for the different agro-ecologies of Ethiopia

Forage species	Adaptations
Grasses	
Avena sativa (Oats)*	High to mid altitude
Pennisetum purpureum (Elephant, Napier grass)*	Low to mid altitude
Chloris gayana (Rhodes grass)*	Low to high altitude
Panicum coloratum (colored Guinea grass)	Low to high altitude
Panicum maximum (Guinea grass)	Low to high altitude
Melinis minutiflora (Molasses grass)	Low to mid altitude
Sorghum Sudanese (Sudan grass)	Low to mid altitude
Sorghum alum (Columbus grass)	Low to mid altitude
Cenchrus ciliaris (Buffel grass)	Low to mid altitude
Legumes	
Vicia dasycarpa (Vetch)*	High to mid altitude s
Trifolium spp, (annuals & perennials clovers)*	High to mid altitude
Melilotus altisimus	High to mid altitude
Lotus maizeiculatus (Birdsfoot trefoil)	High - altitude
Medicago sativa (Lucerne, Alfalfa)	High to low altitude
Lablab purpureus (Lablab)*	Mid to low altitude
Vigna unguiculata (Cowpea)	Mid to low altitude
Desmodium intortum (Green leaf Desmodium)	Mid to low altitude s
Desmodium uncinatum (Silver leaf Desmodium)	Mid to low altitude
Stylosanthes spp (Stylo)	Mid to low altitude
Macroptilium atropurpureum	Mid to low altitude
Browse Trees	
Chamaecytisis palmensis (Tagasaste, Tree Lucerne)*	High altitude
Gliricidia sepium (Gliricidia)	Mid to low altitude
Cajanus cajan (Pigeon pea)	Mid to low altitude
Calliandra callothyrsus(Calliandra)	Mid to low altitude
Acacia spp (Acacia)	Mid to low altitude
Leucaena leucocephala (Leucaena)	Mid to low altitude
Leucaena diversifolia	Mid to low altitude
Leucaena pallid	Mid to low altitude
Atriplex canescens	Low altitude areas
Sesbania sesban (Sesbania)	Mid to low altitude
Root crops	
Beta vulgaris (Fodder beet)	High altitude

** Forage species and varieties registered in the book of crop variety register, Ministry of Agriculture and Rural Development, Crop Development Department (MOARD, 2007)*
Source: (EARO, 2000)

Highly productive and quality forage crops such as alfalfa, elephant grass, cowpea, lablab, vetch and others are suitable and productive in well-organized intensive production systems through better production

inputs and irrigation to supply quality feed for highly productive fattening and dairy animals on a large-scale. Moreover, such forage crops could also be produced and processed in to products such as feed pellets that could be used locally and exported to different countries, particularly to the Middle East, after meeting the demand for domestic livestock production. Recently there are signs of increased interest in commercial forage production.

Forage seeds and planting materials

Forage research and existing forage production technologies are focussing mainly on herbage productivity, major agronomic practices and feeding values of the forage crops. Forage seed production has not been given due emphasis both in research and extension. As a result, the available forage seed production is generally scanty. Only very preliminary research activities were carried out by some research and/or development institutions such as the Ethiopian Institute of Agricultural Research (EIAR), International Livestock Research Institute (ILRI), and the various development projects of the Ministry of Agriculture such as Arsi Rural Development Unit (ARDU), Fourth Livestock Development Project (FLDP), and National Livestock Development Project (NLDP). Despite high and increasing demand for forage seeds in the country, currently there are no any government or strong private organizations, which are involved in forage seed production at national level. Thus, only very limited amount of forage seed is produced by some research centres, forage production fields, few innovative farmers, and private enterprises.

Seed production of forage crops is a complex process because different forage crops require different agronomic practices, special techniques of harvesting, threshing, and seed processing. Although forage seeds can be produced by smallholder farmers on small plots of land, more successful seed production is made by large-scale forage seed enterprises at selected sites with skilled personnel and modern production and processing facilities.

Annual forage crops require relatively simple management practices for seed production and exhibit higher productivity compared to perennial ones. Moreover, seed processing such as threshing and cleaning for most of the perennial species are difficult and require special skills and knowhow. Seed productivity of most perennial forage grasses and herbaceous forage legumes is in a range of 1- 4 q/ha. Having diverse

agro-ecologies and well-adapted species of forage crops, Ethiopia could be one of the best places where forage seed production in a larger scale can be established to supply not only for local market but also for export.

Improved forage technology transfer and development efforts

In spite of the critical shortage and low quality of the available feed resources, the rate of adoption of forage and pasture production and utilization is extremely low in Ethiopia due to various factors, which may include low economic incentives under subsistence production system, limitations in support service delivery and policy and institutional issues. Assessment of forage adoption by the farmers in the operational areas of the Improving Productivity and Market Success (IPMS) project showed that only 0.15% of rural livestock keepers reported on-farm production of improved forages such as alfalfa and Elephant grass (Tefera et al., 2010). There are many reasons for the poor adoption of improved forage crops. First, farmers own a small land area and depend on communal resources, which does not encourage cultivation of forage crops (Benin et al., 2003); secondly, lack of effective extension systems in forage development in particular and livestock production in general. Moreover, adequate technical and material resources have not been allocated to the sector (FAO, 2004). The fourth factor is the socioeconomic situations of farmers, who operate under high transaction cost and have difficulties in connecting to markets; their animal production is predominantly linked to domestic needs with only limited market orientation and lack of specialization in livestock production. Under these conditions, farmers do not adopt feed improvement technologies, which impose opportunity costs. The insufficient know how and awareness of the farmers has contributed to the low adoption of forage crops (Benin et al., 2003).

However, the potential for adoption of improved forages is high when market oriented livestock production is possible and improved animals (crossbred) respond to improved feeding. The present high demand and price of livestock and livestock products encourages farmers and large-scale investors in the system. It is feasible to initiate development plans with existing technologies within the existing production system, and there seems to be a need for continued adjustments of the strategies in light of the newly gained experiences in the process. To implement such a huge livestock development endeavour the first most important prerequisite is availability of recommended forage seeds and planting

materials. Equally important is a strong and well-structured extension system, adequate budget, focused, and output targeted training to farmers and relevant stakeholders.

Lessons from other countries

The evolution of cultivated forage crops in many countries showed a similar trend. Livestock production systems in developed countries during old times were based on traditional ways of using natural meadows and grasslands. With the intensification of agriculture and commercialization of livestock production, the overall management of the system has been changed rapidly. Among others, the feed component has been intensified significantly. Changes in feed production were focused in the use of improved management practice of pasturelands, cultivation of productive fodder crops, processing of forages, and efficient conservation practices. Though the type of forage species, the management and overall production practices are different, forage development in many countries have a common feature of linking forage to the targeted output. In this regards any investment on forage production is based on planned specified animal product or the forage can be produced and directly sold in the market to livestock farmers. This calls for livestock farmers to keep productive animals and to be guided by cost benefit analysis.

In countries like Australia, integrated forage and food production through crop rotation, improved fallow, and hedgerows intercropping has shown increased benefits of both crop and livestock. Kenya has a similar agro-ecology to Ethiopia; but it is one of the countries with the highest per capita milk consumption. Similarly, Uganda and India have higher per capita milk consumption compared to Ethiopia. This is achieved through small-scale but specialized livestock production with the right management. Of all the management practices, improved feeding systems made the lion's share in bringing the change. Most farmers keep few but productive animals. Cultivated forage production is also one of the components. Napier grass (elephant grass) is the widely grown forage both in irrigation and rain fed condition. In these countries, oats, berseem clover, alfalfa, forage maize, forage sorghum, and some perennial grasses are among the most commonly used cultivated forage crops.

In South Africa and Australia, range resources are efficiently utilized commonly as modern ranches. In these ranches, seasonal feed deficits

either are filled using conserved forages from cultivated forage crops or purchased from other places. In many countries such as Indonesia and Malaysia productive and high quality forage legumes are under-sown in other food and permanent crops such as maize, coffee, palm tree, and rubber tree, which boosted both crop and livestock productivity.

In countries like Australia, New Zealand, Thailand, Kenya, South Africa, and many others, forage seed production is the integral part of forage development. Forage seed technologies are well developed and seed production is commercialized. In these countries, forage seed is largely produced by private seed enterprises that are well equipped with trained personnel and appropriate modern field facilities and postharvest technologies.

Challenges for improved forage production

Production of forage and pasture crops requires various resource inputs. Farmers normally invest their scarce resources when the return is promising. This investment of resources would be feasible if farmers keep productive animals. However, most farmers do not keep productive animals; therefore, farmers may not have incentives to produce forage crops when they do not have productive animals.

The rapidly increasing human population and the dependence on traditional oxen traction for crop production have significant influence on intensive modern livestock production thereby hindering forage cultivation. Moreover, poor crop productivity and shortage of human food supply in most parts of Ethiopia inevitably makes food crop production a priority with least attention given to forage crop cultivation.

Ineffective agricultural extension system and lack of adequate awareness of productive agricultural technologies also influence adoption of improved forage production. Lack of private or public forage seed production systems make the seed system virtually nonexistent.

Other Feed Resources

Thinning, leaf stripping and topping from maize and sorghum

In addition to the dry stover obtained after grain harvest, maize and sorghum can also generate animal feed throughout the cropping cycle as thinning, leaf stripping and topping. Usually farmers plant more than one seed per hill as a security against germination losses. The extra seedlings are thinned at weeding and serve as feed for animals.

Leaf stripping involves removing the bottom leaves from the plant sequentially over a period. Fresh maize leaves contain sufficient protein, macro-elements and energy to support about 100 g/day of body weight gains in lambs with an intake of 770 g/day and feed conversion ratio of 8-10 (Oteino et al., 1992).

Topping is the harvest of maize plant tops at silking stage. Although labor intensive, both leaf stripping and topping can produce better quality feed than harvesting dry stover without significantly affecting grain yield. When maize is harvested in green cob, green maize stover, which is of much better quality than the dry stover, is used for feeding animals. Maize plants that fail to set seed and all male lines from seed multiplication sites and commercial farms are harvested immediately after shedding pollen grains and used as green forage.

Sweet potato vines and tuber

Sweet potato vines have a lower carbohydrate, but higher protein and fiber contents than the tuber. The principal nutritive value of the sweet potato vines is as a source of protein and vitamins. The DM yield of sweet potato vines can be as high as 6 tonnes/ha with a CP content of over 20% and digestibility of 70%. Sweet potato vines have good palatability. Because of very high water content (83-88%), animals fed sweet potato vines do not require additional free water.

In addition to the vines, damaged tubers that are unfit for human consumption can also be fed to farm animals. A combination of sweet potato vines with starch in the tuber and addition of moderate levels of

urea can lead to high rate of live weight gain in beef animals and increase profitability, especially in small-scale fattening operations. In general, in densely populated and land scarce areas, sweet potato has a promising potential for use as animal feed because of its relatively short vegetative cycle and high yield potential with minimal horticultural practices. Sweet potato has a vegetative cycle of 4-5 months fitting into tight cropping systems. It also has wide adaptation to diverse altitudes and temperature conditions and competes better with weeds than other root and tuber crops.

Banana and enset plants and by-products: Banana has a considerable potential for use as food and feed crop as it produces starch-rich fruits for human consumption and leaves, pseudo-stems and peelings that could be used as animal feed. The leaves have moderately high CP content (15%) while the pseudo-stem is rich in fermentable energy (Foulkes et al., 1978). Banana leaves and pseudo-stems can be used as supplementary feeds to pasture and crop residue based diets. The banana plant has a high yield of total biomass. Banana leaves and pseudo-stems have relatively high digestibility of 65% and 75%, respectively. However, both are deficient in fermentable nitrogen. Thus, they should be supplemented with a source of nitrogen such as urea and highly digestible forage or sweet potato foliage. Intake of large amount of water in fresh pseudo-stem may decrease the capacity of the animal to raise its DM intake. The low CP content of the pseudo-stem is another factor contributing to its low DM intake.

Enset is a large banana like perennial plant. It is native to the highlands of south and southwestern Ethiopia. It is cultivated mainly for a starchy human food as well as livestock feed. The pseudo-stem, corm and the stalk of inflorescence constitute the most important components used for human food, whereas all parts of the plant can be fed to livestock. Leaf pruning and thinned *enset* plants are used for feeding animals. The very low DM content of the pseudo-stem poses DM intake limitation on animals while it could be an advantage if drinking water is in short supply. The relatively high CP content of the leaf (about 17%) makes it a favorable feed resource in ruminant feeding, as the protein content is comparable to that of many browse species. The CP content of the pseudo-stem is usually less than 7%. Thus, unless properly supplemented with nitrogen sources, the low protein content could depress the feed

intake and utilization of the corm and pseudo-stem when fed to ruminant animals.

Foliage and pods from naturally growing trees and shrubs

The leaves and pods of trees and shrubs are sources of good quality feed during the dry season when herbaceous forages are in short supply. Foliage of trees such as different Acacia species and *Balanites aegyptiaca* as well as the pods and fruits of *Prosopis* and different Acacia species can be used as a substitute for concentrate supplement. *Prosopis juliflora* has invaded vast areas the rangelands in Afar, Somali, and SNNP Regional States. One way of controlling its expansion would be through proper utilization of the pods as component of animal feeds. The use of Prosopis pods as an ingredient in concentrate feeds needs to be given due attention in future research and development interventions of pastoral areas where the plant is abundantly growing. In general, the supplements are expected to play a catalytic role in feed utilization and are needed in small quantities relative to the basal roughage. Foliages from trees and shrubs are the preferred forage particularly for goats. In harsh and arid conditions, trees provide more edible biomass than pasture and the biomass remains green and high in protein when pastures dry off and senesce. Trees can tap water and nutrients deep in the soil profile because of their deep-rooted nature. The leaves and pods from fodder trees and shrubs usually have higher CP and lower fiber content than dry grass forages and cereal crop residues. Thus, proper and strategic use of these feed resources as supplementary feed during the dry season can help to minimize seasonal fluctuation in animal productivity.

Cactus pear

Cactus (*Opuntia ficus-indica*) pear is a drought tolerant plant adapted to arid and semi-arid areas. It is a very valuable feed resource for feeding animals particularly during drought or prolonged dry season. It is tolerant to poor soil conditions and produces high biomass yield with acceptable palatability to animals. It is generally characterized by low dry mater, crude protein, phosphorus and cell wall carbohydrate contents, but highly digestible and rich in non-structural carbohydrates and calcium contents (Tegegne, 2001; Gebremariam et al., 2006). It can remain succulent during drought or long dry seasons and produce forages and fruit as well as be a source of ample water for animals. It has much higher efficiency of converting water to dry matter than any grass species and is estimated to produce at least 10 tonnes DM/ha/year. The low crude protein content is the main limiting factor of its use in animal feeding, which could be

alleviated by small supplementation of high protein feeds such as oilseed cakes.

Feed Resources Availability

National availability of feed from different sources is shown in Table 7. Crop residues and other agricultural by-products were estimated based on 2010/11 crop production data from CSA (FAO, 1987) whereas the amount of feed obtainable from different grazing sources was based on estimations of WBISPP (2001). Cereal crop residues have the highest contribution to the total feed supply at country level. At national level, cereal and pulse crop residues contribute about 50% of the total feed supply followed by grazing (40%), whereas the balance is supplied by other agricultural and agro-industrial by-products of which *enset* contributes about 3%. About 72 and 28% of the feed obtainable from *enset* is produced in SNNPR and Oromia, respectively (Tolera, 2007). In addition, substantial amount of brewery and distillery by-products and limited amount of cereal grains are also used as components of livestock feed.

Table 7. Quantity of different feeds available in Ethiopia

Feed sources	Quantity (tonne DM)
Cereal straws/stovers	33,403,800
Pulse crop haulms	2,343,832
Oilseed straws	1,127,499
Vegetable wastes	101,735
Root crop by-products	465,059
Fruit crop by-products	2,164,572
Chat & coffee by-products	172,096
Sugar cane tops	356,332
Enset	5,558,482
Aftermath grazing*	8,121,471
Pasture grazing*	10,436,493
Fallow land grazing*	6,556,682
Woodland grazing*	1,486,960
Oilseed cakes	141,362
Wheat milling by-products	336,548
Others (5% of total)	3,644,995
Total	**76,417,918**

**Source: WBISPP (2001)*

Conclusion

Traditionally livestock feeding in Ethiopia is based on grazing of natural pastures and fallow lands augmented with crop residues and stubble grazing. However, due to rapidly increasing human population there is expansion of cropping into traditional grazing areas. As a result, the importance of natural pasture as source feed is decreasing from time to time whereas fallow lands have virtually disappeared from most of the densely populated and intensively cultivated areas of the country. Moreover, there is marked seasonal variation in availability and quality of natural pastures following seasonal distribution of rainfall.

The production and supply of most agro-industrial by-products is uneven and localized around the main urban centers. Most agro-industries are operating below their capacity due to inadequate supply and high price of raw materials and limited demand for main products (e.g. flour and oil) produced by the factories. Although the sugar factories are producing a substantial amount of molasses, nearly all the factories are planning to use the molasses for other purposes that will make it unavailable for animal feeding. In short, the supply of agro-industrial by-products is not consistent all year round and is not adequate to boost productivity of livestock. The various by-product feeds are produced in the process of producing other products and they are not intentionally meant for feed production. Hence, there is no deliberate production of feed.

The pervasive and severe rangeland degradation and the corresponding feed insecurity have negative impacts on the livelihood and survival of pastoral communities. More comprehensive, participatory, and concerted long-term development efforts are needed to restore the productivity of the rangelands, ensure household food security and dignified life for the pastoral communities. This requires sustained policy, institutional and technological supports, and the full involvement of stakeholders including the grassroots communities. The specifics of such supports and actions are outlined below.

Strengthening customary institutions and encouraging mobility: For generations, customary institutions have played an important role in determining human settlements patterns, periodic livestock mobility, the responsibilities. and access to resources by different members of the community. They managed these by enacting

by-laws and enforcing them in localities falling within their jurisdiction. Today, the customary institutions are largely weakened and their authorities taken over by formal institutions such as pastoral kebele associations with consequent disruption of the effective community-based rangeland resource management. The situation was further worsened by developments restricting livestock mobility such as expansion of crop agriculture and growing incidences of conflicts. It is, therefore, essential that the functioning of customary institutions and mobility of livestock encouraged and supported to help pastoralists maintain their livelihood and manage these fragile environments in more sustainable manner.

Rehabilitating degraded rangelands: Most rangelands are in poor state of health. Comprehensive and sustained restorative measures are needed to bring the degraded rangelands back to their productive states.

In view of the high demand for livestock development in Ethiopia, both for food self-sufficiency and for export market, improved forage development will play a crucial role. Two key components are necessary for successful development of improved forages. The first one is establishment of a strong and sustainable forage seed system. Reliable quality forage seeds of the desired species could be produced by private and government seed enterprises. Moreover, small-scale informal seed systems could develop at cooperative and individual farmers' levels. Secondly, there is a need to strengthen the supply of breeder seeds, recommended seed production technologies, post harvest processing facilities, conservation technologies and other related interventions to seed producers. These are the bases for producing and supplying quality forage seed in the desired amount.

Farmers may readily accept improved forage production and feeding management if the return from the investment is attractive. Availability of credit and micro financing would be vital for improving smallholder livestock production. Moreover, marketing of livestock and livestock products should be well organized and facilitated if one aims at keeping the sector productive and sustainable.

Generally, extension of forage development could focus on two scenarios. The first one is low input integrated forage development where farmers establish forages as part of other routine activities with crops or

planting forages on marginal lands or other areas such as field borders, fence lines and backyards. The second one is targeting for more intensive livestock farmers with productive animals in which forage is cultivated conventionally with inputs and improved management practice such as fertilizer application and irrigation. Intensive production, processing and marketing of high value forage crops like alfalfa could be encouraged primarily for domestic use to boost our livestock production and after meeting the domestic demand for export, as there is a high demand in most Middle East and North Africa countries. There is a need to establish an efficient extension system with skilled and dedicated development workers to demonstrate and popularize proven technologies of improved management practices in feed resource production and utilization. The ultimate effect of pasture improvement is measured by the level of animal performance. To make this a reality, livestock technologies should be designed in a holistic way including animal feed, breed, health and over all husbandry practices as one system to promote the required output.

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Chapter 3

Feed Resources Availability and Quality *vs.* Animal Productivity

Adugna Tolera

NATURAL PASTURES and crop residues are the main sources of feed in most parts of Ethiopia. However, the area of grazing land and the overall feed resource base is decreasing from time to time. The limited availability, seasonal variability, and poor quality of the available feeds are the main factors limiting livestock production and productivity. The shrinkage of grazing areas and declining feed resource base have led to degradation of pasturelands, shortage of feed supply, reduced livestock holding per household, loss of indigenous plant and animal biodiversity and reduced performance of the existing livestock herds and flocks.

Production Performance of Livestock

Although Ethiopia has the highest livestock population in Africa, the productivity level is one of the lowest. Average yields per animal slaughtered are estimated to be 110 kg of beef and 10 kg of mutton. Similarly, the average milk production performance of cows is about 1.5 liters per cow per day over a lactation period of about 6 months (CSA, 2008), which is about 270 liters per lactation. The performance of the Ethiopian livestock is much below that of the neighboring countries like Kenya and Sudan. Milk production performance is not keeping pace with the population growth. According to Staal et al. (2008), the national milk production increased by 1.6% while the per capita production declined by 0.8% annually from 1966 to 2001. The average per capita consumption of milk and meat is estimated to be 16 and 10 kg, respectively. These figures, which are among the lowest in the world, are clear testimonies of the very low production performance of the livestock subsector.

