Feed and fodder markets in South Asia and East Africa : A synthesis of four PRA case studies

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Table of Contents

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1 Background and objectives

Livestock contribute to the livelihoods of more than two-thirds of the world's rural poor and to a significant minority of the peri-urban poor. Therefore, if animals are managed properly, they can provide an important avenue for reducing poverty and boosting the economy in developing countries. A predicted increase in demand for food products of animal origin in developing countries – called the Livestock Revolution - offers the poor livestock keepers an important opportunity to benefit from a rapidly growing market. Even though a large share of this expanding market is expected to be supplied by large scale industrial production, especially in case of monogastrics, small-scale livestock producers should also be able to capture a significant share of the market if they can get access to high quality inputs, services and information to produce high quality products demanded in the market (Delgado et al., 1999). Among other things, there may be three pathways for the poor to get out of poverty through livestock- securing current and future livestock assets, sustainably improving the productivity of livestock and agricultural systems, and greater participation of the poor in livestock-related input and output markets (ILRI, undated). Improving productivity of both crop and livestock is considered by some authors as the key to achieve competitiveness for greater market participation and future survival of smallholder farms in developing countries (Hazell et al., 2007).

Feed scarcity – inadequacy of feeds in terms of quantity as well as quality- has been a long standing technical constraint for productivity improvement of livestock in smallholder mixed farming, pastoral and agropastoral production systems in developing countries, crop residues complemented with collection from and/or grazing of animals on communal land, forests, roadsides or fallow land are the principal sources of feeds in mixed crop-livestock systems. Small quantities of concentrates derived from milling by-products of crops are also used by some producers. In pastoral/agropastoral systems, grazing on common property resources are the main sources of feeds, which are complemented by feeding crop residues where accessible. Purchased concentrate use is rare. National and international research institutions have developed many feed production and utilization technologies – grasses, legumes, dual purpose crops, rations based on agro-industrial by-products to name a few broad categories- but they have been rarely adopted by smallholder producers (Ayantunde et al., 2007; Hall et al., 2008). Within this general pattern, there are variations between production systems and agroecologies in terms of specific types of feeds used, their sources and degree of scarcity.

The predicted livestock revolution is expected to accompany significant increase in the use of cereal grains as feed, especially for monogastrics, and most of it is also predicted to be traded in the international market (Delgado et al., 1999). On the other hand,

roughages for ruminants are nontradables in the international market because of bulkiness though such feeds are traded locally in varying degrees depending on production systems and their evolution trend, nature and extent of feed scarcity, market orientation of producers, and quality of transport infrastructure and its consequences on cost. For example, in many developing countries small scale urban and peri-urban dairy production has developed responding to urban market demand for milk and the lack of links between urban consumers and the large number of small rural dairy producers due to poor road infrastructure. In such conditions, collection of milk from dispersed small producers for processing and marketing in urban areas is more difficult and costly than transporting feeds from rural to urban and peri-urban areas for milk production nearer to consumers. Similar situation prevailed in the European cities in the mid 19th century but by the turn of the century, urban/peri-urban dairy disappeared for a variety of reasons including cheaper increased supply of milk from rural areas and greater market orientation of producers due to improved road infrastructure on the one hand and higher cost of transportation of feed from rural areas and that of manure out of towns and suburbs (due to municipal and public health regulations) (Phelan and Henriksen, 1995; Jabbar et al., 1997). Urban/peri-urban dairy practiced in many developing countries today will eventually face the same fate as their European counterparts but until such time feed market will continue to play a key role in the supply of milk to the urban areas.

Feed scarcity has two main dimensions- temporal or seasonal and spatial, and both are to some extent mitigated through conservation, storage, trade and marketing of feeds. But there is very little current or past research on feed/fodder markets, especially those serving smallholders, in the developing countries. Some recent studies sponsored by the SLP and implemented through CGIAR intercentre collaboration in partnership with national institutions reveal that feed is a major constraint for smallholder commercialization of livestock but feed technology research on its own is unlikely to ensure adoption and innovations in diffusion process without adequate knowledge about characteristics and performance of feed markets. Recent work in India has suggested that fodder market research can aid in understanding key problems of feed availability and shortages for example by identifying suppliers and supply routes, kind and availability of feed by season, and the relationship between feed price and feed quality. Smallholders may face different nature of feed market constraints compared to large scale producers (Blümmel and Parthasarothy Rao, 2006).