Feed shortage and poor quality of the available feed resources constrain animal output all over the country. Hence, the overall livestock productivity is unsatisfactory. Grazing animals subsist mainly on poor quality pastures and crop residues. In some livestock operations, where supplementary feeds are given, the main supplements are protein and energy in the form of agro-industrial by-products such as oilseed cakes and cereal brans. Very often little or no attention is given to the mineral and vitamin contents and nutritional balance of the diets. Nutritional constraint leads to slow growth rate in growing animals and low production and reproduction performance. Poorly fed animals give low output of meat and milk and have compromised immune system and ability to fight diseases. Nutritional problems also lead to delayed age of onset of puberty, long parturition intervals, low conception rates, and low overall lifetime productivity.

In poorly fed animals, feed resources utilization is highly inefficient. In Ethiopian smallholder livestock production system, 85% of the feed intake is used to meet maintenance requirement of the animal and only 15% is used for production. In such a system, there appears to be a tremendous potential for improvement. Two-third of the productivity of livestock is affected by the nutritional status of the animals. Moreover, feed cost accounts for about 70% of the total cost of livestock production. Therefore, the feasibility and profitability of livestock enterprises is a function of the type of feed and feeding system. It is estimated that up to five-fold increase in productivity of tropical livestock can be attained if there is optimal feed resources utilization (Yami, 2008). However, the economics of productivity (output/unit time) is different when a feed with low to moderate nutritional value has low/no cost.

Growth rate

Underfeeding and malnutrition lead to low birth weight and sub-optimal growth rates in farm animals. Sisay and Ebro (1998) reported an average birth weight of 25.6 kg for Boran cattle in the mid-Rift Valley area of Ethiopia and showed an average 317 g of pre-weaning (at 6 months) and 176 g of post-weaning growth rates. At this rate of growth, the bulls weigh less than 200 kg at 2 years of age. Such animals should be fed for about 6 months under feedlot conditions to be finished at 350-400 kg for the export or domestic markets.

Most livestock destined for export or slaughter are produced in the pastoral areas from rain fed pastures and are slaughtered with little or no access to better quality feeds required to increase weight, improve condition and dressing percentage. Under poor feeding conditions, animals take too long to reach optimum slaughter weight and the meat produced by such animals may not satisfy the desired quality attributes such as tenderness to satisfy the requirements of the consumers. Hence, the plane of nutrition affects the age at which slaughter animals can be marketed or slaughtered and both the quantity and quality of meat produced when the animals are slaughtered.

Slow growth of heifers increases cost of rearing the heifers as they will not be bred and come into production at an early age. Feeding management, among other factors, is the main contributor influencing the age at sexual maturity in breeding females and age at first parturition. In general, heifers on high plane of nutrition can attain puberty and first calving at an early age, require less number of services per conception, and produce more milk in the first lactation. Hence, proper supplementation of growing heifers would be necessary to achieve rapid growth, early maturity, high subsequent milk production and increased lifetime productivity (Yilma et al., 2000; Gojjam et al., 2011).

Milk production

The average milk yield of local cows under traditional farmers' management is about 1.5 liters per head per day with an average lactation length of about 6 months. The average milk yield of Horro cows under farmers' management was reported to be 1.7 liters per head per day at peak lactation; but decreased to 0.89 liters per head per day in late lactation (Mekonnen, 2008). However, well-managed Horro cows in urban and peri-urban production system produced an average of 4 liters milk at peak lactation, which decreased to 2.2 liters during late lactation. Camels produce about 4-6 liters while goats produce about 0.3 to 0.5 liters of milk per day under farmers or pastoralists management. Based on a study conducted in Erer Valley, Eastern Hararghe, Moges (2001) reported that milk yield of camels increased from 7.6 to 9.1 and 12.9 kg when supplemented (0.5-4 kg/day) with ground maize (energy) and groundnut cake (protein), respectively, during the night on top of browsing/grazing during the day.

The average milk yield of crossbred cows under farmers' management varies from 4 to 6 liters per head per day. On-farm milk production performance of Barka-Friesian and Barka-Jersey crossbred cows at mid-altitude and highland agro-climatic zones around Bako and Holeta Research Centers, respectively, was found to be in the range of 3.9-5.4 liters/head/day (Kumsa, 1995). Similarly, the average milk yield of crossbred cows in Lemu-Bilbilo Woreda Dairy Cooperative in Arsi zone of Oromia Regional State varied from 1.81 to 6.83 liters/day depending upon the stage of lactation (Teferi, 2008). On the other hand, the crossbred cows produce an average of about 8-12 liters of milk in commercial dairies and government farms. For example, the average daily milk yield of 50% crossbred and grade cows at Haramaya University was about 8.9 liters whereas that of grade cows 12 liters (Dereje and Baars, 1998). The production gap between farmers' management and commercial producers is a reflection of feeding and management differences. Oilseed cakes and milling by-products, which make up the bulk of the concentrates mixtures, are not easily accessible to the smallholder farmers due to high demand, inadequate supply, access problem and escalating prices. There is seasonal fluctuation in the supply of different feed ingredients even to the commercial producers. Thus, the performance of the crossbred cows even under the commercial setting is suboptimal by the international standards.

Mortality rate

Nutritional stress results in high mortality rate of young and mature animals thereby causing high economic loss to livestock producers. Sisay and Ebro (1998) reported pre-weaning (at 6 months) mortality rate of 25.4% in Boran cattle. A study conducted over 10 years at Bako Research Center showed a low survival rate of 42% to yearling age for Horro lambs, which represents a major economic loss. The study also further indicated that there is a significant relationship between body weight, which is a function of feeding management and nutritional status of the animals, and survival rate of the lambs (Gojjam et al., 2005). During prolonged dry seasons or droughts, there is massive death of livestock in the pastoral areas due to shortage of feed leading to starvation of the animals (PLI, 2007).

Reproductive performance

The reproductive efficiency of breeding animals is determined by factors such age at first mating, age at first parturition, parturition interval, and number of services per conception. Nutritional problems lead to delayed age of onset of puberty, delayed age at first parturition, long parturition interval, low conception rates, and low overall lifetime reproductive performance.

Age at first parturition

Age at puberty and first parturition are important factors that limit productivity of animals. Age at first calving marks the beginning the productive life of a cow and influences the lifetime production and reproduction performance of the cow. It has a direct influence on the lifetime calf crop and milk production of the cow and an indirect influence on the cost of up bringing the cow. Heritability of age at first calving is low, which indicates that it is highly influenced by environmental factors such as the type and quality of feed supplied and the feeding management. Nutritional stress causes slow growth rate. Hence, heifers attain age at first sexual maturity and at first calving very late.

On average, the age at first calving of local cows is about 4.5 years. For example, age at first calving of Boran cattle in Ethiopia was reported to be 46-51 months (Hailemariam and Kassamersha, 1994) while they can calve at earlier age of 34-36 months under better management in Kenya. The age at first calving of Boran heifers under pastoral management condition was reported to be 4 years of age (Coppock, 1994) whereas under improved management at Abernossa ranch the heifers reached puberty at 22 months of age (Tegegne, 1989). Kurtu et al. (1999) reported that the age at first calving of local Arsi and crossbred cows to be 52 and 31 months, respectively. Similarly, Workneh and Rowland (2004) showed that the age at first calving for pastoral and agro-pastoral production system in Oromia are 51 and 48.4 months, respectively. According to IPS (2004), the age at first calving for indigenous cattle in pastoral and agro-pastoral areas of Ethiopia is about 4 years (48 months). A study in Wolayita area in southern Ethiopia (Tolera, 1990) showed that heifers attain sexual maturity at the age of 4.5 years and calve for the first time at the age of 5.5 years. Wolayita is a very densely populated and intensively cultivated area facing critical shortage of feed due to extreme

shrinkage of grazing land. Age at first calving for local and crossbred cows at Lemu-Bilbilo Woreda Dairy Cooperative was found to be 4 and 3 years, respectively (Teferi, 2008). According to Yalew (2009), the age at first calving of Holstein Friesian heifers varied from 32.4 -55.5 months with an average of 40.9 months (Figure 1). Heifers born from 1989 to 1991 had the highest age at first calving due to lack of appropriate calf and heifer rearing management due to insufficient budget allocation for the farm during the last days of the Dergue government.

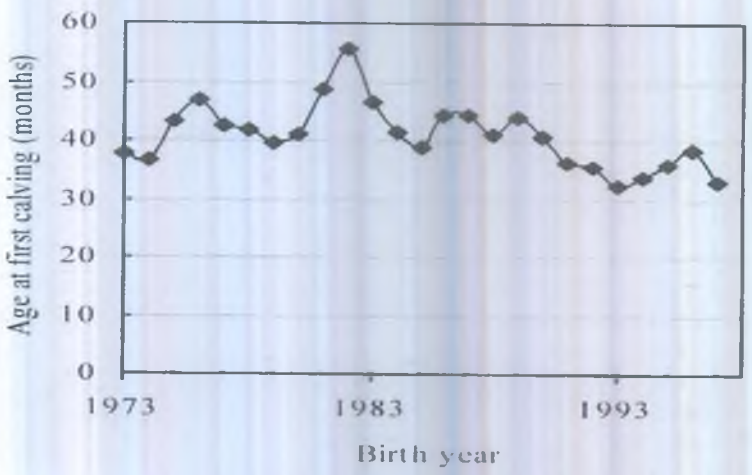

Figure 1. Effect of birth year on age at first calving of heifers born at Holeta Cattle Improvement Center

NB. The years are in Ethiopian Calendar and the years 1973, 1983 and 1993 correspond to 1981, 1991 and 2001 in G.C., respectively. The effect of birth year is due to feeding management of the calves born during those particular years (Source: Yalew, 2009).

A recent study (Gojjam et al., 2011) showed that nutritional manipulation of Friesian-Boran crossbred dairy heifers in the post-weaning period accelerated the growth rate and improved reproductive performance of the heifers. Under intensive indoor feeding management, where the ration consisted of 50% concentrate and 50% hay, the heifers came in heat at 15 months of age, enabling them to calve approximately at two years of age. However, when the post-weaning feeding management was lowered to a concentrate to roughage ratio of 30:70, the heifers could attain puberty about three months later at 18 months of age, whereas the puberty age was further delayed by 5 to 12 months in a grazing based outdoor management system compared to those supplemented indoor. Attainment

of puberty at an early age could enhance economic returns and create favorable environment for genetic improvement of the herd as it can enhance selection process. The relatively higher cost of feeding can be compensated by the return gained from production of calves and milk at earlier age and subsequent contribution for genetic improvement.

In general, the age at puberty and first calving are related with weight and inversely related with plane of nutrition of replacement heifers. The ultimate goal of heifer rearing is to raise the heifers economically and bring them to proper size and body condition for first service and calving at a reasonable age. On the other hand, poor heifer rearing systems can end up with poor replacement heifers, which may attain puberty at a late age and have poor conception rates. Such heifers may also have poor development of the mammary system, which will affect subsequent milk production. Nutrition is a major determinant for attainment of the proper weight at proper time. Protein and energy are the most critical nutrients for the growing young ruminants and should be provided in adequate quantity and quality to support maintenance and growth. This can be achieved by adjusting the concentrate and roughage ratio of the diet and feeding according to age and body weight of the animals. Thus, dietary manipulations can be used to advance or delay puberty in both male and female animals.

Parturition interval

It is the period between consecutive calving and is a function of the number of days open and gestation length. It has low heritability, which can be improved by proper feeding and other management practices. For optimum economic benefits, it is desirable to have shorter parturition intervals to attain higher lifetime productivity of the female animal. For example, under intensive dairy production systems, it is desirable to have cows calving every year. However, this is not attainable under many conditions. The calving interval of zebu cattle raised under traditional management in Ethiopia is about 26 months or every two years (Perera, 1999).

Conclusion and Recommendations

In general, livestock productivity is low for all classes of animals. The growth rate of growing animals is very slow and the overall production

and reproduction performance of the animals is sub-optimal. The milk yield of local cows is scanty and that of crossbred cows is much below their potential. The relatively late age at sexual maturity, the long parturition intervals and the low production performance of the animals reflect an environment in which animals are subjected to long periods of nutritional stress. Both the quantity and quality of feed supply are very low during most of the year although the problem is more aggravated during the long dry season. The seasonal variability in the quantity and quality of feed on offer gives rise to an annual cyclical pattern of live weight gain and losses.

The relatively low energy content of the main concentrate ingredients such as wheat bran and wheat middlings suggest that superior animal performances could be achieved by inclusion of high energy feeds such as maize grain. The inclusion of oilseed cakes with relatively high fat content (8-10%) can increase the overall energy content of the diet.

The following are suggested as recommendations to alleviate the problem.

- Proper feeding, health care and overall management of livestock is a pre-requisite for realizing the potential benefits of the huge livestock resources of the country. Available feed resources should be used more effectively and efficiently. There is a potential for enhancing livestock productivity by supplementary feeding using different agro-industrial by-products, horticultural crop wastes and occasional surplus grain;
- The types of ingredients to be included in balanced rations depend on their availability locally in adequate quantities, their possible alternative uses, their cost relative to their nutritive value, and other considerations such as their ease of feeding and whether processing is needed;
- High moisture roughages that are seasonally produced can be used fresh when and where they are available and conserved in hay or silage form for subsequent use. The mode of utilization should enable maximum exploitation of the available feed resources;
- The advantages and disadvantages of exporting oilseeds without value adding vs processing locally in to oil and oilseed cakes needs to be critically assessed;
- Farms that have adequate land for forage production should consider the production of forage crops that give high biomass yield; and

- Ethiopia produces a broad range of potential livestock feeds that together supply the macro and micronutrients. Thus, there is a need for adoption of the use of balanced "best cost" rations for more efficient and effective utilization of the available feed resources to attain the desired level of productivity.

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Chapter 4

Drought-Induced Livestock Feed Crises and Emergency Responses

Lemma Gizachew

Extent and Intensity of Livestock Feed Crisis

IN THE PAST, livestock asset depleting feed crisis are mainly confined to arid and semi-arid lands (ASALs) (Coppock, 1994; Yemane and Mesfin, 2000). Presently, due to prolonged heavy grazing pressure and continued conversion of traditional grazing lands into crop fields, the problem of feed insecurity has expanded deep into the highland proper. The mild drought of 2008, for instance, has pre-disposed over 340,000 heads of cattle in agro-ecologies cutting across the arid, semi-arid, and highland environments. This population is only for Afar, Oromia, Amhara and Tigray regions, and do not include the huge livestock population equally faced with similar critical feed shortage in Somali and Southern Nations, Nationalities and People's (SNNP) Regions. Due to the poor state of the feed resource base, slight deficit in rainfall in one corner of the country disrupts the feed security in wider geographic area including the commercial livestock productions systems in the highland. In such circumstances, growth, production, and reproduction of livestock come to complete stand still or at best reduced substantially in the affected areas and far beyond. As witnessed in the recent drought, severe feed deficit even results in heavy livestock mortality. The livestock mortality data in Table 1 show how all agro-ecologies of the country are vulnerable to drought induced feed deficits.

Table 1. Drought-induced livestock mortality in selected high, medium, and low altitude woredas (case in 2008)

Livestock	Highland (Kofele woreda)		Midland (Raya-Azebo woreda)		Lowland (Dire woreda)	
	Total population	Livestock died	Total population	Livestock died	Total population	Livestock died
Cattle	166,063	3,762 (2.3)	171,439	6,700 (3.9)	144,137	10,496 (7.3)
Shoats	114,905	4,000 (3.5)	176,538		97,354	2,438 (2.5)
Equines	33,969	1,970 (5.7)	24,472		10,120	

Figure in parenthesis represent %age livestock mortality due to starvation

Consequences of the Feed Crisis

Critical feed deficits had number of negative impacts on both household and country's economy. Livestock keepers, consumers, livestock traders and the market oriented livestock enterprises all suffer the consequences of the deepening livestock feed crisis. The most important consequences of the feed crisis that deserve mentioning are listed below (Fig 1).

Economic damage to emerging small-scale dairying and feedlots: The 2008 feed crisis explains this very well. In 2007/08, the severe feed crisis first hit the pastoral and agro-pastoral production systems. Over 3,290 tonnes of concentrate and 4,100 tonnes of fibrous feeds were mobilized from the central highlands to some of these affected areas by various agencies to save the lives of the core breeding livestock. This has aggravated the feed shortage and increased feed price in the central highland proper. In the capital and its surroundings, with the start of the survival feeding in the pastoral areas concentrate and fibrous feed price increased by over 150 and 40 %, respectively. This caused substantial productivity drop and heavy financial loss on the emerging dairy farms and feedlots. The feed crisis forced feedlots and small-scale dairying to scale down their operation. Some dairy farmers who were unable to cope up with the soaring feed prices even disposed the dairy breeding stock built at great cost and quit the business. Similar instances were observed during the 2011 drought as well and this may continue unless appropriate interventions are made to address the chronic problem of feed shortage.

Household food insecurity and loss of livelihood: Prolonged and severe feed deficits arrest livestock production and reproduction. Lactating cows cease producing milk and oxen become unable to pull the

plough, and in the worst cases succumb to death. This will directly be reflected on household food security, and post drought recovery. The impact of such feed crisis is particularly more devastating to those households with few heads of livestock. Such groups will be obliged to sale the only replacement and female breeding stocks to buy the relatively expensive cereal grain (maize), thereby depleting the livelihood asset. In Borana, for instance, at times of drought half of the cattle supplied to the local livestock market are breeding females. The 2008 drought, for example, has forced over six million people in Somalia, Afar, SNNP, Oromia, Amhara, and Tigray Regions to live on relief food aid.

Shortage and un-affordability of animal products: Feed crisis escalate the prices of animal products notably milk. In the recent drought, milk price rose by about 65%. This has caused malnutrition in children, and pregnant and suckling women. The lack of milk in the diets of children has long lasting negative impact on the country's human capital that determines its future.

Loss of traction power: In the drought stricken highlands and agro-pastoral areas, oxen are among animals affected by the feed deficit. In such places, farmers' ability to timely prepare seedbed will severely be compromised either due to complete loss of the oxen or drop in traction output.

Decline in export competitiveness: The shortage and sharp price rise of feed will increase the finishing cost of animals intended for the export market. This will become disincentive for many of live animal exporters and export abattoirs.

Increased incidences of conflict: Feed crisis trigger massive mobility of people and animals to places with relatively better forage and water availability. In most of the cases, at times of drought access to these resources is stiffly contested. Oftentimes, such conflicts culminate in the loss of asset and human lives.

Loss of biodiversity: Prolonged and recurrent droughts not only affect the availability of feed but also affect the well-being of the animal and plant biodiversity. The impact of bio-diversity loss has not been systematically document but no doubt, it is substantial. Droughts followed by heavy grazing pressure will accelerate the depletion of seed-

soil bank of the most desirable forage species and their eventual disappearance.

What aggravates the livestock feed crisis?

The root causes of livestock feed insecurity are numerous but the most notable ones are the following (Fig 1).

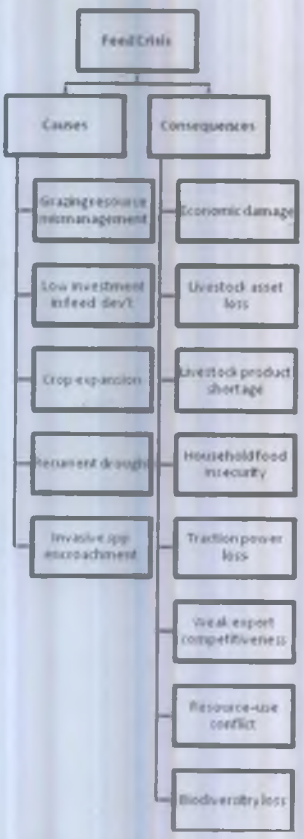

Figure 1. Cause and effects of livestock feed crisis

Mismanagement and degradation of grazing lands: Grazing lands both in the pastoral, agro-pastoral and mixed farming systems are owned communally. In principle, all members of the given locality have use rights to these common resources. Unfortunately, users of such resources are rarely accounted individually for their mismanagement. Across all production systems, high grazing density without rest period resulted in excessive removal of the vegetation cover and loss of desirable perennial herbaceous forage species. In the *arid and semi-arid lands (*ASALs), heavy utilization pressure is also imposed on edible browse species. For instance, excessive drought-time lopping has made irreversible damage to important indigenous browse species such as *Balanites* species, *Terminalia brownie*, *Olea* species and many others (Gizachew, 2009).

Recurrent drought: The growth of pasture and browse species as well as the availability of crop residues is a function of rainfall. However, rainfall in ASALs is becoming more erratic both in occurrence and in distribution. The rest of the country is also experiences more of the same. Such incidences are creating situation unfavorable to the growth and regeneration of the pasture, and the production of adequate crop residue biomass. Repeated rainfall failures in the ASALs have worsened the feed situation by accelerating the loss of vegetation cover and depletion of soil-seed bank of desirable forage species). The depletion of desirable indigenous species and the loss of vegetation cover of the rangelands have reduced resilience of these areas to recurring droughts (Gizachew, 2009). Furthermore, the poor state of the rangelands has compromised the post-drought recovery and the ability of surviving animals to withstand subsequent droughts. In such areas, production and reproduction from livestock are generally low and mortality of weak animals continues even long after the droughts are over.

Limited preparedness to periodic feed deficit: Largely, vulnerability to periodic feed deficit is associated with the low attention given to feed resource development and actions that reinforce drought preparedness. Some of these weaknesses are presented below.

- Feed availability increases during and immediately after the rains. As most livestock keepers do not practice feed conservation, part of the forage biomass which otherwise used to bridge the dry season feed deficit is wasted due to trampling and shattering loss. Even in places where livestock keepers practice feed conservation,

the nutritional value of the conserved feed is compromised due to excess exposure to sunlight and rain;

- Most farmers and agro-pastoralists recognize the value of crop residue as sources of feed and construction material. Immediately after crop harvest, they stack them around their homesteads. However, crop residue users grossly lack the skill for proper storage, processing, and treatment. As a result, this valuable resource is underutilized due to the absence or limited use of technologies that reduce wastage and enhance nutritional value; and
- A handful of improved forage genetic materials adaptable to different agro-ecologies of the country are available. However, their production on a larger scale is limited to research centers, private farms and very few innovative grassroots communities. Weak technology dissemination, shortage of planting materials, lack of forage development schemes with market oriented livestock production, and uncontrolled or free grazing system have hindered the wider use of these productive forages.

Encroachment of invasive species: Rapid spread of invasive species into the traditional grazing lands is the other threat to livestock feed security (Yemane and Mesfin, 2000; Coppock, 1994; Gizachew, 2009). Wherever they occur, invasive species have reduced the effective size of the pastureland and hence the forage available to grazing animals. In the ASALs, woody invasive species of both native and exotic origin that are posing the most daunting challenge. The most prominent woody invaders include *Prosopis juliflora, Acacia drepanolobium, A. seyal, A. mellifera, A. senegal, A. nubica, A. reficiense* and *A. horrida*. Among the herbaceous invaders, *Parthenium hysterohorus* has managed to spread into pasturelands and crop fields across the country.

Expansion of crop agriculture: Rapid population growth and the attendant increase in the demand for cultivated land has contributed to substantial reduction in grazing land. Seasonally flooded plains and swamps in the mid and high altitudes, and fallback grazing areas in the lowlands, which used to supply the bulk of forage to grazing animals have largely been converted into permanent crop fields. To a large extent, the expansion of the crop agriculture into areas unsuitable for arable farming, particularly in the drought prone rangelands, is undertaken to achieve land ownership rights rather than production of crop with reasonable harvest (Coppock, 1994). Considering the rapidly increasing human population and the shortage of grain for human consumption, the

expansion of crop agriculture would be inevitable. However, the main concern is about expansion of cropping into marginal areas where the land cannot support meaningful crop production.

The continued shrinkage in grazing lands, specifically in the mixed farming systems and agro-pastoral areas increased the dependence of livestock on crop residues and purchased feed. Feed insecurity in such environments is further worsened by the diversion of crop residues to other competitive uses such as fuel wood and construction materials.

Coping strategies

Mobility or livestock re-location: For generation pastoralists have employed mobility as strategy to escape the negative consequences of seasonal and drought-time feed crisis. The mobile form of livestock keeping is the most effective and ecological sustainable way of land use for the ASALs (Kamara *et al*, 2003; WISP, 2008). Unfortunately, such opportunistic forms of rangeland uses have been restricted due to conflicts and expansion of crop agriculture. The increased incidences of conflicts are associated with the dwindling of the grazing resources and weakening or breakdown of traditional resource management structures. Alaydege, El-Gofa, and Sagan buffer-grazing reserves are examples of some of the grazing areas underutilized due to resource use conflicts (Gizachew, 2009).

Use of bought-in survival feed: This is largely carried out in ASALs through supports accorded by governmental, NGOs and UN (FAO) agencies to protect core-breeding stock. The number of targeted animals and benefiting households from such assistance are modest but the feed procured for survival feeding commands substantial resource (Table 2). In the 2008 drought, for instance, over 2.2 million US $ was spent on feed assistance. Of the above feed expense, 36% went to cover feed transport cost. Out of the over half a million heads of cattle requiring survival feed nation-wide in 2008, only less than one-third was reached through the survival feeding. In the recent drought, pastoralists and farmers have also been noted buying feed to sustain the lives of their animals although the exact number of pastoral households and feed procured are not properly documented. The types of feed used in these survival-feeding schemes are limited and the main ones include concentrate feeds, wheat bran, grass hay, and cereal crop residues.

Table 2. Survival feed mobilized by various agencies and livestock targeted (case of 2008 drought)

Agencies	Targeted regions and zones	Feed mobilized		Livestock targeted
		Concentrate (q)	Grass hay (bales)	
FAO	Oromia, Tigray, Afar	11,486	54,286	34,544
GTZ	Tigray	4,000	0	12,900
CARE	Oromia	4,260	56,800	12,200
SC-US	Borana, Guji Somali	3675	39,751	19,250
OPADC	Borana, Guji, E.Shewa	0	73,049	13,101
AFD	Dhas	350	5,990	500
COOPI	Guji, Liben (Somali)	3,300	18,000	7,800
Gayo	Dillo	0	18,049	2,500
LPDA	Liben	4,505	0	1,800
IRC	Somali (Degehabur)	0	375	440
SC-UK	Somali (Fik)	0	10,666	1,300
Oxfam-GB-APDA	Afar	1,400	0	30,000
Total		32,976	276,966	136,335

High feed transport cost, late response, over-dependence on external support and focus on limited feed types were the major limitations of the bought-in feed based survival feeding. Despite these limitations, the feed assistance has helped enhance beneficiaries' skills and protect core cattle breeding stock. Moreover, the feed assistance has avoided the costly post-drought re-stocking, dependence on relief food aid and human suffering. The 2006 and 2008 survival feed assistance saved the lives of over 20,000 and 130,000 heads cattle breeding stock, respectively. The feed assistance also helped to create market demand for feed in pastoral and agro-pastoral areas. Feed processing plants, feed vendors from the highland, pastoral cooperatives and women have generated income from the marketing of compound feeds, grass hay, cereal straws, and agro-industrial by-products.

Externally supported rangeland development initiatives: Two large-scales externally supported rangeland and fodder bank development namely; the Third Livestock Development Project and the Forth Livestock Development Project have been implemented in mid 1970s and late 1980s with the overall objective of enhancing the feed production potential of the pastoral and mixed crop productions systems. Due to low beneficiary participation and lack of immediate economic incentives, both projects have had limited success.

Community led participatory drought preparedness schemes: Although not many, there are communities who currently have taken long term feed development more seriously. In southern zone of Tigray and Northern Wollo zone of Amhara regions, farmers have started growing and using cactus to bridge feed deficit in periods of drought. Here, cactus is planted as hedge along the borders of the private land holdings and on hillsides devoid of vegetation. A cactus variety in wider use is the spiny type. The major limitation of cactus as survival feed is the low DM content. Affording farmers compliment cactus based survival feed with crop residues.

In the ASALs, the community-led participatory range rehabilitation initiatives have succeeded in restoring the productivity of bush-encroached group grazing reserves or *kalos*. Rehabilitated rangelands of Dire and Miyo districts are the witnesses of such positive developments (Gizachew, 2009). The combined effects of bush thinning, rest period and controlled-fire effectively restored the productivity of degraded rangelands. Perennial grass species that made satisfactory recovery following the above rehabilitation efforts were *Themeda triandra*, *Crysopogon plumulosus*, *Cenchrus ciliaris*, *Cynodon* species, and *Chloris roxburghiana*. The recovery of the herbaceous grass has attracted wild herbivores into the area, which includes Thomson's gazelles, antelopes, and zebras. Pastoral communities in the same place are also conserving locally available forage materials for use in lean period. The conserved feeds include crop residues, grass hay, weeds, and indigenous fodder tree pods. There are still agro-pastoral community groups in Afar and Somali regions that just started growing irrigated forages through the support of research and development organizations. *Chloris gayana*, *Panicum maximum*, *Sorghum sudanese*, *Cenchrus ciliaris*, *Leucaena leucocephala* and *Medicago sativa* are some of the species being grown in these regions.

Commercial and slaughter de-stocking: In the last couple of years, government and humanitarian agencies have been encouraging livestock keepers in drought-prone areas to timely de-stock part of their herd before their condition deteriorate and succumbed to death. Depending on the stage of the drought cycle, either accelerated commercial de-stocking or slaughter de-stocking is adopted. Despite, the obvious benefits of these practices their actual scope was limited due to lack of timely livestock early warning information, low level of awareness, and lack of credit.

Conclusion and Recommendations

Up-scale community-led rangelands and grasslands rehabilitation initiatives: Although the scale is limited, community led rangeland rehabilitation efforts are bringing positive change in vegetation cover and supply of feed to grazing herbivore. This has empirically been demonstrated in pocket areas of the once denuded-landscapes of Tigray and Amhara and bush-encroached rangelands of Oromia (Borana). Up scaling such positive developments would require the concerted efforts of the grassroots community, governmental and no-governmental organizations including the donor communities. As these restoration exercises would demand resources and time, they should also be viewed beyond the short-term economic benefits.

Link emergency response to long term feed development program: With growing frequency of drought incidence and degradation of the feed resource-base, the population requiring humanitarian assistance including survival feed is growing to unmanageable proportion. This is making the livelihood asset protecting initiatives more expensive. Provision that mainstream emergency drought response into the recovery phase of the drought and beyond will help to countervail the problems of feed insecurity in more sustainable manner.

Strengthen drought preparedness of moisture deficient environments: The interval could vary from place to place but almost all ASALs experience cyclic livelihood asset eroding feed crisis. Containing such frequent and pervasive feed crisis would require investing more in activities that strengthen drought preparedness at the level of the grassroots. It is only then that the persistent livestock feed insecurity problem is controlled and productive pastoral and agro-pastoral livelihoods are created. This would entail enhancing the grassroots capacity with respect to feed production, conservation, and utilization strategies. In addition to natural resource rehabilitation, the aspect of drought preparedness will include the timely stockpiling of locally available feeds, fodder bank development, and increased and improved use of agricultural and agro-industrial by-products.

Empowering and capacitating customary institutions: For generations, customary institutions in the arid and semi-arid environments have succeeded in managing rangelands in a more

sustainable manner. Nevertheless, inadequate supports to customary institutions and lack of recognition of their role have contributed to the mismanagement and ever-worsening livestock feed situation. Empowered and well-capacitated customary institutions are better placed to protect key pastoral assets, and maintain practices that ensure judicious management of rangelands such as peace building, defined settlement, and grazing patterns, and free mobility of grazing animals across the spatially heterogeneous and temporally variable landscapes.

Create viable forage marketing system: Forage as an economic activity demands skill, capital, and organizational set-up. Most farmers, agro-pastoralists, pastoralists, however, lack the basic technical skills necessary for growing, processing, preserving, and utilizing cultivated forage. Imparting these technical skills on would-be forage growers, therefore, is crucial for success. Furthermore, economic incentive must exist for forage growers to have interest and take the task more seriously. In the past, the limited success in externally supported projects partly related to lack tangible economic benefits to forage growing farmers. Therefore, support in terms of a start-up capital, credit access and market linkage is crucial for market oriented forage development programs. Accessing inputs and marketing outputs are cheaper when dealt in groups than on individual basis. Therefore, organizing farmers or agro-pastoralists who aspire to produce forage for market into groups is as vital as the skill enhancement and financial assistance.

Minimize resource use conflicts: Due to the decline in productivity and shrinkage in grazing resources, conflicts over the use of pasture and water resources are escalating. These conflicts, other than denying one or both contesting parties from accessing these resources are claiming human lives. Enhancing the equitable access of these resources and minimizing the negative impacts of droughts would necessitate strengthening community led peace-building initiatives. In order to create lasting peace and warrant judicious use of grazing resources in conflict prone areas, customary institutions, and concerned government agencies have to work in unison.

Improve the timeliness and accuracy of Livestock Early Warning Systems (LEWS): An accurate and well-timed LEWS assist producers and donors take timely actions that help protect livelihood asset. Accessibility and quality of such information is important to commercially de-stock the less important part of the herd and re-locate

remaining core breeding stock or economize feed needed to maintain them. Above all, the usefulness of LEWS is dependent on swift response of the donor communities to early drought indicators. Unfortunately, the economic and social benefits of LEWS to pastoralists have not been adequately realized due to slow and delayed response.

Promote research on innovative livestock feed production: Promote applied research on innovative livestock feed production in addition to the conventional ones that are currently practiced, for instance, use of proven bio-tech and emergency feed for drought period.

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Chapter 5

Compound Feed Processing Industries

Alemu Yami and Yirdaw Woldesemayat

THE FEED MILLING INDUSTRY and modern livestock production are interdependent. The feed milling industry depends on the growth or success of commercial livestock and poultry production. Similarly, the productivity and profitability of livestock and poultry are also dependent on the production efficiency of the feed milling industry, as reflected in its capability to produce high quality feeds at reasonable and stabilized prices. The quality of feeds has been a major impediment to profitability of commercial livestock production. The reasons for this include the high cost of imported ingredients such as premixes, amino acids, vitamins and the low quality and availability of other feed ingredients.

The supply of agro-industrial by-products that constitute more than half of the ingredients used in mixed rations has not been growing commensurate with the growth in demand. As a result, the price of ingredients and manufactured feeds has been increasing at a very fast rate. This has recently been so fast that many farms have gone bankrupt and out of production. There are reported instances of valuable dairy animals sent for slaughter.

Feed Processing Industries

The development of the feed processing industry in Ethiopia goes back to the beginning of modern forms of animal husbandry, i.e., the early 1950's (PPE, 1984). Currently, a number of feed mills owned largely by the private sector operate in and around Addis Ababa. Earlier, the big feed processing factories were operated by government enterprises mainly the feed processing enterprise and by public institutions like

agricultural Colleges and research institutes. The feed processing factories under the feed processing enterprise have now been privatized and a number of private feed processing plants of various capacities using technology that is more advanced have recently come into operation. All of these feed mills are operating below capacity estimated at about 25%. It seems, therefore, that there is sufficient capacity to satisfy the present and possibly demands for feed mixtures—despite the expected considerable growth over the years to come. The distribution of feed mills has some relation to the concentration of intensive types of livestock production namely the environs of Addis Ababa and Adama having the largest concentrations of feed mills and intensive forms of livestock production.

Capacity and volume of industrial feed production

The capacity of feed mills ranges widely from 0.5 to 12.5 tonnes/hour. The output of compound feeds has increased during the recent years. Most of the industrial feeds are poultry feeds. The standard for a feed mill is 2000 hours of operation annually. The feed mills in Ethiopia are generally operating much lower than this standard. Almost all factories operate for much lower than eight hours per day while they can potentially operate for at least two shifts of eight hours each. The main reasons why installed capacities are not used efficiently are the low availability of ingredients, inadequate storage capacity, localized distribution of the plants and various technical limitations. The capacity of feed mills owned by members of the Ethiopia Animal Feed Industry Association (EAFIA) is presented in Table 1.

In addition to the commercial feed mills listed in Table 1, the FEED Project of ACDI/VOCA funded by the United States Department of Agriculture (USDA) assisted nine cooperative unions located in different parts of Ethiopia to install feed mills with 0.6 tonne/hour capacity each. Even though the capacities are smaller, the feed mills of the unions are more of wider geographic distribution in the country—including Mekelle, Adigrat, Debre Birhan, Chancho, Hossana, Hawassa, Wonji, and Addis Ababa—than the commercial feed mills.

Table 1. Feed milling capacity of EAFIA members who provided information

Name of feed mill	Facility/Installed Capacity					
	Feed mill (t/h)	Mixer (t/h)	Pelleting (t/h)	Liquid mixing facility	Ingredient storage capacity (t)	Processed feed storage capacity (t)
Alema Koudijs P.L.C	12.5	15	-	1.5	50 00	1000
Ashraf	6.25	6.25			500	300
Akaki Animal Feed P.L.C	5.2	8	-	-	1000	500
Kality Animal Feed Enterprise	4	6	-	-	1500	-
Addis Alem Agricultural Development PLC	2	4	2	-	3000	1000
BSLF Animal Feed Processing Plant	0.5	0.5	-	-	-	-
Fantu and Family	0.5	0.5	-	-	100	-
H.B.A General Business	2	1.5	-	-	50	20
Ada'aa Dairy Cooperative	1.5	1	-	-	100	60
Almaz Poultry and Feed Processing Enterprise	0.5	0.5	-	-	40	-
Ethio-Feed PLC	2.0	1.0	-	-	300	20

Type and form of mixed feed production

The different feed processing plants currently produce various types of compound feeds (Table 2). The compound feed types produced include poultry rations such as broiler starter, broiler grower, broiler finisher, layer starter, layer grower, and layer; dairy ration, sheep ration, beef fattening ration and livestock emergency feeds for breeding stocks. One of the factories (Alema Koudijs PLC) also produces pig rations (pregnant sow ration, pig fattener ration, suckling sow ration). Poultry feed is the most widely produced compound feed by most of the feed mills followed by dairy cattle ration with exception of Addis Alem Agricultural Development PLC, which produces more beef cattle ration than other feed processing plants. Currently, all feed mills are producing mixed feeds in mash form and a small amount of multi-nutrient blocks (MNB). Most mills do not have the facilities to produce pelleted feed. Some mills have such facilities but do not pellet feed due to the low awareness of buyers. Protein concentrates and premixes are not produced by any of the feed mills. This limits the possibilities of small-scale home mixing of compound feeds.

Table 2. Amounts of mixed feed (quintals) produced by eight feed mills that supplied information

Name of Feed Processing Plant	Type of compound feed	Year		
		2008/09	2009/10	2010/11
Akaki	Poultry	33,760	35,587	32,074
	Dairy	14,782	13,887	12,443
	Beef	337	317	427
	Others	833	884	876
Kalitti	Poultry	9531	9308	13,566
	Dairy	6637	6344	9845
	Beef	9955	9516	14,767
Addis Alem Agric. Develop PLC	Poultry	2650	2750	2870
	Dairy	1325	1375	1435
	Beef	22,525	23,375	24,395
Alema Koudijs PLC	Poultry	-	60,848	86,113
	Dairy	-	15,054	14,446
	Beef	-	1322	7840
	Swine	-	6027	7844
	Others	-	449	94
H.B.A	Poultry	912	724	574
	Dairy	4954	5000	4416
Ethio Feed PLC	Dairy	370	500	1400
	Beef	375	400	1400
Genesis Farm	Poultry	9993	11379	16765
B.S.L.F	Poultry	8000	9500	10,800
Total		**126,939**	**214,546**	**264,390**

Availability, quality, and cost of feed ingredients

The principal cost in the manufacture of compound feeds is that of raw materials; this could amount to as much as 80% or more of the manufacturing costs in large size mills. Ethiopia produces a wide range of ingredients suitable for concentrate feed mixing. The main problem, however, is that some ingredients particularly cereal grains have priority for human consumption. Although Ethiopia remains food deficit, the supply of some feedstuffs like mill by-products and crop residues is gradually increasing because of the introduction of new high-yielding crop varieties and expansion of food-processing industries even though not at the rate of the increase in demand. The following are the main agro-industrial by-products used:

- **Flour milling by-products**: Wheat bran, wheat shorts, wheat middlings, rice bran;
- **Oil milling by-products**: Oil seed cakes/meals like noug, cotton, rapeseed cakes/meals;

- **Brewery by-products:** Brewers grains, brewer's yeast; and
- **Malt factory by-products:** Malt by-products

These by-products are also directly fed especially to dairy and fattening animals as well as carthorses. Feed ingredient prices are variable depending on the supply, source, transport costs etc.

Nutritional Value and Price of Industrial Compound Feeds

Low availability and high cost of feed ingredients, the lack of enforcement of quality standards and lack of feed formulation knowledge are the main factors that reflect negatively on the quality of industrial feeds. The feed mills in the country are very variable in age and level of technology used. There are obvious differences in the quality of compound feeds depending on the technological level of the processing plant. As a result, some compound feeds do not meet the requirements of the target animals while others contain certain nutrients higher than necessary.

The high cost of compound feeds is one of the main reasons for the slow growth of intensive livestock production in Ethiopia. Mixed feed prices have generally gone up very fast during the past few years largely due to the increase in feed ingredient and transport costs.

Home Mixing of Feeds

Many feedlot operators and some dairy producers do home mixing of compound feeds. Very little home mixing for other types of compound feeds is done. This is primarily due to lack of ration formulation skills and the unavailability and high cost of ingredients if purchased in small quantities. There is no feed mill in the country that produces protein concentrates and premixes. Animal producers could mix their own all-mash feeds on farm from the concentrates and homegrown maize and/or other ingredients readily available had there been production of protein concentrates in the country.

Quality Control and Feedstuff Legislation

So far, Ethiopian feed millers pay very little attention to the quality of raw materials they use and the compound feed they produce. This is because they are not obliged to guarantee the nutritional value of the compound feeds they produce. Moreover, customers of mixed feeds are not yet adequately aware of the fact that quality pays and most go for cheaper compound feeds of low quality.

The former Quality and Standards Authority of Ethiopia (QSAE), the current Ethiopian Standards Agency (ESA), has developed standards for industrial compound feeds and feed ingredients. The standards came into effect as of 2005. These standards were prepared at the request of the Ethiopian Society of Animal Production (ESAP). The standards contain minimum requirements for compound feeds based on current recommendations for good feeding practice considering the circumstances in Ethiopia with respect to availability of raw materials for manufacturing compound feeds and the economics of livestock production. These standards are, however, only "voluntary" and lack the strength to enforce these standards on a mandatory basis. As a result, strict government enforcement of the standards and quality control of feed ingredients and compound feeds is not practiced. Quality control is left to the feed industry to monitor itself. The industry does not do this due to a combination of factors such as:

- small-scale of operation;
- failure by management to appreciate the need for quality control;
- lack of qualified staff; and
- limited of laboratory facilities and services available to the feed processing industry

The lack of animal feed quality control services has made it impossible to monitor feed particularly from the smaller feed mills, feed ingredient manufacturers, distributors, suppliers, dealers, retailers, and importers. The chances of adulteration of feeds are high at any of the handling stages.

Under license from the Ethiopian Standards Agency, manufacturers of standard feeds are allowed to use the authority's *Certification mark*. The presence of the mark on a product is an assurance to consumers that the

feeds have been produced to comply with the requirements of the Ethiopian standards under a system of supervision, control and testing in accordance with the certification mark scheme. No feed mill is using the certification mark. Consumers are also not aware of the meaning and implications of a *Certification mark* and thus do not demand it.