In order to fill this knowledge gap, a rapid appraisal was conducted in Bangladesh and India representing South Asia and Ethiopia and Tanzania representing East Africa. A review of literature on feed/fodder market was conducted with a focus on these two regions, then case studies were conducted on selected feed/fodder markets to understand the dynamics of feed/fodder markets in these countries and explore how smallholder livestock keepers may benefit from these markets as producers of feeds/fodder and/or as buyers of feeds/fodder. The specific objectives are to identify nature of feed scarcity, types of feeds traded in the market, quality-price relationships, types of actors who participate in traditional fodder markets; the structure, organization and performance of these markets under different production systems; specific constraints and opportunities for smallholders to benefit from these markets, and identify the key interventions that can

improve sustainable smallholder access to high quality fodder and feed, and also that raise smallholder benefits from production of high quality fodder. The principal output will be a set of preliminary results and evidence on feed market characteristics and performance in a set of diverse situations, which will allow development of more precise questions and hypotheses for development of a full proposal to undertake a study on feed markets in Sub-Saharan Africa and South Asia.

What follows is a summary of the case studies highlighting the key findings, their similarities and differences, and knowledge gaps that need to be filled with further research. The summary is organized as follows. In section 2, a brief summary of the literature review is presented highlighting existing knowledge on feed/fodder markets. In section 3, a summary of the case studies including locations and scope of the studies, methodology used, and the key findings are presented. Summary and recommendations are presented at the end.

2 Review of literature on feed/fodder markets

In order to put the study on fodder markets into a proper context, a literature search was conducted separately for South Asia and Sub-Saharan Africa because of the differences in the systems of livestock production, especially the relative advances in small and large scale commercial livestock production. Although there is much literature on feed resources and feed technologies for both the regions, literature on feed market is rather scanty, so what is presented here is a brief summary of the search process and available information.

2.1 Livestock feed markets in Sub Saharan Africa[1]

Extensive search from various bibliographic data bases using a range of key words produced very little information on feed/fodder markets. The literature search raises a major conceptual problem: definition and classification of livestock feed markets. What emerges from the literature is the 'duality' if not 'plurality' of livestock feed markets - i.e. informal/traditional markets and formal/commercial markets and/or small scale and large scale markets. Whilst the formal feed market is most advanced in South Africa (not technically an SSA country) and at 'medium stages' of development in Kenya and Zambia, it is fairly under-developed in the rest of the continent though high-intensive dairy and poultry producing regions (especially in Kenya, Tanzania, Uganda, and Zambia for example) fairing better than non-dairy and non-poultry producing regions. Resolving this conceptual/definitional problem is critical not only in identification of livestock feed markets but also in the analysis of the market structures – including the supply and demand structures of livestock feed products.

The literature makes few references to livestock feed markets *per se* – in part because of the problems with definition outlined above and partly because of the generally underdeveloped nature of these markets in SSA. There is however considerable mention of livestock feed products, both **traditional** (i.e. crop residues, natural grass – e.g.

[1] Material for this section is derived from Ochieng (2007).

Kikuyu grass (*Pennisetum clandestinum*), star grass (*Cynodon* spp.), Rhodes grass (*Chloris gayana*) setaria (*Setaria sphacelata*)**, conventional** (e.g. fodders such as Napier grass (*Pennisetum purpureum*) sweet potato (*Ipomoea batatas*) vines, various kinds of vetch (*Vicia* spp.) desmodiums (*Desmodium uncinatum*, *D. intortum*) or fodder trees such as calliandra (*Calliandra calothyrsus.*) and leucaena (*Leucaena leucocephala*), **manufactured** (e.g. concentrates and agro-industrial by-products such as bran, wheat pollard and dairy meal) and **emerging products** (e.g. fishmeal as livestock feed (especially in Namibia, Zambia and Kenya), cassava chips and other processed cassava products (especially in Nigeria, Cameroon, Ghana, Tanzania and Uganda

The literature search suggests that structure of livestock feed markets in Africa – formal or informal - vary between given countries, and most available information is about manufactured feed rather than about roughages. In South Africa, Kenya and Zambia, a near value-chain market structure can be discerned in some feed markets (in South Africa and Kenya – encompassing large private sector actors - such as Meadow Feed Company in South Africa, Unga Feeds Limited in Kenya, Meadow Feed, Tiger Feed and Yielding Feed, all of Zambia - and either cooperative societies, wholesale traders, stockists and retailers). In Zambia, this involves a combination of public, private and civil society agents – the aforementioned private companies, the National Milling Corporation (a parastatal) and cooperative societies, especially the Livestock Services Co-op Society (LSCS) are key players. In the rest of the continent, the search suggests that the formal market is still largely in infancy in most places. The relatively sophisticated level of feed markets in South Africa and Kenya is manifested by the existence of national feed manufacturer associations in both countries – AFMA (Animal Feed Manufacturers Association of South Africa) and KFMA (Kenya Feed Manufacturers Association) although the latter is not very active.

Kenya and Zambia stand out in the sophistication and diversity of their livestock feed markets, so these were explored a bit more than the others. Prior to economic liberalization in the 1990s, the livestock feed markets (formal) in both countries were dominated by a few big players (Unga Feed and National Milling Corporation respectively). However, liberalization has led to increasing dynamic and competitive markets in both countries. According to a recent analysis of the Kenyan dairy sector (Springfield Centre, personal communication), UNGA Feeds continues to dominate the manufactured feed market with a claimed 70% market share although competitors with lower priced products are increasingly biting into its share currently, and there is a growing fodder supply business in Kenya. 'Business Partners' supply many feed stores (about 500-700 stockists, probably representing over half of the total number of feed retailers nationally) in smaller towns and rural communities. UNGA Feeds also provides support to farmers through co-operatives and self-help groups, running seminars and training sessions on the technical aspects of its animal feed products. The company tries to respond to the largely smallholder farmers' market through mass means of communication (national field days, radio programmes etc). The formal feed market in Kenya though limited, generally functions well in terms of distribution and retailing of products through networks such as those employed by UNGA Feeds. It also appears that the fodder market (supply and demand) exhibits a growing trend in Kenya.

In Zambia, although liberalization has brought in more players, the formal feed market is dominated by just 3 players: Tiger Feed, National Milling Corporation and Meadow Feeds, which represent 94.5 percent of the formal feed sector (Table 1). The Livestock Services Co-op Society (LSCS) set up in the 1990s plays a major role especially in distribution. LSCS was set up to supply Zambian farmers with additives, medicines and small quantities of specialist feeds.

In summary, the literature on markets for livestock feed in Africa is very thin and suggests that the market for livestock feeds in a majority of African countries is thin, although it appears to be growing at different speeds in different countries - with Eastern and Southern African countries showing a lot more market dynamism than West and Central Africa. Information gap is more pronounced with respect to markets for roughages. The literature suggests that policy, institutional, economic, environmental, technological and demographic factors constrain the development of livestock feed markets in Africa. However, from the literature reviewed, it is difficult to build a comprehensive picture of the livestock feed markets for a majority of African countries, in respect of the following: development status, basic characteristics, market size, market structure, growth rate and product structure. Countries such as South Africa, Kenya, Zambia and Egypt might fair relatively well in this regard. Commercial livestock and feed markets are complementary industries, so an understanding of the dynamics of both the industries is essential for harnessing the potential of these industries.

Table 1. Feed production in Zambia in 2001 (tons)

Manufacturer	Volume (tons)	Percent
Tiger Feed	48 000	42.4
NMC	25 000	22.1
Meadow/QualityFeed	6 000	5.3
Farmers	30 000	26.5
Other manufacturers	4 200	3.7
Total	**113 200**	**100.0**

Source: FAO 2001

2.2 Livestock feed markets in South Asia [2]

The literature search was conducted extensively through internet and online databases covering the period from 1980 to the latest available year and was restricted to English. The scope of the search was defined broadly by using an extended list of key words related to feeds and fodder production and utilization on the one hand and supply, demand, firms, industries, markets and prices on the other. From the above search a total

[2] Material for this section is derived from a section in Blummel and Parthasarothy Rao (2008)

of 650 records - 60 full papers and 590 abstracts - were found. After several stages of screening and checking, 195 references were found to relevant : 170 related to feed resources, 18 to feed industry and only 7 to feed and fodder marketing (Table 2).