The feed milling industry is "requested" by the feed quality standards to declare the guaranteed nutritional value and the ingredient composition of compound feeds. There is, however, no industry except the recently established Alema-Koudijs feed mill that labels its compound feeds since the legislation is not binding. The feed standards available do not include feed additives and there is no regulation on licensing of imported feed additives and their use.

The Animal and Plant Health Regulatory Directorate of the Ministry of Agriculture has recently come up with a legislation to put a regulatory mechanism in place and enforce feed quality standards. This legislation has now been approved and implementation has started. It is hoped that the compound feed quality problem will improve when this legislation comes into effect fully.

Professional Organizations

The feed milling industry has recently organized itself under the "Ethiopian Animal Feed Industry Association EAFIA." There are 45 members out of which 9 are feed mill owners. The main duty of the association is to act as mediator between the industry and the government and be the mouthpiece for the feed industry. The association is, however, still young and needs further nurturing to meet the enormous challenges and tasks the industry faces.

Challenges/ Constraints

The Ethiopian feed industry has gradually started to move forward. However, it is faced with an array of challenges and constraints. The challenges or constraints faced by the industry are outlined hereunder.

- Unavailability/ shortage and high cost of feed ingredients: Feed mills require a high amount of at least the main ingredients in a feed formula and a large variety of micronutrients (vitamins, minerals, additives). The

major components of the formula (grains, oil meals, industrial by-products) are not always available at the right time and at the right place. The unavailability/shortages also directly result in sky rocketing prices of ingredients with the consequences of high compound feed prices. Many feed mills are currently producing much lower than installed capacity. The following are some of the reasons for the unavailability/shortage and high cost of feed ingredients and compound feeds:

- The high demand for ingredients like maize as human food and the resultant inflationary soaring of prices;
- Drought in the lowlands causing channeling of ingredients to these areas creating shortage in supply to feed processing plants;
- Oil seeds are largely exported whole without oil extraction resulting in unavailability of the by-products (Oil cakes/meals) locally for feed processing in country;
- There was a ban imposed on the use of protein sources of animal origin in compound feed mixtures because of the mad cow disease scare. This has now partially been lifted for use for poultry use only. There is still shortage of this ingredient. Other slaughter houses do not either have the facilities to process these by-products or available facilities are not functional;
- Unavailability of local sources of vitamins, amino acids macro and micro-minerals and the resultant high cost of importation with subsequent increase in the price of mixed feeds;
- limitations arising from shortages of hard currency for importing ingredients like premixes;
- Multiple taxations are imposed at different stages of animal feed processing. Premixes (vitamin, mineral, and enzyme supplements) normally constitute about 7% of the total cost of compound feeds for poultry. However, due to the very high import taxes of 53% constitute almost 20% of the total cost of poultry compound feeds. For ingredients purchased from the local market, taxation inflates prices as the raw materials are taxed twice i.e. when purchased from the market and again after processing. A combination of these results in an undue increase of more than 30% on the total sales price of compound feeds;
- High transport costs and delays;
- Insufficient storage capacity of annual crops or by-products produced seasonally;
- Lack of market information like ingredient prices, mixed feed prices, etc

- Low consideration and awareness for high quality feed. Customers are looking for inexpensive feed regardless of the quality. However, cheap is not always economical. This also applies to most feed millers.

- Poor quality of ingredients;

- Adulteration of feed with lower quality feed material is a common practice. Feed ingredients that should be rejected on quality grounds are often used by millers due to the lower cost of such ingredients;
- Lack of access to feed laboratories resulting in no possibilities for checking on quality;
- Deterioration in feed quality during storage is also common. The hot-humid conditions during the wet season are especially conducive to fermentation, rancidity, mycotoxin production and/or perhaps growth of salmonella; storage pests are often a menace;
- Processing of raw materials varies from very efficient to primitive methods resulting in extremely variable products. The following are some examples:
  - Extraction of oil from oil seeds may differ between extractions technologies used. The more efficient solvent extraction method or a high or low-pressure oil expeller or both are used. Depending on the process, residual oil increases Metabolizable Energy (ME) but lowers the crude protein (CP) content and this leads to a short shelf life;
  - Many protein meals that need cooking are sometimes under or overcooked;
  - Locally processed fishmeal is manufactured from a mixture of trash fish resulting in a product of very variable composition;

- Lack of quality control services and / or poor implementation of the Ethiopian feed standards: Despite the presence of legislation on the composition, description, and marketing of ingredients and manufactured feeds, quality control and follow up is non-existent due to the "voluntary" nature of the existing quality control legislation. This may change after approval and enforcement of the draft legislation on feed quality standards by the Ministry of Agriculture (MoA);

- Low market demand:
  - The livestock production of Ethiopia is largely of a subsistent type where compound feed supplementation is extremely low. The low income of consumers and the consequently depressed markets and declining trend in consumption pattern of animal products as a result of inflation have contributed to the low production of livestock and animal feeds.
  - While the available demand for mixed feeds is dispersed all over the country, the concentration of firms in and around Addis Ababa has resulted in unfavorable effects on marketing and distribution costs, as well as procurement costs of ingredients.

- Problems related to the formulation of rations:
  - Lack of experience and facilities such as computer software for best-cost feed formulation for efficient animal production;
  - Another major problem of the industry is compounding feeds from composition tables that have limited information or have been

produced in other countries. Quite often the results of chemical analysis of the final product do not tally with the tabulated values;
    - Professional advisory service is rarely used.

- Other limitations like power interruptions and lack of spare parts for maintaining existing equipment are among the most frequent causes of low output or insufficient quality of feed produced by the feed milling industry;
- Many of the feed mills are older than 20 years and thus utilizing old technology. This has its own implications on the quality of compound feed produced and maintenance requirement because of frequent breakages;
- Lack of expertise in commercial methods of compound feed manufacturing;
- Inadequate extension and technical support services to the feed milling industry by government, research, and international agencies. Whatever little focus there was has been on roughage;
- Inadequate research information on the use of local by-product feed ingredients and reliable information on composition;
- Lack of appropriate credit facilities;
    - The industry's dependence on imported equipment and machinery and associated high investment cost;
    - Insufficient storage capacity of annual crops or by-products produced seasonally; and
    - Very limited effort/attempt to go into diversified forms of feed products such as pellets and mineral licks

Opportunities

- Prospects of marked increase in demand in the near future;
    - There is an increasing trend of intensification of livestock production especially the poultry industry. This opens the opportunity for a substantial increase in the demand of compound feeds;
    - Increased consumer demands as a result of forecasted increase in income and purchasing power of the population;
    - A welcome trend in the increase of the commercial orientation of animal production in Ethiopia; the breeds/strains of animals have also started to change in line with advanced countries. The improved breeds are dependent on commercial mixed feeds. This is expected to continue at a faster rate in the future;
    - Potentially high demand in neighboring countries for compound feeds and livestock products and the comparative advantage of Ethiopia in supplying this demand;

- Other opportunities for better prospects for the growth of the feed milling industry:

    - Increase in the production of raw materials for mixed feed production in terms of yield per unit area and acreage; there appears to be an opportunity for increased production through application of improved technologies including irrigation use and increased hectarage planted to soybeans and maize, the major input ingredients to the compound feed milling industry. Thousands of hectares of land are being leased by investors for the production of soybeans and maize;
    - Encouraging development in the direction of construction of small capacity feed milling and mixing equipment locally that can help reduce investment cost of establishing feed mills. This effort needs to be nurtured;
    - Formation of association such as EAFIA that can facilitate exchange and promote linkage, networking, and coordination work.

Conclusion and Recommendations

Government should encourage investment in feed production/processing. This entails for example availing land and specific loans for feed production/processing. The Government should institute sound policies to assure adequate feed supplies and reliable quality of raw materials and finished feeds at prices affordable to livestock and poultry raisers. Some possible innovations by the government to encourage compliance to existing animal feed standards could be the following:

- Speed up the coming into effect of the feed inspectorate service
- Accreditation of service laboratories to increase chemical analysis capabilities for faster results;
- Create platform for development and research institutions to closely work and engage with the private feed industry
- Awards and recognition for consistent compliance to rules and regulations;
- Conduct dialogues, public hearings, workshops to increase level of awareness, improve feedback mechanism and encourage private sector in policy formulation;
- Linkages with local and international government and non-government organizations for information networking and support;
- Tax issues: Avoid multiple taxation and or consider tax exemption for feed ingredients and compound feeds (like many other food items) at least for a period to give an initial push to help the industry kick off;
- Give priority to the local feed industry over exports of feed ingredients;
- Strengthening the Ethiopian Animal Feed Industry Association (EAFIA): Feed millers have bonded into the EFIA in order to achieve

certain efficiencies and affect some production cost savings. This association can play a big role in terms of:

  - Serving as the mouthpiece of members to help solve their problems by bringing the same to the attention of relevant bodies;
  - Set up an agreed vision and mission of the feed milling industry and help members to work towards that goal. The greatest opportunity for growth will be the industry's ability to help customers meet the demands of consumers. Vision to "help feed the world affordable, wholesome food" by developing feeding programs that optimize health, performance and profitability with customers should be pursued.
  - Act as focal representative body to facilitate the linkage of national and international development and research institutions for transfer of proven technology and innovative work.
- Motivate national professional societies such as ESAP, EVA and the like to dwell on practical feed related undertakings.
- Enforcement of feed legislation and launching feed quality inspection services are required. This can be implemented in a step wise manner
- The Ethiopian feed standards were put in place as of 2005. It is thus advisable to review and update the standards to reflect the present scenario where small-scale as well as large-scale feed mills are emerging. This should be done in view of making the regulations accommodative of the smaller upcoming feed millers and those that are at the upper end;
- Enforce the legislation: The already available Ethiopian feed quality standards are "voluntary" standards. The first step after revisiting the standards as indicated in the preceding bullet, needs to be making these standards "mandatory" so that all actors along the line of compound feed processing are obliged to abide by the stipulations of the law;
- Awareness creation by the government, the EAFIA, and other professional associations on the usefulness of implementing the quality standards on a mandatory basis to all parties involved. This should be taken as one of the priorities for application of the standards;
- Gradually start enforcement of the legislation and routine inspection practices commensurate with the increase in awareness;
- The quality control legislation can only be successfully implemented if the government can support the staff and material requirement of an efficient quality control laboratory and where materials are sold on the basis of these quality measurements. This can also be done on a step-by-step basis. Initially, central labs can be established and/or the capacity of the lab at the Ethiopian Standards Agency be strengthened to support the feed inspection service. The bigger feed mills should be encouraged to set up their own quality control labs in due course. A

Advisory service:

- Extension service to come up with recommended alternative formulae based on different ingredients for various classes of stock to encourage home mixing of compound feeds;
- The EAFIA come up with an "Animal Feed Service Bulletin" published regularly (quarterly, 6-monthly etc.) that contains results of the analysis and market information on feeds;
- In collaboration with likeminded national and international institutions, the EAFIA should organize training, workshops and conferences for its members on key feed related topics;
- Organize professional advisory service; for example, on ration formulation and manufacture to give support to the industry.

Upgrading of equipment and facilities of feed processing plants to increase efficiency:

Most feed processing plants are using very old technology and equipment. It is useful to improve this to increase quality, efficiency and cost of production, etc. The following are some steps that need to be taken:

- Help and advise feed processing plants to install liquid mixing accessories (fat and molasses) and pelleting facilities
- Enhance ingredient and processed feed storage capacity to minimize fluctuations in ingredient and compound feed prices
- Provide credit services for replacement of obsolete equipment, installation of auxiliary facilities and give training to personnel on maintenance and overhaul of feed mills.

Improve supply and cost of ingredients

Increase production of ingredients:

- Increase in the production of raw materials for mixed feed production in terms of yield per unit area and acreage. There are opportunities for increased production through application of improved technologies and increased hectarage planted to feed ingredients either by opening new areas or by replacing other crops of lower demand or over-production.
- Increase efficiency of use of by-products:
  - Value addition before export:- promotion of oil extraction and flour milling factories so that by-products are made more available for the feed milling industry;
  - collection and processing of slaughter house and slaughter slab wastes;
  - Improve collection and processing of fish offals that is largely wasted

quality control laboratory requires high initial investment and is expensive to maintain. As a result, it may be essential, at the initial stages, to use simpler methods that may not conform to the standards of developed countries. This is justified because the problems of feed quality are slightly different from those of developed countries. The control on quality can start, for example, with the very common problem of feed adulteration that can be detected immediately through the simple and inexpensive method of "feed microscopy." Feed microscopy reduces the need for feed analysis;

- Millers could be made to bear the costs of feed inspection through time;

Quality ultimately pays off : Feed processing companies need to be pro-active to counteract low profits or even losses by differentiating their products through superior quality and performance. Although this comes at an additional cost, improved value at farm level usually more than compensates for such costs. This makes the investment in technology and experts by larger feed companies worthwhile as better customer performance helps to maintain some profits at such tough times.

Capacity building

Training, information, and awareness creation is necessary in the following areas among others:

- Developing knowledge in feed formulation adapted to local conditions of animal production;
- upgrading the technological skill of feed mill operators to manufacture and maintain equipment;
- Awareness of feed manufacturers that quality pays and customers of manufactured feeds (animal producers) that "cheap is not always economical". This is key in the enforcement of quality assurance and ultimately development of the feed milling industry and the livestock sector;
- Equipping extension officers with appropriate skills in feed supplementation packages. This will help to increase the awareness of producers served by the trained extension agents on the use of compound feeds and consequently increase demand; and
- Some countries provide producers with simple and inexpensive quality control kits, and educate them to do their own monitoring. This approach may be considered as a partial solution to the problem of feed quality during the interim period.

Chapter 6

Feed Marketing and Quality Issues

Dawit Alemu, Seyoum Bediye, and Yirdaw Woldesemayat

Feed Marketing and Food-fuel Competition

FEED MARKETING is not a recent phenomenon in Ethiopia as there are experiences in the past, where farmers used to lease in land for *in situ* grazing (Gebremedhin et al., 2009). Recent trends show that feed has become a marketable commodity in all part of the country, where different market actors market both concentrates and roughage feeds. The increasing number of commercial livestock producers and decreased availability of alternative feeds have increased the commercialization of feed resources and the price of marketed feeds (Tolera, 2009).

The low level of production and reproduction performance of the livestock population is due to various factors among which animal feed shortage is the most limiting. Feed shortage, both in quantity and in quality, has been a critical problem in Ethiopian livestock production system (Tolera, 2009, Gebremedhin et al., 2009, Hussen et al., 2008). The problem of feed shortage is leading to poor nutrition, which is manifested in slow growth rate, poor production and reproduction performance, and increased susceptibility to diseases (Bediye et al., 2007). Overall, among the factors contributing to the feed shortage, the poor feed marketing system is the dominant one, which is characterized by poor market information, localized thin markets and limited premium price for quality. Moreover, along with the global trend, there is also transition from food–feed to food–feed–fuel competition for grains and other by-products in the country, which implies that the grain and/or other by-product use equilibrium comes to be intricately linked with the movement of oil prices (Banerjee, 2011).

- Increase research effort on the inclusion of non-conventional feeds processed compound feeds. Cultivation of protein rich algae in nitrogenous effluent is an area where research could contribute

- Promotion of sorghum and millet where maize cannot do well as an energy substitute;
- Promote the production of Soybean;
- Promote the production of premixes locally to reduce cost;
- Promote the production of protein concentrates to foster home mixing of compound feeds by incorporating farm produced grains like maize
- Reduction of ingredient costs:
  - Increasing availability helps to reduce cost of ingredients;
  - Avoid double (multiple) taxation;
  - Encourage entrepreneurs to produce premixes locally;

- Increase demand for compound feeds
  - Create awareness on the value of using compound feeds in improving animal productivity;
  - Improve feed marketing channels e.g. creation of a system of encouragement and incentives to foster the use of commercial compound feeds. Organizing a possibility for dairy producers to collect compound feeds from milk delivery sites etc.

Improve support services

- Availing credit, land etc for establishment of feed mills;
- Increase research support to the feed milling industry. Generate information on the feeding value of locally available resources through laboratory and field trials and make it available to the industry;
- Increase extension support to the feed milling industry; and
- Enforce the quality control legislation and organize a quality inspection service

Reference

Poultry Production Enterprise (PPE). 1984. Production program, operational and capital budget proposal. Planning and programming service, Addis Ababa, Ethiopia.

Even though, the market for the different feed type is increasing from time to time, there is no any quality control and assurance mechanism, be it ingredients or mixed ration, sold either by feed processing plants or retailing shops (Tolera, 2009).

The growth and transformation plan (GTP) clearly states the need to increase by close to three-fold the production of improved animal fodder seed and cattle feed supply by the end of the plan period in order to meet the livestock production target at the end of the plan period (MoFED, 2010). This implies the huge potential of the feed markets and the challenge in making the marketing system efficient to support the matching of demand with supply in terms of quantity, quality, and time of supply at reasonable prices.

This part provides the current trends in the country's feed markets in light of the emerging issues in the livestock sector:

- expansion of commercial livestock production (dairy, fattening, poultry etc),
- a shift from the traditional food-feed to food-feed-fuel competition (the conversion of domestic molasses by public sugar factories into ethanol) ;
- increased demand of livestock and livestock products for domestic and export markets; and
- the missing enabling environment related to quality assurance, optimization of the competition for feed-fuel like in case of molasses.

Potential for feed markets

Characteristics demand for animal feed

The demand for livestock feeds has increased greatly, particularly for intensive commercial and smallholder livestock enterprises. It is reflected primarily in the increased cash value of crop residues, but there is also a gradual increase in trading of both local and exotic forages. Fresh forage markets, to date, have not developed to the same extent as, for example, in India, Sudan, and South-east Asia, but there are indications that there is likely to be a very rapid expansion, especially to supply peri-urban livestock. Cash returns from forage for this market can be very attractive compared with most alternative crops except vegetables. The potential

for lucerne hay production in irrigated lowland areas has now been demonstrated, and there are indications that the enterprise will expand very rapidly for support of larger commercial livestock operations. To date there has been no development of the huge potential for incorporating leguminous leaf meal into the feed milling industry, or for direct sale within the market as leaf meal. Leaf meal production could encompass species such as Leucaena, common stylo, and Desmanthus, and models need to be established. The absence of such initiative reflects a lack of exposure to activities in other countries, and not an absence of a suitable market (MoARD, 2007).

With the over increasing demand for livestock and livestock products for both domestic and export markets, the demand for any form of animal feed will increase from time to time, which is well recognized in the New GTP, where the supply is expected to increase by close to three-fold to match the demand.

Livestock feeding systems in Ethiopia are changing rapidly, largely in response to increasing land pressures and declining productivity of grazing land. The use of concentrates is common in urban and peri-urban livestock production system, green fodder (natural pasture, cultivated forage or both) and crop residues are used in rural livestock production system, where there is crop-livestock mixed production system, and pure grazing based feeding system is practiced in pastoral livestock production system. Of course, the on-going settlement program in most of the pastoral communities will bring a shift in the feeding system of the pastoral livestock production, which will imply increased demand for other sources of feed in addition to grazing.

The supply aspect

The status of feed supply in the country is at an alarming state where the shortage problem is not limited to only the shortage of home produced feed or naturally available feed such as from grazing lands, but also the unavailability of feed supply for those who can afford to buy (Gebremedhin et al., 2007). This has a direct implication in the promotion of livestock production especially in urban and peri urban areas where there are a number of investments in livestock production (dairying, fattening and commercial poultry production).

Under Ethiopian condition, the feasibility of livestock enterprise is largely a reflection of the type, availability and quality of feed and the strategy of feeding (Fekadu and Bediye, 2007; Bediye et al., 2007). The same studies estimate that feed cost usually accounts for 60 – 70% of the total livestock production costs in areas where there is not problem in terms of feed availability. However, it should be mentioned that in most of the potential peri-urban and urban areas of the country there is availability problem.

The area of grazing land has declined markedly, particularly in the highlands, and this trend is continuing at an increasing rate due to expansion of cultivation, and to a lesser extent through land degradation (MoARD, 2007). On-farm production of forage is being increasingly adopted along with the expansion of intensive management systems, but still it represents a very small fraction of total feed, on a national scale. Sales of fresh fodder are increasing, particularly in peri-urban areas. With the expansion of cropping and declining area and productivity of grazing land, crop residues are becoming increasingly important in the annual feeding cycle, already accounting for more than 50% of total feed in some areas. Market for straw is developing, particularly in areas adjacent to dairy and fattening operations. Crop stubble is heavily grazed, but the rigorous harvesting of straws and stovers is diminishing the stubble value in some areas.

The price of agro-industrial by-products (principally bran, molasses, and oil seed meals and cakes) has greatly increased in recent years. They are primarily used within fattening and dairying programs (MoARD, 2007). The estimated production level of the different agro-industry by-products during 2005/06 was 269238 tonnes of wheat bran, 102,225 tonnes of oilseed cake, and 80,824 tonnes of molasses (Tolera, 2007).

Feed quality

The feed quality issue is related with fulfillment of the nutritional requirements of the livestock under consideration with minimum possible cost. Therefore, the quality of feed considers the nutrient requirement of the livestock under consideration and the nutritive value of feed ingredients available. Determination of these parameters minimizes under or overfeeding of nutrients. Underfeeding can cause impaired performance of animals whereas over feeding would increase feed cost.

Cognizant of the need to ensure feed quality, different manuals were prepared for use for practitioners (Fekadu and Bediye, 2007; Bediye et al., 2007; Tolera, 2008).

Due to the limited number of feed processing companies, most of the dairy, fattening, and poultry farms use their own feed formulation and mixing. Those farms that buy compound feed complain about the quality mainly related with the poor nutritional composition. This has created mistrust among actors in the industry further thinning the compound feed market, which needs to be addressed through implementation of vibrant public quality and standard enforcement mechanism.

Feed markets

The feed market types and marketing practices are different depending upon the livestock production system along with the types of feed. In general, the feed markets can be categorized into three main market types. These are markets for compound feeds, markets for agro-industry by-products, and markets for roughages.