Table 2. Number of papers related to feed and fodder market in south Asian countries (1980-2007)

Country	Number of papers by subject area			Total
	Feed resources	Animal feed industry	Feed and fodder marketing	
India	49	11	5	65
Nepal	16	-	-	16
Pakistan	48	3	1	52
Bangladesh	10	1	1	12
Sri Lanka	32	-	-	32
South Asia	15	3	-	18
Total	**170**	**18**	**7**	**195**

Source: Blummel and Parthasarothy Rao, 2008

In South Asia feed resources can be classified into four main categories. These are fodders (native and improved grasses, herbaceous legumes, forage crops and multi-purpose trees), crop residues (rice, sorghum, millet and wheat straw), agro industrial by products (AIBP) (rice and wheat bran; groundnut, rapeseed, soybean, sunflower and cottonseed cakes) and non conventional feed resources (NCFR). AIBP and NCFR contribute less than 10 % of feed requirements (Devendra et al 2000). Most of the studies allude to feed deficit and shortages in all the south Asian countries. Own produced resources like crop residues and grazing on common lands are the most important sources of feed. Concentrate and ready mix feeds constitute a small proportion of total feed, use of grain as feed is limited to the poultry sector with small quantities given to milk animals.

Private sector dominates the animal feed industry in the South Asian countries. Countries in this region usually do not import ready mix compound feed. All the countries in South Asia except India import feed ingredients like maize and soybean meal (Ranawana, 2002). The animal feed industry in the region can be categorized into the following three types:

- Large scale vertically integrated operators who make feed for their own livestock operations
- Registered commercial manufactures of animal feeds for sale
- Small commercial producers and those who buy ingredients for mixing and selling.

Information on relative market shares of these three types is not known. Further, in India, the animal feed industry can be classified into three categories (Kleih et al., 2000): organized sector, which includes CLFMA, co-operative sector and unorganized sector, which includes small scale feed millers.

The animal feed industry is currently evolving from a fragmented industry into an organized sector. Unorganized sector dominates the feed industry and organized sector accounts for only around 8–10 percent of the feed requirement (Singh et al, 2003). Pathak (2003) estimated that the total concentrate feed requirement for all species of livestock including poultry in 2002 was around 114.4 million tons and has been increasing at the rate of 2.6 percent per annum. But the estimated concentrate feed production was 67.6 million tons in the same year, thus showing a deficit of about 41 percent. In estimating production of concentrate feeds, output of all cereals and oil seed cakes were considered. The increasing potential in poultry and dairy sectors will lead the demand for compound feed to grow at 12 percent per annum for the next few years (Pathak, 2003).

In India compound feed manufacturing on a commercial basis started around 1965 with the setting up of medium-sized feed processing plants in northern and western India mainly to serve the large ruminant sector, especially dairy, as the poultry sector was not yet well developed at that time. Over time, especially in recent years, demand for poultry feed increased more rapidly due the expansion of industrial production of poultry while demand for manufactured feed for large ruminants increased rather slowly as they depend mainly on crop residues and other milling by-products and feed ingredients. CLFMA estimated that total demand for balanced feed was about 60 million tons in 2005 but CLFMA members and non-members together produced about 5 million tons, the remaining feeds are ingredients mixed by farmers themselves. CLFMA members accounted for 72 % of the total compound feed production. Out of total production of compound feeds by CLFMA members in that year, poultry feed accounted for 55% and cattle feed 44 % production. Eighty three percent of compound feed production is concentrated in southern and western regions of the country. There is a clear demarcation in the pattern of utilization of feeds in these two regions. In the Southern region, poultry feed accounts for 68 % and in the western region cattle feed accounts for 68 % of total compound feed production (CLFMA, 2005).

Table 3. Demand and production of balanced manufactured feeds in India, 2005

Sector	Feed demand (million tons)	Feed production (million tons)
Dairy cattle	45.00	2.0
Poultry- Broiler	6.21	3.0
Poultry- Layer	8.13	-
Aquaculture- Fish	2.10	0.01
Aquaculture- Prawns	0.24	0.19
Total	61.68	5.20

Source: CLFMA. 2005.

India has enjoyed a competitive advantage in production of many primary livestock products for some time because of low production costs of farm based resource – crop residues as feeds and labour, but is not competitive in exports of value added products because of high marketing and processing costs and distortions in the world market. Despite this, the share of livestock products in agricultural exports increased from 3.5% in

1979 to 6.6% in 2003. At the same time the share of livestock in total agriculture imports fell leading to a positive trade balance for livestock products particularly from 1990 onwards. India's major livestock products export is buffalo meat that accounts for 71% of total livestock exports. Exports of buffalo meat showed tremendous growth over the last two decades, with policy support from the government.

The prices for feed such as sorghum and maize have been increasing in Indian market at a faster rate in the past few years than the prices of meat and milk (Figures 1- 4). Feed prices, which constitute nearly 50 to 60% of the production costs of different species of livestock have increased dramatically, especially in the past few years. This increase is expected to continue, and with the degradation of common grazing land, the dependence on purchased manufactured feed as an input in the livestock sector is set to increase and this may impact on both domestic and export prices of livestock products and comparative advantage in export. The prices of the final products, especially of milk and poultry, have actually fallen in the same period. The market for livestock products is very demand driven and the cooperatives in most states compete with each other that keep the prices of the final products down.

Some countries provide huge farm and market subsidies and other support to their livestock sectors, while in India such support is almost non-existent. Thus, India needs to negotiate in WTO for reduction in distortions in world trade to gain access to world markets. In fact, there exists a considerable potential for India to export livestock food products mainly dairy products to the neighbouring countries such as Bangladesh and Sri Lanka, which are deficit in milk production.