Similarly, the markets for urban, peri-urban, and rural areas vary considerably. In urban and peri urban areas, where there is semi-intensive livestock production in the form of dairying, ruminant fattening and poultry, there is considerable market for compound feeds, agro-industry by-products and also for fodders mainly for baled hay and straw. In rural areas where there is a mixed crop-livestock production system, majority of the livestock producers use feeds from own farm. For instance, about 54% of dairy producers in southern part of the country use solely feeds from own farm and 24% use both feed from own farm and communal grazing (Yigrem et al., 2008). On the other hand, in the pastoral production system, the source of feed is mainly free grazing without as such market for any type of feed. However, during dry seasons and during drought times feed markets are emerging in some pastoral communities.

Markets for compound feed

The markets for the different compound feeds are concentrated along the Addis Ababa-Adama corridor, where the feed processing enterprises and modern livestock farms (poultry, dairy, pig, and cattle fattening) are

found. The market is expanding gradually due to the increase in the number of different livestock farms.

There are about eight feed processing enterprises along the stated corridor engaged in compound feed production using purchased grains, agro-industry by-products and imported vitamins and minerals. The current markets for compound feeds are characterized by direct sale to individual purchasers, who normally buy small quantities ranging from one to 5 quintals per purchase, participation in auctions to deliver to modern livestock farms and for relief purposes, and supplying compound feed based on orders, which is commonly practiced by NGOs that promote livestock production. In addition, linking livestock marketing cooperatives/unions from the pastoral areas of Borena zone and Somali region by NGOs with feed processing companies has shown promising results that need to be encouraged in the future.

Experts' estimates suggest that only about 25% of the by-products of agro-industries are used for preparation of compound feeds that are formulated to meet the nutritional requirements of different types of animals, while the remaining 75% is used directly to feed animals.

Markets for by-products of agro-industries

Feed resources as by-products of the food processing industry in the country are wheat bran, wheat middling, cottonseed cake, noug seed cake, rape seed cake, linseed cake, groundnut cake, molasses, and brewers spent grain (BSG). The major producers of wheat by-products are flour companies like privately owned DH Geda Flour Factory and stated owned Kaliti Food Share Company. Oil crop by-products are produced mainly by food oil processing factories starting from very small to large ones like Addis-Modjo Edible Oil Complex Share Company. Molasses is produced by the state sugar factories namely Wonji-Shewa and Metehara Sugar Factories. Some breweries also sell BSG as by-product.

The by-products of agro-industries mainly from flour mills and oil processing factories are directly marketed to users or through traders, who buy in large quantities for the purpose of retailing and making available in small quantities for urban and peri-urban livestock producers. The customers are mainly dairy farmers, feedlot operators, commercial poultry producers, urban, peri-urban smallholder livestock

producers, and urban equine, which are located close to the sources of the agro-industrial by-products. For instance, dairy producers in urban areas of the southern part of the country use roughage and concentrate feeds, non-conventional feeds like "atella" and stacked hay especially during dry period (Yigrem et al., 2008).

Markets for roughages

In recent years, the market for roughages is booming due to continuous reduction of grazing areas and expansion of commercial farms mainly in urban and peri-urban areas. The main roughages marketed are cereal straws and baled hay. The trade for baled hay is dominated by commercial livestock farms. It also follows a marketing practice where commercial livestock farms contract in grazing lands, harvest, and bale, use for their own farm, and sell the surplus to other livestock farms; and the second practice is the purchase of dry hay by commercial farms from small-scale farmers who produce hay on small-scale bases on pasturelands.

The market of cereal straw used to be limited to rural and peri-urban areas and it was characterized by direct trade between the farmers and livestock producers, who are in short supply of straw. In Bale and Arsi areas wheat and barley straws, from both commercial and small-scale farms are commonly baled for sale. However, recent trends show that tef straw is also marketed in the urban centers both in the open market and by small feed retail shops. In rural and peri-urban areas, the straw is commonly traded in heaps or sacks.

Price Trends of feeds

Compound feeds (concentrates)

The ration types produced are dairy cow feed, layers feed, growers feed, starter feed, calves feed, sheep feed, bulls feed, heifers feed, pig feed, and beef cattle feed. The trend in the prices the different concentrates/rations shows that there has been considerable increase since to 2003/04 with a pick in 2007/08 and recently in 2010/11 (Table 1). The types of rations, which show very high increase, are layers', growers, starters and calves feed. This is linked with a considerable increase in demand for poultry and dairy products, which links back to the increase in feed prices. The price increase in 2010/11 compared to 2004/05 was more than two-fold for all rations with more than three-fold for calves and sheep rations.

Table 1. Price trends for concentrates

Concentrate/ ration	Price (Birr /Quintal)							
	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	% change
Layers ration	152	164	179	360	374	380	503	231
Growers ration	147	138	170	357	360	370	552	276
Chick starter ration	169	169	202	386	420	450	655	288
Dairy ration	86	108	128	302	230	230	334	288
Calves' ration	94	107	136	312	340	350	428	355
Bulls ration	88	106	127	301	310	310	300	241
Heifer ration	92	114	134	308	320	320	280	204
Beef cattle ration	83	111	131	305	260	260	352	324
Sheep ration	84	105	125	301	240	260	354	321

Source: Ethiopian Animal Feed Industry Association, 2011
Note: The %age change presents the comparison of 2004/05 with 2010/11

By-products of agro-industries

The price of the different by-products has been consistently increasing from time to time. The average price of the main agro-industry by-products (wheat bran, wheat middling, noug cake, and molasses) has increased more than three times in 2010/11 compared to 2004/05 (Table 2). The increase in the average prices of maize, rapeseed cake, and cotton seed cake is close or more than double in 2010/11 compared to the status in 2004/05. It is only for soybean meal that price increase was moderate mainly due to the higher initial price. The increasing trend is associated with the overall price increase in agricultural products and increased demand for these by-products following expansion of commercial livestock production mainly in the urban and peri-urban areas.

The factory gate price of molasses at Wonji-Shewa Sugar Factory increased from 5 Birr/q in 2004/05 to 7.0 Birr/q in 2007, which further increased to 47 Birr/q in 2011 (Table 2). Taking into consideration the use of molasses for bio-fuel production, the demand is expected to increase, which will result in even more price increase. In addition to the price hike in molasses, the process in purchasing molasses is quite tiresome in that if one wants to buy 1 barrel (200 l) of molasses or more than 100 barrels the purchasing process is the same. One should go to the Sugar Corporation in Addis Ababa to finalize the process and go back to

the factory to collect the molasses. This process is both time and resource taking and needs revisiting.

Table 2. Price trends for agro-industry by-products in Birr/q (2004/05 - 2010/11)

Byproduct	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	% change
Maize 1st grade	117	140	158	560	350	300	400	242
Wheat bran	56	63	96	220	130	125	280	400
Wheat middling	70	76	109	230	170	170	300	329
Noug Cake	63	88	170	250	220	220	300	376
Rapeseed Cake	45	50	65	70	75	75	130	189
Soybean meal	ND	ND	450	480	590	600	750	67
Cotton seed Cake	170	175	180	200	214	220	455	168
Molasses	5	4	7	7	26	47	47	840

Source: Ethiopian Animal Feed Industry Association. 2011
Note: The %age change presents the comparison of 2004/05 for all ingredients except soybean meal for which the price in 2006/07 is compared with 2010/11.
ND-No data

The annual nominal price trend of other main animal feed ingredients such as Methionine, lysine, vitamin premix, limestone, and salt also showed considerable increase since 2004/05 (Table 3).

Table 3. Price trends for vitamin premix, mineral and amino acid supplements in Birr/q

Ingredients	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	%-age change *
Methionine	8200	8500	9000	9435	16000	16000	18500	126
Lysine	5516	5800	6000	6200	6723	6700	9000	63
Vitamin premix	2100	2300	2350	2500	2625	2800	3200	52
Meat & bone meal	ND	ND	380	380	575	575	850	124
Limestone	12	12	12	12	16	16	80	567
Salt	77	88	92	135	220	220	320	316

Source: Ethiopian Animal Feed Industry Association. 2011
*Note: * The %age change presents the comparison of 2004/05 for all ingredients except meat and bone meal for which the price in 2006/07 is compared with 2010/11*
ND - No data

In addition to the consistent increase of prices of these by-products over the years, there is also considerable price seasonality within a year especially for by-products linked with grain processing. This is mainly due to the higher demand in the early months of the rainy season and also the grain price seasonality. This has direct implication to the seasonality of prices for animal rations.

Roughage

Following the general price increase in the economy, fodder prices have also risen sharply in recent years. In general, fodder prices tend to be higher during the dry and wet seasons and lower during harvesting season. Similarly, there is considerable variability in prices among different areas in the country, which is reflected in the price ranges for the different types of straw (Table 4).

The price of tef straw ranged from 0.65 Birr to 2 Birr/kg in 2008 and from 1.70 to 4.50 in 2011, which is mainly the reflection of the multipurpose use of tef straw as animal feed also as input for construction. Similarly, the price of baled hay ranged from 0.50 Birr/kg to 1.66 Birr/kg in 2008 and from 1.70 to 4.50 Birr/kg in 2011, which is the reflection of location variability. The price of a bale of hay or straw increased from the range of 3 to 30 Birr/bale in 2008 to a range of 25 to 67 Birr/bale, which shows the price of fodder feeds per quintal is more than most agro-industrial by-products and more or less comparable with a concentrate mixture.

Table 4. Price ranges for different fodder feeds

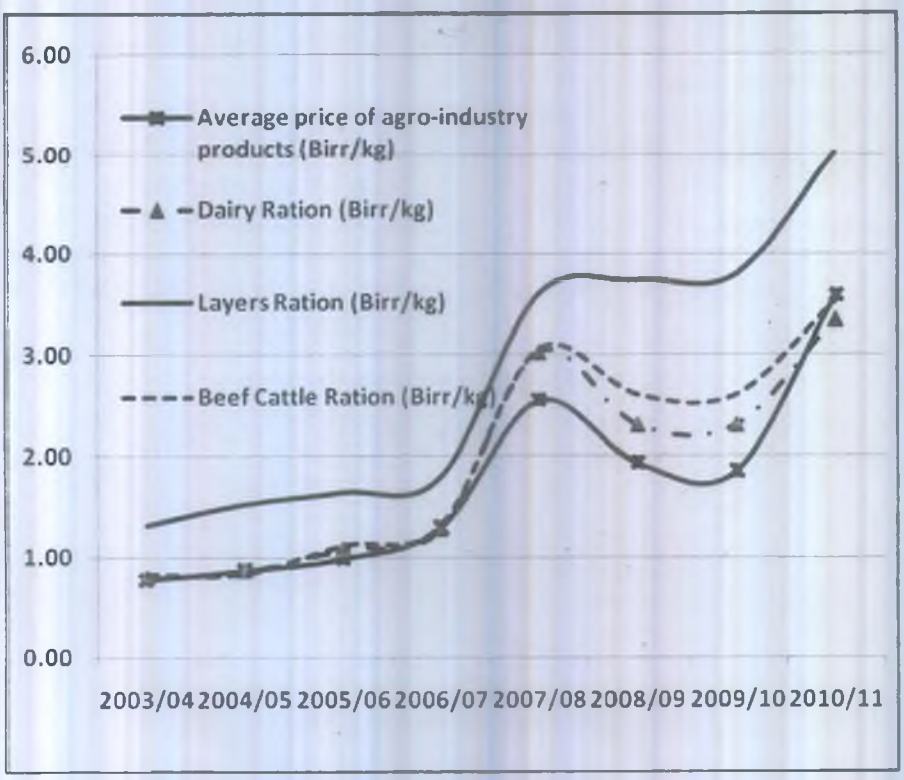
Fodder type	Price range (Birr/kg)	
	2008[1]	2011[2]
Tef straw	0.65 – 2.00	1.70 - 4.50
Barley straw	0.60 – 1.00	
Sorghum stover	0.20 – 0.65	
Hay, loose	0.30 – 1.00	1.70 - 4.50
Hay, baled	0.50 – 1.66	1.70 - 4.50

Source: [1]Gebremedhin et al. (2009); [2]personal communication with hay and straw traders

Feed and animal products price trends

In general, the price of animal products (milk and egg) showed an increasing trend with increasing price of the different feed products. However, the recent trends especially since 2009 show relatively stabilized price for animal products whereas further increasing trend for feed prices including the prices of by-products of agro-industries (Figure 1). The presented average price trend for by-products of agro-industries is estimated considering the prices of maize 1st grade, wheat bran (furusca), wheat middling (furscallo), noug cake, rapeseed cake, and cotton seed cake.

Since feed is the major component of cost of production of the different animal products (estimated to range from 60 – 70% of the total cost), this trend will have considerable effect on the livestock sector in terms of mainly continuous reduction of demand for animal products and shrinkage of the livestock sector.



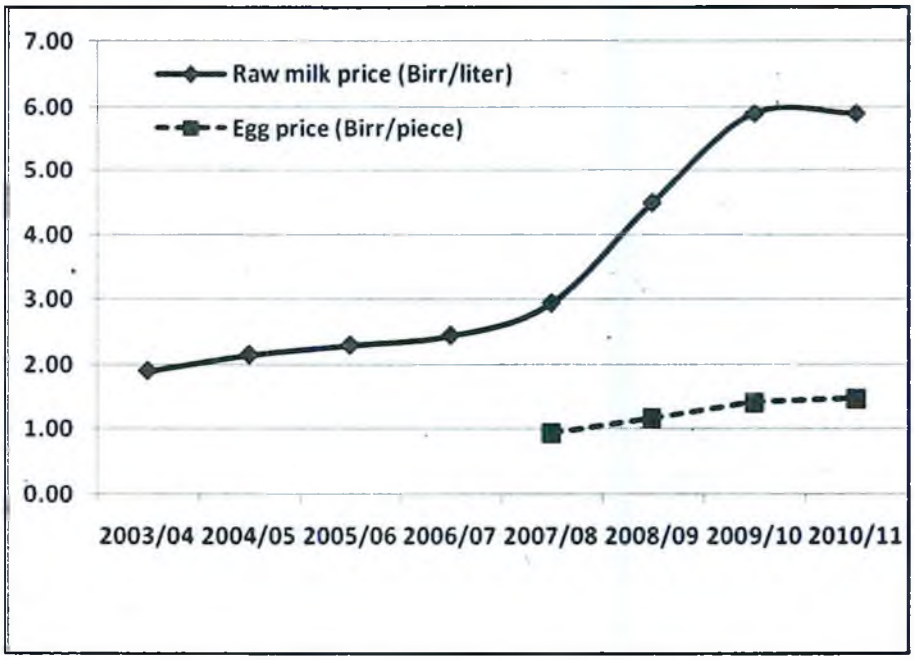


Figure 1. Trends in the average prices of feed products and animal products

Conclusion and Recommendations

The market for compound feeds, agro-industrial by-products, and roughages is showing increasing trend, even though the amount marketed is still small considering the livestock population of the country. It is important that along with the expansion of commercial livestock farming, mainly in urban and peri-urban areas, the feed marketing aspect have to expand proportionally so that the required feeds in terms of quantity and quality will be available at the required time at reasonable price. This will help to improve the competitiveness of the sector domestically and internationally that will boost the contribution of the sector to the national economy.

Under Ethiopian condition, the feasibility of any livestock enterprise is largely a reflection of the availability and quality of feeds as well as feeding and management systems. In most commercial livestock operations, feed cost accounts for 60–70% of the total livestock production costs. Moreover, availability or accessibility of purchased feed could also be a problem in some potential livestock production

areas. Therefore, in order to promote livestock production especially through semi-intensive and/or intensive system in urban and peri-urban areas, the feed production and marketing aspects need to get due attention.

The trends in prices of different feed products such as concentrates, agro-industry by-products, imported ingredients, and fodders show considerable increase since 2003/04 with more than 100% increase since 2007/08. Unexpectedly, the price of a 100 kg hay or straw became the same as the price of 100 kg of concentrate during the drought of 2011. This trend is particularly observed when different agencies start intervening in emergency livestock feeding in drought affected pastoral areas of the country. Such traders are those who wait around the corner to make a grandiose profit out of crisis.

Currently the feed industries are operating at about 25% of their capacity due mainly to limited demand for processed compound feeds, which could be due to increased price of factory mixed compound feeds because of value added tax charges. Another reason cited by some livestock producers is that mixed feeds purchased from feed processing plants do not meet their expectations with respect to nutritional quality and animal performance. In order minimize the effect of the current low demand for compound feeds, some of the feed processing enterprises are practicing vertical integration, i.e., engagement in modern livestock production (fattening, dairy, poultry and/or pig farming) in conjunction with the feed processing plant. The issue of vertical integration needs due attention especially in terms of the free competition between enterprises, which are vertically integrated and those that are engaged only in livestock production. The feed industries should strive to win the trust of their customers, the livestock producers, by addressing the poor nutritional quality issues claimed by most livestock producers. Unless the existing mistrust between the buyers and sellers of compound feeds is properly resolved, it will result in further thinning of the market, perpetuating a situation where feed processors complain of lack of market whereas livestock producers complain of absence of well balanced and fairly priced compound feed that meets their expectation to enhance performance of their animals.

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Chapter 7

Institutional and Policy Support for Ensuring Feed Security

Seyoum Bediye and Dawit Alemu

Historical Dimension and Rationale for Better Support

THE ETHIOPIAN AGRICULTURAL DEVELOPMENT STRATEGY acknowledges the importance of a more dynamic and competitive innovation to be critical for transforming the livestock sector. However, it has yet to translate that notion into a system with the potential to improve rural livelihoods. Evidences suggest that Ethiopia's innovation policy climate is not robust enough to support such efforts. For example Gebremedhin *et al.* (2006) reported that linkages between research, extension and education are still largely top down, supply driven, uni-modal, and driven by state priorities.

Despite decades of research and development efforts, the rate of forage technology adoption has also been reported to remain extremely low (Ahmed et al, 2004); crossbred and exotic dairy cattle to constitute only 1.8% of the milking cows (Pratt et al, 2008); and input and output marketing systems for smallholder dairy not yet well established (Tefera *et al.*, 2008).

In general, despite some favorable policies on science and technology, education, and private investment, the country does not have a strong innovation climate for vibrant growth of the livestock subsector. This rationalizes the need for strong institutional and policy support to enhance the productivity of livestock through enhanced animal feed

security. Along with the changes in the overall economic policy, there have been changes in the institutional and policy support to the feed sector in Ethiopia over the years. The institutional and policy support to the feed sector has been the responsibility of the Ministry of Agriculture of the different regimes and have been the integral part of the overall agricultural support interventions without adequate focus to it.

In the early 80s, however, a bit focused interventions based on projects supported by bilateral agencies (First Livestock Development Project, Second Livestock Development Project, Third Livestock Development Project, Fourth Livestock Development Project and National Livestock Development Project) came into picture even though these projects later suffered from lack of sustainability and weak institutional support.

Following the 1991's market liberalization and the introduction of the Participatory Demonstration and Training Extension System (PADETES), the feed sector emerged as part of the livestock development package even though the coverage was limited to forage and pasture extension package. Assessment of the impact of PADETES indicates that the livestock sector was the list beneficiary and most constrained by several challenges. The participants in the livestock package were only 1 out of 100 participants in the entire PADETES packages (Kassa, 2008).

The institutional and policy support to feed sector is a rational move in response to the current challenge in availability of livestock products, the future challenges ahead of us in responding to the needs of rapidly growing human population (Delgado et al,1999) and from the perspectives of maintaining global competence. Annual consumption of livestock products in Ethiopia is currently far from adequate and lower than Kenya. Annual consumption of whole milk in Ethiopia is 16 kg per person per year vs 97 kg in Kenya while annual consumption of beef in Ethiopia is 4.0 kg per person vs 9.0 kg in Kenya (FAO, 2003). Kenya's success story is not only through technological innovations but supported by appropriate institutional innovation and a series of policy reforms to maintain the growth of the sector.

Besides huge livestock resources and potential for socio economic growth, the livestock sector in general and the feed industry in particular should receive due attention it deserves in terms of institution and policy. More challenge is as well ahead of us as others are more prepared to

respond to huge demand for animal products in the years to come. Moreover, the attainment of the targets set in the next five years Growth and Transformation Plan (GTP) with respect to the livestock sector requires institutional innovation and appropriate policy support. The GTP has targeted to achieve high level of meat and milk production at end of the plan period. It aims to increase milk production from 3.3 million tonnes in 2010 to 11.2 million tonnes in 2015 (an increment of 243%). Similarly, the GTP has set a high target for meat production and export. Meat export is targeted to increase from the base 10,000 tonnes to 111,000 tonnes in 2015, which is an increment of 1010% (MoFED, 2010). The attainment of these target cannot be met without adequately addressing the current challenges of livestock feed supply and quality. Feed is the major input affecting livestock production and productivity.

Status of Institutional and Policy Support to the Feed Sector

Overall, the status of the current institutional and policy support in the country emanates from economy-wide institutional and support programs; agricultural sector based programs; and feed sector specific institutional and support programs.

Economy-wide institutional and policy support

The economy-wide institutional and policy support that have relevance to the feed sector are related with trade and investment licensing and incentives. The investment incentives that apply for the feed sector are part of the agricultural investment incentives (Terfasa, 2008), which are related with income tax exemption and exemption from payment of customs duty.

Income tax exemption

Domestic investments in the area of manufacturing or agro-industrial activities or the production of agricultural products are eligible for income tax exemption for 5 years if they export at least 50% of the products, or if they supply at least 75% of the product to an exporter as a production input. In addition, domestic investment in relatively under developed regions such as Gambella, Benishangul- Gumz, South Omo, and Afar are eligible for income tax exemption for an additional 1 year.