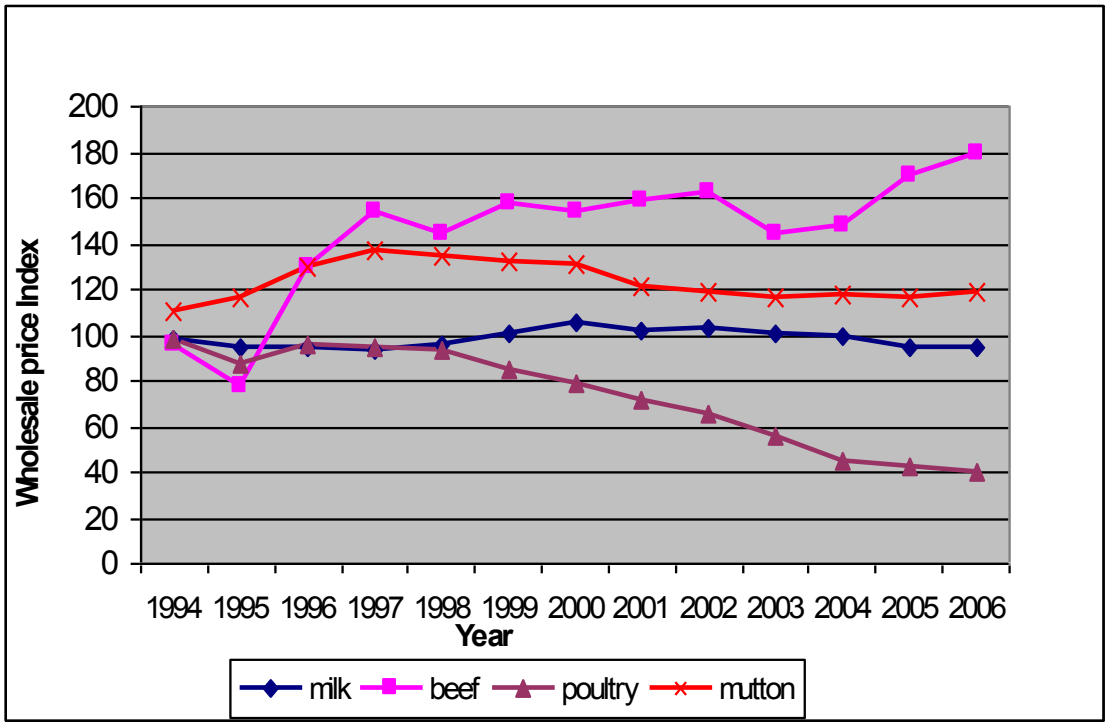

Figure 1. Real prices index of livestock products in India: 1993-94=100

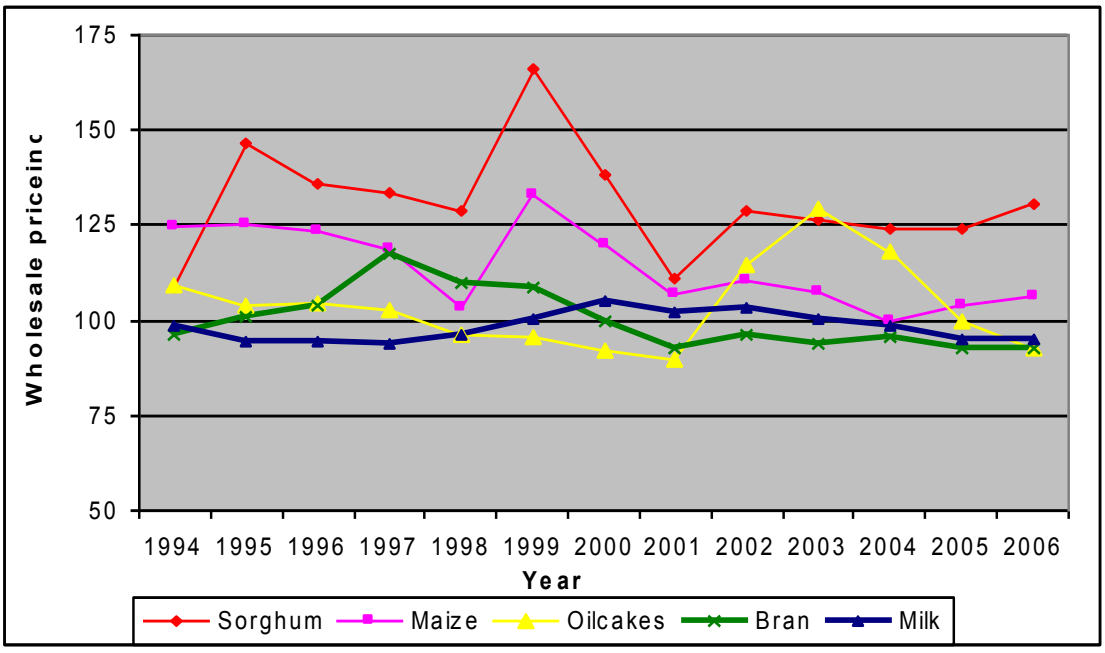

Figure 2. Real price index of feed and milk: 1993-94=100

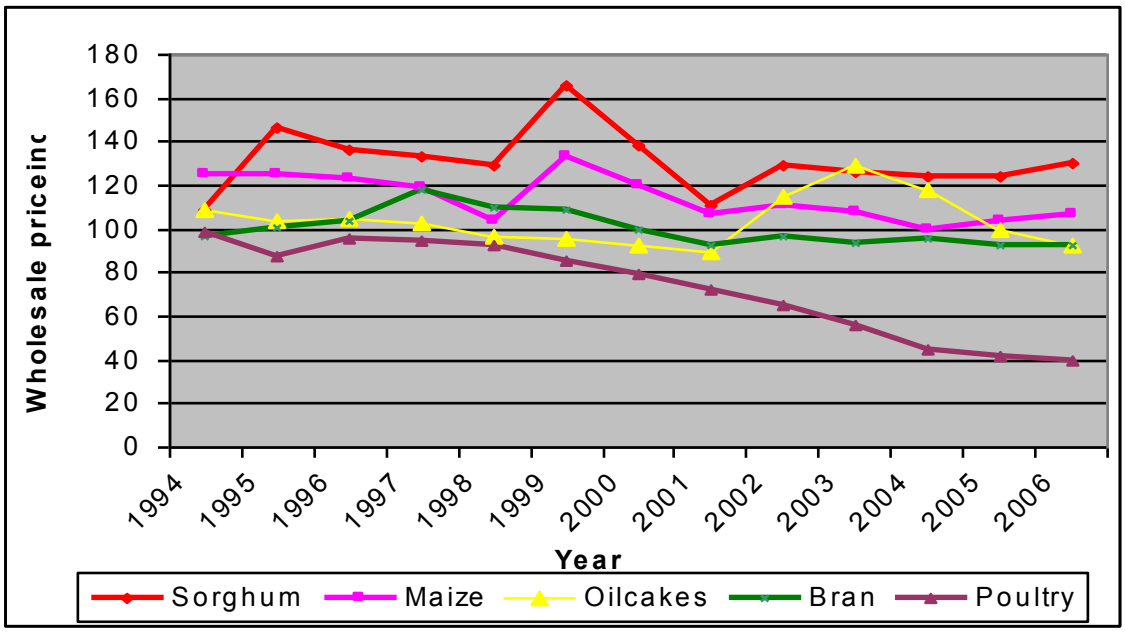

Figure 3. Real price index of feed and poultry meat: 1993-94=100.