Exemption from the payment of customs duty

An investor shall be allowed to import duty free capital goods and construction materials necessary for the establishment of a new enterprise or for the expansion or upgrading of an existing enterprise. In addition, an investor granted with a customs duty exemption privilege shall be allowed to import duty free capital goods necessary for his enterprise.

Agriculture sector based institutional and policy support

The institutional and policy support for the feed sector in particular and livestock sector in general, emanates from the 2006 Plan for Accelerated and Sustainable Development to End Poverty (PASDEP). The plan had two main components to support the livestock sector. The first component is the focused intervention to promote small ruminants and chickens mainly because of the quick returns and limited land requirement linked with the perceived immediate impact on poverty and food security. The second is focused on large livestock, particularly cattle, for their export potential and contribution to the commercialization of agriculture. The specific interventions stipulated in the plan include distribution of small ruminant breeding stock ; support for processing facilities; for example, abattoirs, milk and hide processing plants; development of forage seed production sites; introduction of improved breeds, artificial insemination and genetic improvement; disease control, quarantine, and veterinary services; and technical assistance with production of milk, honey, silk, and other animal products.

The specific intervention in the area of animal feed in the plan are therefore related with introduction of improved forage varieties; promotion of the production of forage and fodder crops at household level; improvement of community grazing land; and strengthening livestock extension services both in mixed farming and pastoral areas.

Pastoral development interventions

The feed sector development in pastoral areas has been the major component of the different pastoral development initiatives, though it is mainly linked with feed provision during drought emergency. The main activities constitute drought time emergency livestock feeding and the rehabilitation of degraded rangelands with emphasis on bush

management. Government and non-governmental agencies have been carrying out the emergency response supports in accordance to the National Guidelines for Livestock Relief Interventions. This guideline encourages the feed intervention to be implemented alongside with complementary interventions in animal health and stock water.

Natural resource management and feed development

As part of the conservation-based agricultural development strategy, different natural resource conservation and development activities have been implemented mainly in parts of the country where environmental degradation is severe (Gebremedhin et al., 2006). Some of these interventions are related directly or indirectly with animal feed development such as construction of soil and water conservation structures; area enclosures linked with cut-and-carry system of forage supply; community grazing land management; and small-scale irrigation schemes.

Feed sector specific institutional and policy support

The actors/institutions in the feed sector and the policy support they provide are different for forage and concentrates.

Forage value chain

The institutional support in forage value chain can be looked at differently for cultivated forage and natural forage and crop residues. The stakeholders in the cultivated forage are those who are involved in the provision of forage seed, forage production, and marketing and those who play regulatory roles. Accordingly, the main forage seed providers are the National Agricultural Research System, ILRI, and very few private seed companies and NGOs. Forage production is mainly undertaken by small-scale farmers mostly for own direct use. Either on the other hand, the production of natural forage and crop residues is performed by small-scale farmers, who normally directly uses for them, sell to users, or sell to traders (Figure 1). In the forage value chain, the public sector in terms of extension service provision or in terms of regulatory support is very limited. In very few areas, the extension service is provided in forage production and marketing.

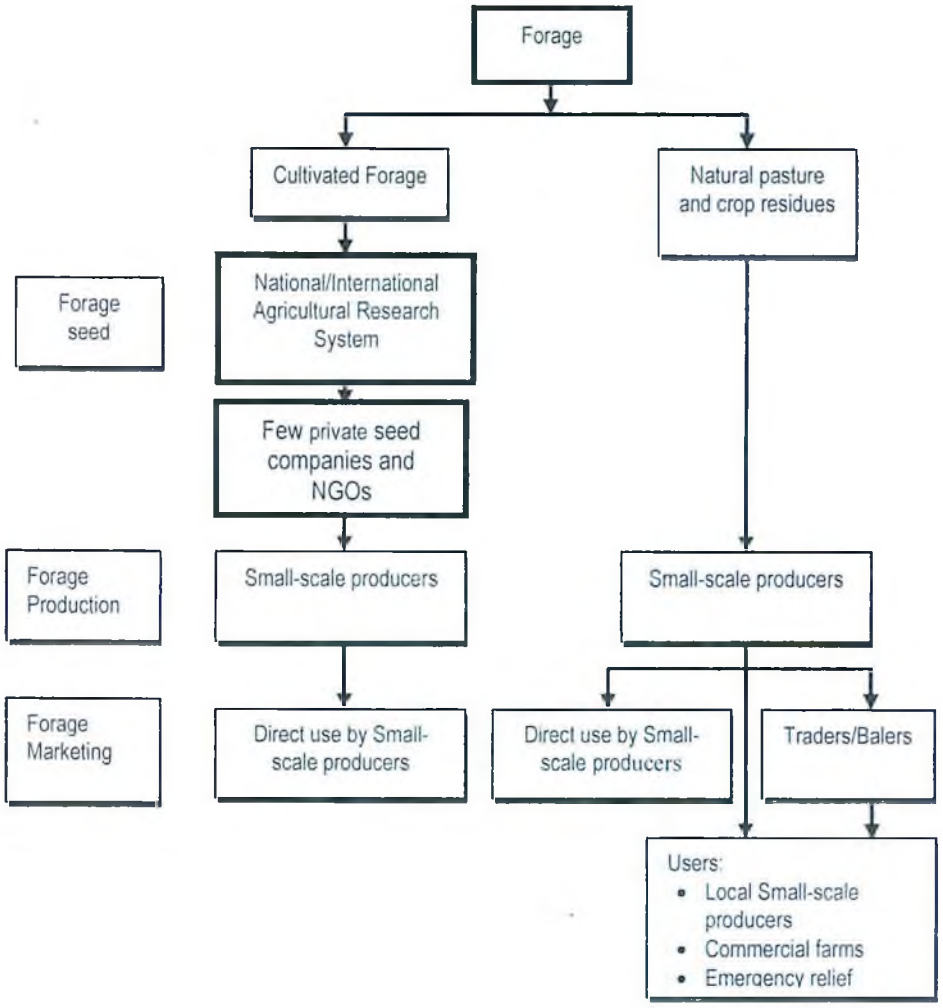

Figure 1. Stakeholder analysis in forage value chain

Concentrate feed value chain: The main actors/institutions in the concentrate feed value chain are input providers—importers of additives, local agro-industries, and local grain traders, agro-industry by-product traders, feed processors, public organizations that provide regulatory roles, and end-users—commercial farms, small-scale urban and peri-urban farmers, and feedlots.

In general, the input providers can sale the inputs directly to end-users, to feed processors and/or to traders (Figure 2). Even though, there is Ethiopian Standard (ES) for animal feeds in the country, so far, there has

not been any regulation on its implementation and most potential users are not even aware of the existence of such standards. Thus, popularization of the standards may play a vital role to increase the awareness and understanding of the actors in the feed sector regarding the types and expected quality of the different feed ingredients and compound feeds.

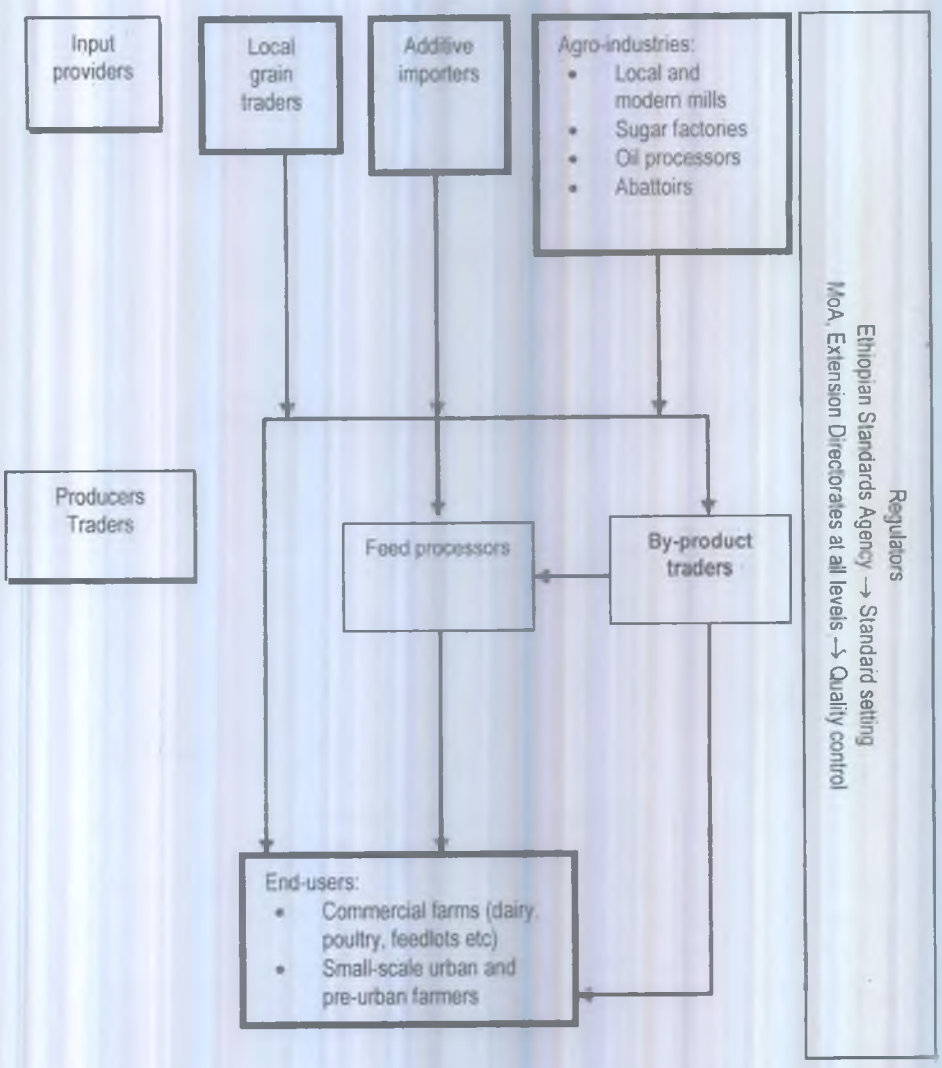

Figure 2. Stakeholder analysis in concentrate value chain

Research support

Cognizant of the importance of feed in livestock development, the National Agricultural Research System has strong research programs namely animal feed and nutrition program and rangeland management. So far, considerable numbers of forage specie have been released along with recommendations of feeding packages. One such intervention would be popularizing the released forage variety and linking the research outcomes from the research centers to the users.

Quality and standards

Quality and Standards Authority of Ethiopia (QSAE) specifies the requirements for the different animal feedstuffs for use as animal feed ingredients. As indicated in Table 1 there are set Ethiopian standards for different feed ingredients and compound feeds.

Table 1. Some of the Ethiopian standards for different ingredients of animal feeds

Ethiopian standard	Specification as an animal feed ingredient
ES 1033: 2005	Meat meal/meat and bone meal for poultry and pig
ES 1037:2005	Cotton seed cake (meal)
ES 1038:2005	Groundnut cake (meal)
ES 1039:2005	Linseed cake (meal)
ES 1040:2005	Niger seed cake (meal)
ES 1041:2005	Rapeseed cake (meal)
ES 1042:2005	Safflower cake (meal)
ES 1043:2005	Sunflower cake (meal)
ES 1044:2005	Sesame cake (meal)
ES 1045:2005	Soybean cake (meal)
ES 1047:2005	Brewing by-products
ES 1048:2005	Maize and maize processing by products
ES 1049:2005	Wheat milling by products
ES 1027:2005	Compounded poultry feeds - specification
ES 1030:2005	Compounded cattle feed supplements - specification
ES 1046:2005	Compounded young cattle feed supplements- specification

Source: QSAE

Based on the strategic plan of QSAE (QSAE, 2004), some of the strategic interventions of the authority in enforcing the set standards are related with promotion of quality stamp based on the set standards; and promotion of product certification for quality based marketing system. Even though, the standards are set they are not implemented yet. For smooth implementation of the standards and ensure production of quality feeds it would be advisable to work in partnership with the relevant department of MoA and EAFIA.

Feed relevant livestock development programs

Ethiopia is currently promoting geographically differentiated development intervention considering livestock production system in the highlands and the lowland pastoral system based production system. There is also a differentiated intervention for urban, peri-urban, and rural livestock production systems. This has implication in the differentiated interventions for feed sector development. In general, the promotion of poultry farming, dairying, and fattening in urban and peri-urban areas is promoting market for roughage and compound feeds and the demand has been consistently increasing.

The national livestock extension package has a feed extension component along with other components. The placement of a development agent at each KA with educational background in livestock production is an opportunity for better promotion of the feed sector. However, there is a need to equip the DAs with the required technical skill and physical facilities.

Intervention Areas

Strengthening the support to the private sector in the feed industry

National capacity in guiding and rendering support to private sector must be created through a focal public institution both at the federal and regional level. Unattended duties such as quality regulation, seed certification, basic seed supply, analytical services etc deserve attention in terms of institutional support. Technical support to private sector in terms of business development and technical details should be rendered to up lift the entrepreneurship and technical capacity of the private sector. Research and extension support is also required to help the private sector move forward and institutional innovation in the public system is required to respond promptly to the needs of private sector. Some of the Key areas of support to the private sector are highlighted. In summary areas of partnership work between the public and private sector would be:

- Research and pilot on innovative production of livestock feeds. In particular to address emergency livestock feeds during drought;
- Transfer of proven technology that will improve quality, durability and affordability of feed products;

- Linkage with national and international research institutions for scaling up the research recommendations;
- Technical capacity building in feeds and feeding for feed processors; and
- Incentive/loan for the provision of equipment and materials that is not locally available.

Strengthening the institutional and policy support for enforcement of feed quality standards

As indicated above, currently there are no clear definitions for feed ingredients under implementation, even though there are Ethiopian standards. Thus, it is important to promote these standards through awareness creation and proper enforcement mechanism. There is also a need to establish standards for different compound feed formulation that are produced from different feed ingredient mainly from agro-industry by-products. The limited implementation for the existing standards and unavailability of standards for compound feed are one of the major constraints for building trust in the feed market and improving marketing system.

Strengthening commercial livestock production

Even though, the availability of quality feed at economically feasible prices is the key for the development of livestock production, the growth of the livestock sector specifically commercial livestock production is also in turn a crucial factor for sustainable feed sector development. That means there cannot be commercial livestock production without provision of quality feed while commercial livestock production is a driving force for feed sector development. Therefore, parallel promotion of livestock production and the feed industry needs to be promoted taking into consideration the production systems.

Strengthening the economic incentives for improved investment in feed production

Both public and private investment need to be promoted to ensure feed security at all levels. Public investment has to capacitate public institutions to give guidance and central role in developing the industry.

Private investors need be encouraged in feed production, processing and marketing channels.

Multiple taxation on feed and import taxation and VAT on feed supplements imported from abroad have recently led to sky rocketing price of feed. The high feed price has led to loss of interest in some of the farms leading to failure to deliver quality livestock products. Farms, which have remained in the business, are hardly coping with the increase in price of feed and they are forced to increase the price of livestock products. As feed is a major livestock production input, the current taxation requires revisiting in order to avail livestock product at a reasonable price to consumers. Besides supply issue, the price of livestock products is a major problem to consumers and it is often noted to be the most expensive commodity compared to prices in the neighboring countries.

Strengthening the institutional and policy support for differentiated feed sector development

There is a need to strengthen the institutional and policy support for the feed sector along with the differentiated livestock development approach in the country taking into consideration the specificities of

- sedentary crop-livestock mixed farming vs pastoral production systems;
- urban, peri-urban and rural production systems;
- smallholder vs commercial production systems; and
- livestock type

The existing trends show that intensive livestock production supported by compound feed market is prevailing in urban and peri-urban areas mainly in those towns where agro-processing industry with by-products for concentrate feed production is available. Thus, there is a need to focus the institutional and policy support for intensive livestock production along with compound feed production. Similar differentiated institutional and policy emphasis should be given for feed sector development in peri-urban and rural areas along with the specificities in pastoral and in the crop-livestock production systems.

Ensuring the efficient and adequate use of agro-industrial by-products

Agro-industrial by-products such as molasses, oil seed cakes, wheat-milling by-products, etc. constitute the most important sources of livestock feed supplements. The relatively inexpensive by-products such as molasses could supply the highly palatable and energy rich diet to livestock. With the growing government interest to convert molasses into ethanol, the amount available for livestock feed and the bureaucratic process in purchasing it would likely decrease in the years to come. Exclusive use of molasses for ethanol production aggravates the feed shortage and become a major setback to the emerging market oriented livestock industry. Fair allocation of the product as livestock feed should be set as a policy to spur the continued growth of the livestock industry and ensure the cost-effectiveness of the livestock emergency response operations.

Encouraging the processing and value addition of exportable oil and pulse crops

Like roughages, the health and productivity of livestock in Ethiopia is seriously constrained by shortages of affordable supplementary feeds. One of the options to get around this problem is to step up efforts of generating quality by-products from oil and pulse crops, which currently exported intact and unprocessed. Processing and value addition in such agricultural commodities could tremendously increase the local availability of by-products used to supplement fibrous feeds, and boost productivity and profitability of the livestock sub-sector. Besides, these schemes help the staggering feed industries operate at full-capacity and ensure the sustainable supply of affordable quality compound feeds. It would be worth mentioning shortage and high price of slaughterhouse by-products such as bone and meat meal. The banning of these products for use in ruminant diets and high cost associated with them as source of poultry feed deserves attention and requires solution.

Re-vitalizing and empowering customary institutions

Customary institutions can play key role in enforcing rules and regulations relevant to maintain sound management of the grazing resources.

Presently, these institutions have become dysfunctional as their role is largely taken over by formal kebele structures. The undesirable consequences of the customary institutions' disengagement in grazing resources administration are evident throughout the ASALs of Ethiopia. This is very much so in Borena rangelands. During time where these institutions were strong and functional, the widely observed traditional rangeland resources administration rules and regulations have allowed to maintain productive rangelands. With the weakening of the customary institutions, the strategic use of the wet and dry-season grazing resources disrupted, haphazard human settlements and crop farming proliferated, pro-active collective range resources restoration actions faded, which eventually led to the degradation of the rangelands and the present state of increased vulnerability to drought shocks. This situation will drag on until the authority of customary institutions is restored. Devolving power from the formal kebele structures to customary institutions and giving due recognition to the latter is crucial for creating local ownership and managing rangelands in sustainable manner.

Supporting the observance of ecologically compatible land uses and the protection of key grazing resources in pastoral areas

The inherent poor soil fertility regimes and low and erratic distribution of rainfall in much of the Ethiopia's ASALs cannot support viable crop production. These agro-ecologies are rather best suited to the extensive forms of livestock production.. As crops grown in these environments fail in two out of three years, indiscriminate cultivation of the rangelands other than obstructing seasonal livestock migration routes and damaging the fragile ecosystem has limited development impact. Policy advantage points that encourage the protection to key grazing areas and match the land-use to the agro-ecological potential are vital for creating sustainable livelihood and restoring rangeland productivity. Article 40 of the Ethiopian constitution gives pastoralists use grazing resources freely but do not have the provision for the protection of key grazing areas against conversion into non-sustainable forms of land uses. Parts of the pastoral areas, which harbor fertile plains bisected by perennial rivers, could be considered or crop production. Where the conversion of such types of rangelands into irrigated agriculture is inevitable, cultivated fodder crops

that boost the productivity of the pastoral production system -should be given the first priority.

Foster healthy relationships between game reserves and extensive forms of livestock production

The major contentious issue undermining the peaceful co-existence of these two land use systems is the competition over grazing resources. The tension between the game reserves and the surrounding pastoral communities over the access of the grazing resource reach its peak during the times of drought. Provisions that allow regulated access of the games reserves at such difficult time and putting in place mechanism where the local communities benefits from eco-tourism will create the win-win situation.

Encouraging the temporal and spatial mobility of livestock across the heterogeneous rangeland landscapes

Periodic livestock mobility is important to manage risks and uncertainties that frequently encountered in these harsh environments. Furthermore, the mobility is useful to efficiently exploit forage and water resource wherever it is available, and give part of the rangeland to rest and recovery.

Strengthening the eradication, management and control of the spread of invasive plant species

The rapid spread of exotic and indigenous invasive plants has seriously compromised the availability of forage and disrupted the soil-hydrological balance of the rangelands. Among others invasion of *Prosopis juliflora* in the regions of Afar, Somali, Oromia and SNNPR and *Acacia drepanolobium* in the Borena rangeland are real threats to the pastoral and agro-pastoral livelihoods. The intrusion of *Parthenium* weed in the rangelands of the pastoral areas is very alarming and requires serious attention. Policy directives that encourages for the sustained management including the alternative use and control of these undesirable plant species are essential to ensure livestock feed security and restore the productivity of rangelands.

Conclusion and Recommendations

The need for reconfiguring institutional and policy support in the feed sector is not only limited to economic and biological dimensions of attaining self-sufficiency in foods of animal origin. Self-reliance in foods of animal origin goes beyond food and income security as mental cognition of children is recently noted to be highly related to access to food of animal origin. What is currently produced has a remarkable bearing not only on the current generation but also influences the capacity of future generations. Creating enabling environments to avail food of animal origin to citizens has therefore far-reaching implications beyond ordinary biological and economic issues. Growth and transformation of the feed industry requires technological/knowledge based interventions along with institutional innovations and policy reforms. Efforts undertaken over the years were far from adequate in realizing the desired change in the industry. Realizing the need for facilitating efficient delivery of services for sustainable and prosperous livestock sector and with the vision to maintain global competence. appropriate institutional and policy reforms need to be put in place to promote, regulate and facilitate livestock production for socioeconomic development and industrialization. As still much remains to be done in terms of transforming the sector through institutional and policy support. the following measures need to be taken

- Creating national capacity to oversee the progress of the sector (MoA): National capacity with the vision of creating favorable legal framework
- for developing the livestock industry and providing support that increase productivity, value addition, and market access for the subsector products. These requires strengthening the capacity of institutions engaged in extension, research/education and regulatory aspects of the feed sector;
- Capacity building and promoting the private sector involvement in the feed industry (MoA and Investment Agency):
- Enforcing the existing feed ingredient quality standards and development of standards for compound feeds (Standards and Quality Control and MoA);
- Boosting commercial livestock production (MoA and Investment Agency);

- Creating economic incentives for all actors in the feed sector especially through evaluation of the taxation system mainly to avoid double taxation (MoA, MoT); and
- Design and implement differentiated feed sector development targeting crop-livestock production system vs pastoral system, urban-rural, and intensive and extensive production systems (MoA).

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Chapter 8

Looking Ahead

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THE LIVESTOCK RESOURCE OF ETHIOPIA sustains and supports the livelihoods of an estimated 80% of the rural population and contributes around 35-49% of the agricultural GDP and 15-17% of the overall GDP. Livestock and livestock products are the third major export items accounting for 11% of the export revenue. However, the productivity and economic contribution of the livestock sector is much below the potential due to various technical and non-technical constraints. The main technical constraints include inadequate feed supply and high cost coupled with inefficient feed management and utilization, widespread diseases and poor health and poor breeding practices. The non-technical constraints include poor infrastructure and inadequate policy support with respect to extension, marketing, and credit.

Feed cost accounts for 60-70% of the total cost of livestock production. As a result, shortage and escalating prices of feed is adversely affecting the productivity and profitability of commercial livestock operations. Under such circumstances, exploitation of the full potential of the livestock resources of the country will not be possible. Farmers and pastoralists that rely on livestock for their livelihoods will have the basis of their sustenance seriously affected. If animals are not properly fed they cannot express their genetic potential for production and reproduction. They also become susceptible to a number of diseases and parasites. Prolonged shortage of feeds could lead to death of animals. Pastoralists have lost a large number of their animals, sometimes the total herd, during prolonged dry season and drought due mainly to inadequate feed and water supply.

The feed shortage problem is gradually moving to a crisis level. Crop production in the farming areas is directly affected through the important role of livestock at all stages of crop production. Drought induced shortage of feed in the pastoral areas exacerbates the problem of shortage and price hike of feeds in the highlands due to channeling of large quantities of feeds to the drought affected pastoral areas for emergency feeding. Accordingly, during the 2007/2008 drought, substantial amounts of concentrate and roughage feeds were purchased from the highlands and mobilized by different governmental and non-governmental organizations to address the critical feed shortages in the drought affected pastoral areas. This situation coupled with the overall shortage and increased price of feed ingredients created a crisis in animal feed supply throughout the country, including the central highlands. As a result, dairy farms that could not sustain their operation sold their animals for meat while some of the poultry farms were closed. The few feed industries existing in the country were also forced to operate much below their capacity due to the shortage and sky rocketed price of feed ingredients. Despite the critical shortage, the demand for processed compound feeds decreased dramatically during that period as the price was beyond the reach of both smallholder and commercial livestock producers. A similar situation was observed during the 2010/2011 drought as well. In fact, such an incidence is likely to be experienced again after a short interval following the recurrence of drought, which nowadays recurs at an interval of 2 to 3 years.

The feed problem has been deteriorating from time to time and is gradually heading towards crisis proportions. The solution to the problem requires a concerted effort from all those involved directly and/or indirectly ranging from policy makers, producers, pastoralists, NGOs, the public sector, and entrepreneurs.

Immediate action is also called for since the pace of progress of the problem requires that all concerned take immediate concerted action if the situation is to be put under control. This area needs to be given serious attention if the planned targets in the Growth and Transformation Plan (GTP) of the country are to be realized. The team has outlined recommended steps that need to be taken by the different actors to solve the looming crisis.

Many of the recommended measures can and should be implemented parallel by the different stakeholders. However, a central body that takes the responsibility of coordination should be in place and empowered to lead the whole effort. Steps that deserve to be taken in the short term to avert the looming feed crisis have been identified as follows to help implementers to do first things first. This is proposed based on importance of the measure to bring about faster improvement, and ease of implementation.

Required Policy

- Strengthening the capacity of institutions engaged in extension, research/education, and regulatory aspects of the feed sector. Establish a strong unit under the Ministry of Agriculture with the necessary mandate and powers to coordinate and implement the feed related problems that require immediate attention and others presented in more detail under the recommendations section with proposals on who is to do what;
- Avoid multiple taxation that escalates the cost of especially agro-industrial by-products;
- Make similar decisions of setting price ceilings on flour and oil to also apply for flour and oil mill by-products to counteract the current practice by mills of adding whatever is lost on the flour and oil onto the by-products that resulted in exorbitant price hikes on by-products;
- Evaluate the benefits of direct export versus value addition of oil seeds by processing locally and promote value addition locally; ban export of oil cakes/meals to foster availability and reduction of cost;
- Spare a portion of the molasses currently utilized for ethanol production for use as feed. In this regard, there is a crucial need for inter-sectoral linkage and communication in development planning;
- Strengthen the economic incentives for increased investment in feed production

    - Making land available for the production of feed ingredients and establishment of feed processing plants;
    - specific loans for feed production/processing;
    - Provision of investment incentives (as is, for example, the case for the flower/horticultural industry); and

- Consider tax exemption/tax holidays for feed producers. This is necessary because the country cannot boost its livestock production and benefit from this huge resources potential without encouraging and boosting feed production.

Increase Efficiency of Utilization of Available Feed Resources

- Encourage sugar factories or create a conducive environment for other entrepreneurs to establish animal production enterprises to utilize unutilized/underutilized feed resources like sugar cane tops
- Intensify extension effort to promote better utilization through promoting:
    - Use of simple technologies like physical treatment and/or urea treatment of residues;
    - Targeted allocation of scarce feed resources to the most responsive livestock;
    - Conservation of available feed resources;
    - Manufacture MNB from agro-industrial by-products and use as supplements;
    - Production and use of improved forages
        - Aggressively promote the incorporation of forage development into the current NRM effort;
        - Establishment of demonstration plots at farmer training centers (FTCs)
        - Encourage business oriented forage planting material (e.g. forage seed) production and marketing at small-scale through provision of appropriate incentives
        - Widening and strengthening the source base of hay production in the country
        - Land use planning followed by policy decision that reduces encroachment of key hay production areas like the *Sululta* plains for hay and dairy production;
        - Establish cooperatives of hay producers to market the hay they are producing directly to dairy producers without the unnecessary intervention of intermediaries who snatch the biggest share of the benefits creating a huge disincentive to hay and dairy producers;
        - Improve the species composition of available hay production fields by oversowing adaptable, more nutritious and productive species

Speed up the Coming into Effect of the Feed Quality Inspectorate Service

- Revision of the available quality standards to also accommodate small-scale feed processors and at the same time protect mixed feed users; and
- Gradually implement the quality control of mixed feeds

Curbing Rangeland Degradation and Enhance Utilization

- Promote participatory landscape planning and allocation of rangelands to their agro-ecological potential;
- Empower and capacitate customary institutions;
- Train extension personnel with background and targeted skills to handle peculiar rangeland/pastoral situations
- Identify and scale-up appropriate rangeland rehabilitation and management measures including control of invasive species
- Identify, map, and bring into use areas suitable for community-based forage production under irrigation. Establish system of contractual agreements with agro-pastoral households along perennial rivers to produce and supply fodder at times of drought
- Development of Fodder banks:
    - The national or regional stockpiling of fodder at strategic locations against a drought situation; and
    - Establishment of reserve areas in which fodder is grown and held for use in drought. Protect key drought-time fallback grazing areas and prevent their conversion into unsustainable land use systems.

The detail suggested interventions by the different production systems (mixed crop-livestock system, pastoral production system, and mixed feed production) for the prioritized major constraints are presented below:

Mixed crop-livestock system

Constraints	Reasons behind constraint	Needed interve tions
1. Shortage of feed supply	Inadequate feed production	Increase area coverage of forage production
		Give serious consideration to high yield and nutritive value of residues in crop variety development
		Increase production of raw materials for mixed feed production e.g. maize, soybean in terms of yield per unit area and acreage
		Promote contract out-grower schemes of feed production through motivation and support to farmers to specialize in feed production.
		Promote the production of protein concentrates by feed industries to foster home mixing of compound feeds by incorporating farm produced grains like maize
		Strengthen the economic incentives for increased investment in feed production • Making land available for the production of feed ingredients and establishment of feed processing plants • Specific loans for feed production/processing • Provision of investment incentives (as is, for example, the case for the flower/horticultural industry) • Consider tax exemption/tax holidays for feed
		Promotion of forage based feeding for dairy production to spare concentrates for manufacture of mixed feed for poultry
		Encourage and support feed manufacturers to produce their own ingredients like maize and soybean by making incentives like credit and land available
	Dependence on limited number of feed ingredient sources	Expand the utilizable feed resource base by fostering applied research on utilization of alternative sources of feed ingredients (especially energy and protein sources)
		Establish suitable animal production enterprises to utilize large quantities of by-products generated in specific locations like vicinities of sugar factories to utilize unutilized/underutilized feed resources like sugar cane tops
	Exports without value addition	Give priority to local use than exports (e.g. oilseeds)
		Promote value addition before export: • Promotion of oil extraction and flour milling factories so that more by-products are made available for use as feed • The advantages and disadvantages of exporting oilseeds without value adding vs. processing locally into oil and oilseed cakes/meals needs to be critically assessed
		Policy decision to spare a portion of the molasses currently utilized for ethanol production for use as feed. A

Constraints	Reasons behind constraint	Needed interventions
		small quantity of molasses can render large quantities of otherwise unusable by-products into productive feed. It also has a sparing effect on the quantity of grains used for animal feeding
	Wastage of feed	Decrease wastage during harvest, transport, storage and use
		Encourage and enforce the slaughter of animals in abattoirs to save and process slaughterhouse by-products as animal feed ingredients. These are currently largely wasted due to the prevalence of informal animal slaughter
1. Shortage of feed supply (Cont'd...)	Poor efficiency of utilization of available feed resources	Increase utilization of underutilized feed resources e.g. • Improve collection and small-scale processing of fish offal that is largely wasted • Increase research effort on the utilization of non-conventional feeds.
		Adoption of the use of balanced "best cost" rations for more efficient and effective utilization of the available feed resources and attain the desired level of productivity. • Training on simple ration balancing/mixing and awareness on the increase in efficiency of feed utilization/reduced wastage through feeding animals based on need and efficiency of use (life cycle feeding); • Adoption of feeding management practices so that livestock are fed according to their requirements to optimize feed utilization efficiency by animals that have special needs like pregnant females and young stock are treated differently. Implementation of targeted allocation of feed to the most responsive livestock
		Improve the nutritive value and palatability of poor quality feed resources through • Supplementary feeding using different agro-industrial by-products, horticultural crop wastes and occasional surplus grain • Promote use of simple technologies like physical treatment and/or urea treatment of residues to increase efficient utilization
		Use high moisture roughages that are seasonally produced fresh when and where they are available and conserved (hay or silage) for subsequent use.
		Consider alternative fuel sources for sugar factories that spares the bagasse that can be used as a roughage source along with molasses and protein supplements
		Reduce wastage through: • Promotion of proper feed storage • appropriate transport • Proper formulation of rations to reduce wastage through increased efficiency of utilization by the target animal

Constraints	Reasons behind constraint	Needed interventions
		• Promote use of appropriate feeders that reduce wastage during feeding
		Conservation of available feed resources such as forage biomass during times of plenty
		Foster animal production enterprises in the vicinity of high production of feeds e.g. near sugar plantations where high value feeds like cane tops are wasted
		Manufacture MNB from agro-industrial by-products and use as supplements.
		Policy support for sustained supply of agro-industrial by-products such as molasses for use as livestock feed
		Skill enhancement training on efficient use of agro-industrial by-products
		Avail appropriate technologies and formulating agro-industrial products as supplemental or alternative complete rations
		Production and use of total mixed ration (TMR) or multi nutrient blocks (MNB)s or compound rations as production or survival ration or as supplements
		Promote use of upgraded crop residues, sugarcane tops and wastes from cannery/ vegetable markets for market oriented livestock production
		An improvement in animal health would enable livestock to make better use of the limited feed resources available. The aim should, therefore, be to improve the health status of livestock to achieve the maximum benefits from better animal nutrition. E.g. the case of parasites
1. Shortage of feed supply (Cont'd...)	Low production and use of improved forages	Identification and strengthening of proper entry points and strategies to ensure sustainable production, management and utilization of improved forage crops in the farming system. • Identify appropriate strategies and entry points for forage development targeting specific situations • Integrate forage development into the farming system
		• Promotion of forage species suitable for under-sowing, inter-cropping and relay-cropping will help address the land shortage for feed production.
		• Complement these efforts with adequately prepared extension services to raise farmers' awareness about the importance of cultivated fodder and about their utilization methods through: • training ; • Establishment of demonstration plots at farmer training centers (FTCs). This will provide visiting farmer trainees with maximum exposure; • Complement with field days at exemplary farmer field sites;
		Widening and strengthening the source base of hay production in the country, which currently is dependent on natural pasture alone coming from specific locations like the *Selale* plain • Raising awareness about the wider use of improved forages with better nutritional value than natural

Constraints	Reasons behind constraint	Needed interventions
		pasture, as silage or hay, for increased animal productivity, should be the focus of extension activities • Explore the comparative advantage of converting additional areas for hay production instead of unproductive crop production efforts • Improving the species composition of available hay production fields by oversowing adaptable nutritious species
		Application of stock manure from corrals and sheds. The use of animal dung as fertilizer is generally constrained by its alternative use as fuel. This can only be alleviated with the establishment of more fuel wood stands and introduction of other forms of appropriate energy sources to spare manure for fertilization
		• Promote research effort in forage and pasture by focusing, among others, on: o Making thorough assessment of low cost establishment techniques; o Provision of microbiology support facility to produce inoculants for rhizobia specific legumes. The potential yields of many forage legume species used in a development program may not otherwise be realized. o Research effort towards the screening of forage species for low fertility and degraded areas to link forage development with NRM
		Enhance forage seed production • Develop appropriate technologies and mechanisms to enhance forage seed production • Encourage business oriented forage planting material production and marketing at small-scale level; • Provide appropriate incentives for forage seed production • Make arrangements for contractual forage seed production schemes • Linking up forage seed producers with many farmers in their vicinities in an out grower production scheme;
		Create viable market oriented forage development programs
		• Basic technical skills necessary for growing, processing, preserving, and utilizing cultivated forage
		• Create economic incentives for forage growers to have interest and take the task more seriously
		• Support in terms of start-up capital and credit access
		• Organize farmers who aspire to produce forage for market
		• Strengthening the linkage between animal producer cooperatives with feed markets
		Raising public awareness on proper animal husbandry and efficient pasture management and use
		Promotion of food-feed crops to increase the quality and quantity of available biomass without compromising food yield or additional inputs of land and water, which are also required to produce food for people.

Constraints	Reasons behind constraint	Needed interventions
1. Shortage of feed supply (Cont'd...)	Overgrazing/Overstocking/shrinkage of grazing land	Reducing stock numbers (destocking): • Determine the carrying capacities of available grazing • Destock and reduce numbers to a level that can be handled in a productive manner o limit the household herd size preferably replacing the less productive animals with fewer more productive animals especially in medium and high altitude areas o numbers of oxen breeding females and followers to be reduced through: ▪ Promote the use of female cattle for draft as a medium to long term measure to reduce cattle numbers in favor of a larger ratio of females in the herd. ▪ More efficient crop production technologies; ▪ Utilize a large number of lowland oxen into the farming areas, use for traction, fatten and dispose. The number of breeding cattle and followers required to produce and maintain the required number of oxen can be reduced as a consequence ▪ Wherever the size of land holding makes it worthwhile, a shift to the use of four-wheeled or two-wheeled tractors would help to greatly reduce the number of relatively unproductive livestock maintained. o Reduce small ruminant numbers through increasing off take by establishing good and reliable livestock markets accompanied by other programs to increase family cash income o Equine numbers to be reduced through improvement in infrastructure and more efficient rural transport services;
		Planned effort in pasture improvement; • Foster, empower and capacitate customary user organizations that formulate and enforce improved management and utilization guidelines of communal grazing o Give due recognition and support to customary institutions and make effective use of them o Farmer organizations should be effectively used by the extension system. Communal control of grazing areas with well structured farmer groups may afford advantages with a possibility of effective controls over stock access;
		• **Identify and map restoration & utilization measures**
		• **Delineation of areas for haymaking, grazing reserves and restoration** o Stock exclusion areas for vegetation rehabilitation and utilization of forage through " cut and carry" feeding
		• **Implementation of pasture improvement measures**

Constraints	Reasons behind constraint	Needed interventions
		o Identification of species suited to various agro-climatic zones and over sowing large areas of grazing land with higher producing species of both grasses and legumes; o Make arrangements for production of seed for over sowing, pastures, forage crops and inter-row cropping o Establishment of pastures on communal grazing areas etc o Reseeding by oversowing legumes in the medium to low altitude areas where native legumes are often deficient. This could be done with relatively minimum cost and if successful could upgrade a vast area and benefit a large number of producers
		• **Promote controlled or zero grazing of pastureland combined with "cut-and-carry" system of feeding.** o The more intensive feeding like that in the Hararghe highlands where fattening bulls and oxen are tethered and fed crop residues, fresh cut grass, weeds from crop areas and crop thinnings/strips is good practice that should be expanded to similar areas by the extension system; • **Foster development of private fodder production to reduce pressure on communal grazing areas:** o Growing and proper utilization of productive and nutritious forages in association with food crops. o Promote planting and intensive use of fodder trees and backyard forage
		Improving productivity per hectare for both crop and livestock productions helps to reduce the pressure
		Mobilizing the surplus human population into non-agricultural means of survival
2. Soaring feed prices	Shortage of feed supply	Implement the measures suggested for increasing feed supply above. This will help reduce prices
	High transport cost	Promote simple methods like box baling to reduce bulk of roughages to reduce the volume to be transported and thus cost
		Consider dehydration of wet feeds like Brewers grains and production of dried molasses
		Formation of producer groups, which could transport feeds from long distances in bulk and store for the next seasons.
		Commercialization of feed production (seed and/or feed as a markatable commodity)
		• Enhancing business orientation training and support
		• Increase awareness of farmers regarding the importance of agro-industrial by-products and manufactured feed
		• train rural farmers in the vicinity of towns on how to make silage using less sophisticated procedure and material and specialized as feed producers

Constraints	Reasons behind constraint	Needed interventions
	Poor market orientation of feed production	• Cereal crop producing areas could also improve the poor quality of crop residues through urea treatment as a marketable commodity.
		Upgrade storage capacity so that feed can be purchased and stored at times when it is available at lower cost
		• Boosting commercialization and intensification of livestock production
		• Foster supply of feed processing and mixing equipment locally by encouraging small-scale production of such equipment by small-scale and micro-enterprises
		Boosting commercialization and intensification of livestock production
		Foster feed marketing: • Develop market places for feeds an important step in the improvement of the operation of the feed market • Formation of vertical and horizontal linkages of feed producers to input suppliers, animal producers, cooperatives etc. • Encourage cooperative marketing to help reduce the impact of transportation and handling costs o Motivate and support the suburb farmers surrounding the towns to specialize in supplying dry season roughage to urban/periurban farms o Formation of producer groups, which could transport feeds from long distances and store for the next seasons.
	Multiple taxation	Avoid multiple taxation that escalates the cost of especially agro-industrial by-products
	Technical/infrastructural problems of the feed industry	Availing facilities to determine the quality of ingredients within the time required by management to make feed formulation decisions based on "best" choice of ingredients based on a combination of price and nutritional value.
		equip feed mills with equipment/facilities necessary to add molasses to mixed feed
		Encourage/support feed mills to produce pelleted feed – some advantages of in using pelleted feed, one of which is that it reduces wastage when given to livestock. It also increases efficiency of utilization
3. Seasonal variability in feed quality and quantity		Promote feed conservation practices like hay making, silage making and residue treatment to reduce seasonal variability • Grass cut for conservation is usually excessively mature. The extension service should aggressively train and assist farmers to determine the optimum stage of cutting for optimum use of the resources
		Enhance storage capacity to purchase during times of plenty for use during periods of shortage
		Form producer groups which could transport feed (especially concentrates, from long distances and store for

Constraints	Reasons behind constraint	Needed interventions
		periods of shortage
		Motivate and support the suburb farmers surrounding towns to specialize in supplying feed to urban/peri-urban farms
		Inter-row cropping with legumes in areas of higher rainfall to improve dry-season grazing,
		Promote production of fodder trees and backyard forage legumes that can be used as supplements during the dry season
		Promote seasonal calving/lambing/kidding to avoid births during times of feed shortage and its impacts
		Encourage business ventures like UMB and Multinutrient block manufacture as a business venture and also serve as a source of supplement during periods of poor feed supply
4. Low intake, digestibility and nutritional value (especially protein content) of crop residues		Skill enhancement training of farmers on improving crop residue intake, digestibility and nutritive value by physical and chemical treatment
		Development and promotion of affordable and easy to use tools and machinery for physical treatment of crop residues
		Consider supply of urea at farmers level also for residue treatment like that for crop fertilization
		Growing fodder legumes and using them as supplement to crop residue based diets • Improved utilization of crop residues by feeding with: o Foliage from fodder trees, e.g. Leucaena; o High quality conserved legume hay
		Promote urea treatment of crop residues
		Promote feed conservation (hay, silage)
		Use of strategic supplementation of residue based diets
		Promote wastage reduction measures
5.Lack of knowledge and skills		There is lack of experience and training in the more applied aspects of livestock and forage development and management that needs to be upgraded through practical training of field staff;
		Developing knowledge in Animal nutrition, feed formulation adapted to local conditions of animal production and feed milling technology
		upgrading the technological skill of feed mill operators to manufacture quality compound feeds and maintain equipment,

Constraints	Reasons behind constraint	Needed interventions
		Awareness of feed manufacturers that quality pays and customers of manufactured feeds (animal producers) that "cheap is not always economical". This is key in the enforcement of quality assurance and ultimately development of the feed milling industry and the livestock sector
		Equipping extension officers with appropriate skills in: • Feed supplementation packages to help increase the awareness of producers served by the extension agents on the use of compound feeds and consequently increase demand. • Provision of extension services to empower producers to demand for quality feeds
		Provide training on physical tests and judgement of ingredient and mixed feed quality to feed millers, feed buyers etc.
		Promote use of appropriate technologies by strengthening advisory services
		Extension service to come up with recommended alternative formulae based on different ingredients for various classes of livestock to encourage home mixing of compound feeds
		Reduce the time livestock and forage extension staff spend in activities other than livestock/forage extension to increase the amount of time spent on livestock/forage development.
		Morale among extension staff especially those engaged in livestock extension is often low. Consider incentives to boost moral
		The EAFIA come up with an "Animal Feed Service Bulletin" published regularly (quarterly, 6-monthly etc.) that contains results of the analysis and market information on feeds
		Organize professional advisory service e.g. on ration formulation and manufacture to give support to the industry
	Inadequate institutional support services	Facilitate availability and accessibility of credit, land etc. especially to small feed producers and input suppliers
		Increase research support to the feed industry. • Increase capacity of the public research sector to generate information on the feeding value of locally available resources through laboratory and field trials and make it available to the industry • Explore technology generation through contract research arrangements between the public and private sector (e.g. the feed milling industry)
		Strengthen input supply for feed production
		Increase extension support to the feed industry in terms of providing training and technical advisory services
		Enforce the quality control legislation and organize provision of quality inspection service
Weak or no producer organizations		Strengthening the Ethiopian Animal Feed Industry Association (EAFIA) to: • Serve as the mouthpiece of members to help solve their problems by bringing the same to the attention of

Constraints	Reasons behind constraint	Needed interventions
		relevant bodies • Set up an agreed vision and mission of the feed industry and help members to work towards that goal • Conduct of dialogue, public hearings, workshops to increase level of awareness, improve feedback mechanism and encourage private sector involvement in policy formulation; • Facilitate and make arrangements for experience sharing visits by members in the feed industry in a developed country and/or locally • Foster linkages with local and international government and non-government organizations for information networking and support to the sector
Weak national capacity to oversee the progress of the livestock and consequently the Feed sector	Limited integration of the different aspects of the livestock sector	Creating favorable legal frame work for the sustainable development of the livestock industry
		Creating integrated approach for livestock sector development by considering the aspects of (i) livestock husbandry (agriculture), (ii) industrial support related with its linkage with industries (industry), (iii) role in urban economy (urban policy), and (iv) natural resource and environment (land use policy)
		Strengthening the capacity of institutions engaged in extension, research/education and regulatory aspects of the feed sector
		Provide support services that increase productivity, value addition, and market access for livestock products (meat, milk, eggs etc.)
		Formation of a lobby group aimed at inducing private-sector participation in the development of the livestock industry is essential. The functions of such a group could include • Identifying flaws in livestock policies and taking steps to bring them to he attention of policymakers; • Forging working relations among trading communities, development organizations and policymakers, and • Creating forums whereby policy dialogue can take place with relevant bodies on all issues related to improving the participation of the private sector in the livestock industry development process

Pastoral production system

Constraints	Reasons behind constraint	Interventions required to address constraints
Shortage of feed supply	Rangeland degradation	Identify and map rangelands requiring restorative work
		Promote participatory landscape planning and allocation of rangelands to their agro-ecological potential
		Identify and scale-up appropriate rangeland rehabilitation and management measures
		Managing the spread of invasive species
		Strengthening and expanding community-based rangeland enclosures and ex-situ seed banks
		Reseeding extremely degraded rangelands with productive and drought tolerant indigenous and introduced forage species
	Loss of key grazing resources	Protect key drought-time fallback grazing areas and prevent their conversion into unsustainable land use systems (e.g. crop farming)
		Avoid haphazard human settlement patterns and water scheme development
		Encourage seasonal mobility of livestock to/from fallback grazing areas by maintaining traditional livestock migration routes
		Use of fire as a management tool for brush control to shift the balance, back towards grassland and reduce land lost to bush encroachment.
	Weakening of customary institutions	Recognize the vital role customary institutions play in the sustainable management of rangeland resources
		Empower and capacitate customary institutions
		Encourage the effective use of indigenous knowledge and practice in resource management
Shortage of feed supply (Cont'd...)	Conflict over access and use of grazing resources	Strengthen community- led peace-building initiatives that paves a way for equitable and efficient utilization of buffer zones
		Foster broad-based resource use conflict management efforts transcending regional states and national borders
	Inefficient management and utilization of locally available feeds	Scale up technologies that minimize wastage and improve feeding value of local feed resources such as the urea-molasses treatment of crop residues and production of multi-nutrient blocks from agro-industrial by-products and forages
		Increase the efficient use of grazing reserves and browses through well regulated seasonal grazing and hay making practices
		Facilitate reciprocal arrangement between pastoral communities across buffer grazing lands as well as pastoralists and agro-pastoralists/farmers on the use of forage and water resources
	Limited cultivated	Identify and map areas suitable for community-based forage production under irrigation in the lowlands

Constraints	Reasons behind constraint	Interventions required to address constraints
	forage production and marketing culture	Support market oriented (feed, planting material and livestock-product marketing) irrigation-based forage production by agro-pastoral ists through technical backstopping, revolving fund & micro-credit
		Establish system of contractual agreements with agro-pastoral households along perennial rivers to produce and supply fodder at times of drought
	Under utilization of pockets of range resources due to unavailability of water and bush encroachment	• Water development: o Extension of wet season grazing by provision of ephemeral ponds (about 5000 m^3 capacity) to relieve pressure on dry season grazing areas, which are often overgrazed; o Provision of additional permanent waters (large capacity ponds or bores) in areas not currently commanded by water. The spacing of water points is a key factor. About 25 km apart seems appropriate for permanent waters, but ephemeral ponds could be spaced 5km apart. o Use of fire as a management tool: For brush control to use fire in a cheap and positive way to shift the balance, back towards grassland.
	Drought	• Development of Fodder banks: o The national or regional stockpiling of fodder against a drought situation; o Establishment of reserve areas in which fodder is grown and held for use in drought. • Stop encroachment by settled farmers on drought refuges and other incursions into the rangelands
Shortage of feed supply (Cont'd...)	Overgrazing/Overstocking/shrinkage of grazing land	Raising public awareness on proper animal husbandry and efficient range management and use
		Reducing stock numbers (destocking): • Determine the carrying capacities of available rangeland resources • Destock and reduce numbers to a level that can be handled in a productive manner o limit the household herd size by increasing offtake o Utilize a large number of lowland oxen into the farming areas, use for traction, fatten and dispose. o Reduce small ruminant numbers through increasing off take by establishing good and reliable livestock markets accompanied by other programs to increase family cash income and providing advisory service to pastoralists on the productive use of money
		Planned effort in pasture improvement: • Foster, empower and capacitate customary user organizations that formulate and enforce improved management and utilization guidelines of communal grazing o Give due recognition and support to customary institutions and make effective use of them o Pastoral organizations should be effectively used by the extension system. Communal control of grazing areas with well structured pastoral groups may afford advantages with a possibility of effective controls over

Constraints	Reasons behind constraint	Interventions required to address constraints
		stock access; • **Identify and map restoration & utilization measures** • **Delineation of areas for haymaking, grazing reserves and restoration** o Stock exclusion areas for vegetation rehabilitation and utilization • **Implementation of Range improvement measures** o Iden ification of species suited to the different pastoral agro-climatic zones and over sowing large areas of rangeland with higher producing species; o Make arrangements for production of seed for over sowing/reseeding; • **Foster development of fodder production in areas where there is relatively better water supply:** o Water diversion and water retention for fodder or forage production o Growing and conservation of adapted species o Promote feed marketing in association with production • Use supplements for dry- season grazing: The prospects for feeding energy and nitrogen supplements (e.g. Urea Molasses Blocks) to pastoralist herds and flocks need to be explored
Inadequate knowledge and skills	**Lack of timely and accurate livestock early warning information**	Create capacity to predict, analyze and package timely livestock early warning information
		Disseminate accurate and timely livestock early warning information using local languages
	Inadequate preparedness and ineffective response to drought	Promote community-based group enclosures and fodder banks
		Establish feed depots at strategic locations in drought prone environments
		Promote the timely stockpiling of locally available feeds (e.g. grass hay, crop residues, leaves and pods of browse, etc) and create local capacity readily triggered to manufacture and market survival feeds (e.g. MNBs) at times of drought
		Establishing drought insurance scheme
		Link producers (pastoralists) with traders and consumers including marketing cooperatives in big towns, higher learning institutions, military bases
		There is lack of experience and training in the more applied aspects of livestock and Range development and management that needs to be upgraded through practical training of field staff;
Inadequate Institutional support services	**Absence or weak advisory service**	Reduce the time livestock and range extension staff spend in activities other than livestock/range extension to increase the amount of time spent on livestock/range development

Constraints	Reasons behind constraint	Interventions required to address constraints
	provision	Transport communications and other infrastructure (gov't services)
		Morale among extension staff especially those engaged in livestock extension is often low. Consider incentives to boost moral
		Organize professional advisory service e.g. on rangeland development and utilization to give support to the pastoral community, staff working with extension staff and the government
	Inadequate institutional support services	Range resource development requires targeted effort in the form of development projects like the 2nd livestock development project to counteract the ever increasing resource degradation and effective utilization problems
		Facilitate availability and accessibility of credit, etc. especially to small feed producers and input suppliers
		Increase research support to the Pastoral system. • Increase capacity of the public research sector to generate information on range resources management and development • Explore technology generation through contract research arrangements between the public and private sector (e.g. the feed milling industry)
		Strengthen input supply for Range improvement
		Increase extension support to the pastoral livestock system in terms of providing training and technical advisory services
		Empower customary institutions and promote participatory management of grasslands
		Support actions that promote the protection of key grazing resources and encourage the observance of ecologically suitable land uses

Mixed feed production

Constraints	Reasons behind constraint	Needed interventions
Shortage of ingredient supply	Inadequate production	Increase production of raw materials for mixed feed production e.g. Maize, Soybean in terms of yield per unit area and acreage
		Promote contract out-grower schemes of feed production through motivation and support farmers to specialize in feed production.
		Promote the production of protein concentrates by feed industries to foster home mixing of compound feeds by incorporating farm produced grains like maize
		Strengthen the economic incentives for increased investment in feed production • Making land available for the production of feed ingredients and establishment of feed processing plants • specific loans for feed production/processing • Provision of investment incentives (as is, for example, the case for the flower/horticultural industry) • Consider tax exemption/tax holidays for mixed feed production
		Promotion of forage based feeding for dairy production to spare concentrates for manufacture of mixed feed for poultry
		Encourage and support feed manufacturers to produce their own ingredients like maize and soybean by making incentives like credit and land available
	Dependence on limited feed ingredient sources	Expand the utilizable feed resource base by fostering applied research on utilization of alternative sources of feed ingredients (especially energy and protein sources)
	Exports without value addition	Give priority to local use than exports
		Promote value addition before export: • promotion of oil extraction and flour milling factories so that more by-products are made available for use as feed • The advantages and disadvantages of exporting oilseeds without value adding vs. processing locally into oil and oilseed cakes/meals needs to be critically assessed
		Policy decision to spare a proportion of the molasses currently utilized for ethanol production for use as feed. A small quantity of molasses can render large quantities of otherwise unusable by-products into productive feed. It also has a sparing effect on the quantity of grains used for animal feeding
	Wastage of feed	Decrease wastage during harvest, transport, storage and use

Constraints	Reasons behind constraint	Needed interventions
		Encourage and enforce the slaughter of animals in abattoirs to save and process slaughterhouse by-products as animal feed ingredients. These are currently largely wasted due to the prevalence of informal animal slaughter
	Poor efficiency of utilization of available feed resources	Increase utilization of underutilized feed resources e.g. • Improve collection and small-scale processing of fish offal that is largely wasted • Increase research effort on the utilization of non-conventional feeds.
		Adoption of the use of balanced "best cost" rations for more efficient and effective utilization of the available feed resources and attain the desired level of productivity. • Training on simple ration balancing/mixing and awareness on the increase in efficiency of feed utilization/reduced wastage through feeding animals based on need and efficiency of use (life cycle feeding); • Adoption of feeding management practices so that livestock are fed according to their requirements to optimize feed utilization efficiency by animals that have special needs like pregnant females and young stock are treated differently. Implementation of targeted allocation of mixed feed to the most responsive livestock
		Reduce wastage through: • Promotion of proper feed storage • Appropriate transport • Proper formulation of rations to reduce wastage through increased efficiency of utilization by the target animal • Promote use of appropriate feeders that reduce wastage during feeding
		Policy support for sustained supply of agro-industrial by-products such as molasses for use as livestock feed
		Generate technologies and formulating agro-industrial by-products as supplemental or alternative complete rations
		Production and use of total mixed ration (TMR) or multi nutrient blocks (MNB)s or compound rations as production or survival ration or as supplements
		An improvement in animal health would enable livestock to make better use of the limited feed resources available. The aim should, therefore, be to improve the health status of livestock to achieve the maximum benefits from better animal nutrition. E.g. the case of parasites
	Shortage of feed	Implement the measures suggested for increasing feed supply above. This will help reduce prices

Constraints	Reasons behind constraint	Needed interventions
Soaring feed prices	ingredient supply	
	High transport cost	Consider dehydration of wet feeds like Brewers grains and production of dried molasses
		Formation of producer groups, which could transport feeds from long distances in bulk and store for the next seasons.
		Promote bulk transport and storage
	Poor market orientation of feed production	Commercialization /Promotion of feed production
		• Enhancing business orientation training and support
		• Increase awareness of farmers regarding the importance of manufactured feed in improving animal productivity and profitability
		• Improve feed marketing channels e.g. creation of a system of encouragement and incentives to foster the use of commercial compound feeds by animal producers, e.g. organizing a possibility for dairy producers to collect compound feeds from milk collection sites, etc.
		• Introduce different marketing strategies like mini packaging of compound feeds, demonstration of the use and value of compound feeds to small-scale producers, etc. should be promoted
		• Investment promotion in animal feed like organizing exhibitions etc. for increased competition in the feed markets
		• Trust building measures like institution of quality assurance to reduce the prevailing mistrust between buyers and sellers of compound feeds
		• Organizing promotional events like exhibitions for public awareness and competitive spirit
		Upgrade storage capacity so that feed can be purchased and stored at times when it is available at lower cost
		• Boosting commercialization and intensification of livestock production
		• Foster supply of feed processing and mixing equipment locally by encouraging small-scale production of such equipment by small-scale and micro-enterprises
		Boosting commercialization and intensification of livestock production to foster use of mixed feed
		Foster feed marketing: • Develop market places for feeds an important step in the improvement of the operation of the feed market

Constraints	Reasons behind constraint	Needed interventions
		• Formation of vertical and horizontal linkages of feed producers to input suppliers, animal producers, cooperatives etc. • Encourage cooperative marketing to help reduce the impact of transportation and handling costs o Motivate and support the suburb farmers surrounding the towns to specialize in supplying dry season roughage to urban/periurban farms o Formation of producer groups, which could transport feeds from long distances and store for the next seasons.
	Multiple taxation	Avoid multiple taxation that escalates the cost of especially agro-industrial by-products
	Technical/infrastructural problems of the feed industry	Availing facilities to determine the quality of ingredients within the time required for management to make feed formulation decisions on "best" choice of ingredients based on a combination of price and nutritional value.
		Encourage/support feed mills to produce pelleted feed – some advantages of in using pelleted feed, one of which is that it reduces wastage when given to livestock. It also increases efficiency of utilization
		Help and advise feed processing plants to install liquid mixing accessories (fat and molasses)
		Enhance ingredient and processed feed storage capacity to minimize fluctuations in ingredient and compound feed prices
		Provide credit services for replacement of obsolete equipment, installation of auxiliary facilities
		Provide training to personnel on maintenance and overhaul of feed mills
Seasonal variability in feed quality and quantity	**Poor public sector capacity for regulatory functions and quality assurance of raw materials and finished feeds**	Strengthening the institutional and policy support for enforcement of feed quality standards • Speed up the coming into action of the drug and feed regulatory authority to enforce the regulation on feed quality • Revise the current feed standards and upgrade the "voluntary" standards to "mandatory"
		Awareness creation on the usefulness of implementing the quality standards on a mandatory basis to all parties involved
		Establishment of an award scheme for recognition of consistent compliance to rules and regulations
		Gradually start enforcement of the legislation and routine inspection practices commensurate with the increase in awareness: • Initially, public referral central labs can be established and/or the capacity of the lab at the Ethiopian Standards Agency be strengthened to support the feed inspection service. • The bigger feed mills should be encouraged to set up their own quality control labs in due course

Constraints	Reasons behind constraint	Needed interventions
		• Accreditation of service laboratories to increase chemical analysis capabilities for faster results • provide producers with simple and inexpensive quality control kits, and educate them to do their own monitoring as is done in some countries • Enforce regulations under which defaulting manufacturers can be reprimanded
	Poor Storage Capacity	**Enhance storage capacity to purchase during times of plenty for use during periods of shortage**
		Encourage business ventures like UMB and Multinutrient block manufacture as a business venture and also serve as a source of supplement during periods of poor feed supply
Lack of knowledge and skills	Poor access to skill building training	There is lack of experience and training in the more applied aspects of livestock feeding and management that needs to be upgraded through practical training of field staff;
		Developing knowledge in Animal nutrition, feed formulation adapted to local conditions of animal production and feed milling technology
		upgrading the technological skill of feed mill operators to manufacture quality compound feeds and maintain equipment,
		Awareness of feed manufacturers that quality pays and customers of manufactured feeds (animal producers) that "cheap is not always economical". This is key in the enforcement of quality assurance and ultimately development of the feed milling industry and the livestock sector
		Equipping extension officers with appropriate skills in: • Feed supplementation packages to help increase the awareness of producers served by the extension agents on the use of compound feeds and consequently increase demand. • Provision of extension services to empower producers to demand for quality feeds
		Provide training on physical tests and judgement of ingredient and mixed feed quality to feed millers, feed buyers etc.
Ppolicy and institutional support for the development of the compound feed industry	Absence or weak advisory service provision	Promote use of appropriate technologies by strengthening advisory services
		Reduce the time livestock extension staff spend in activities other than livestock/forage extension to increase the amount of time spent on livestock extension
		Morale among extension staff especially those engaged in livestock extension is often low. Consider incentives to boost moral
		The EAFIA come up with an "Animal Feed Service Bulletin" published regularly (quarterly, 6-monthly etc.) that contains results of the analysis and market information on feeds
		Organize professional advisory service e.g. on ration formulation and manufacture to give support to the industry

Constraints	Reasons behind constraint	Needed interventions
	Inadequate institutional support services	Facilitate availability and accessibility to credit, land etc. especially to small feed producers and input suppliers
		Increase research support to the feed industry. • Increase capacity of the public research sector to generate information on the feeding value of locally available resources through laboratory and field trials and make it available to the industry • Explore technology generation through contract research arrangements between the public and private sector (e.g. the feed milling industry)
		Strengthen input supply for feed production
		Increase extension support to the feed industry in terms of providing training and technical advisory services
		Enforce the quality control legislation and organize provision of quality inspection service
	Weak or no producer organizations	Encourage formation of farmers and manufacturers associations to ease extension delivery, acquisition of credit, inputs and other services
		Strengthening the Ethiopian Animal Feed Industry Association (EAFIA) to: • Serve as the mouthpiece of members to help solve their problems by bringing the same to the attention of relevant bodies • Set up an agreed vision and mission of the feed industry and help members to work towards that goal • Conduct of dialogue, public hearings, workshops to increase level of awareness, improve feedback mechanism and encourage private sector involvement in policy formulation. • Facilitate and make arrangements for experience sharing visits by members in the feed industry in a developed country and/or locally • Foster linkages with local and international government and non-government organizations for information networking and support to the sector
	Inadequate policy support	Make policy and institutional arrangement for the regulation and guidance of the animal feed industry. This is necessary to enable all actors in the industry to play their roles effectively
		Avoid multiple taxation at different stages of feed production
		Consider tax exemption/tax holidays for feed ingredients and compound feeds (like many other food items) at least for a period to give the initial push the industry needs to kick off
		Give priority to the local feed industry over exports
		Promote involvement of all categories of stakeholders in the animal feeds industry (farmers, animal feeds manufacturers, traders, policy makers, local governments, civic organizations and other service providers in planning and implementation of the animal feeds industry

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Constraints	Reasons behind constraint	Needed interventions
		Encourage regional and international collaboration in the area of feed production, research and quality control
	Weak national capacity to oversee the progress of the livestock and consequently the feed sector	Creating favorable legal frame work for the sustainable development of the livestock industry
		Strengthening the capacity of institutions engaged in extension, research/education and regulatory aspects of the feed sector
		Provide support services that increase productivity, value addition and market access for livestock products (meat, milk, eggs etc.)
		Formation of a lobby group aimed at inducing private-sector participation in the development of the livestock industry is essential. The functions of such a group could include: • Identifying flaws in livestock policies and taking steps to bring them to he attention of policymakers; • Forging working relations among trading communities, development organizations and policymakers; and • Creating forums whereby policy dialogue can take place with relevant bodies on all issues related to improving the participation of the private sector in the livestock industry development process

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Livestock Feed Resources in Ethiopia is a comprehensive assessment with recommendations for improving production and utilization. Best of all, the authors are Ethiopian professionals, whose first-hand experience under Ethiopian conditions is readily available to serve the needs of Government, donor and private sector decision makers concerned with increasing milk and meat production in Ethiopia.

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