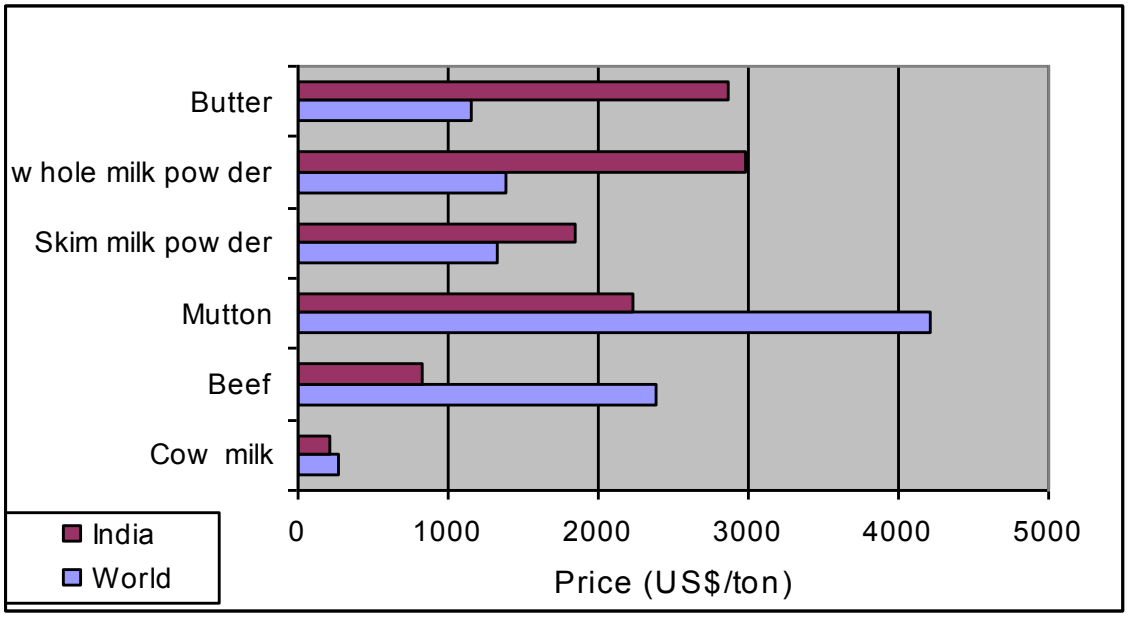

Figure 4. Wholesale prices of livestock products in India in relation to international prices.

3 Case studies on feed/fodder markets [3]

3.1 Location and scope of the case studies

The case studies were conducted in representative countries in East Africa (Ethiopia and Tanzania) and South Asia (India and Bangladesh). Both the regions have high incidence of poverty and livestock, have high potential for poverty reduction through livestock activities, and feed is a major constraint for increasing market oriented livestock production. However, the exact location and scope of the case study in each of the selected countries was partly determined by presence of on-going research on feeds and fodder and also availability of a national partner for implementation.

In Ethiopia, smallholder mixed crop-livestock production systems dominate in the highlands covering over 70% of the country while pastoral and agropastoral systems are practiced in the lowlands. Highlands primarily serve the domestic market while lowlands are the main sources of export animals- sheep, goats and cattle. Peri-urban dairy around large cities and towns is a major commercial activity. Fattening of animals for both domestic and export markets, especially after the policy support for expansion of meat export, is another commercial activity pursued in the south and eastern part of country along the export routes connecting the ports. Feed and fodder markets basically revolve around these different production systems and product market outlets to mitigate local, seasonal and spatial imbalances in supply and demand.

Market oriented agriculture is being promoted as a national strategy for rapid growth in the agricultural sector and a large multi-institutional multidisciplinary research-for-development pilot project called 'Improving productivity and market success (IPMS) of Ethiopian farmers' is being implemented on behalf of the Ministry of Agriculture and Rural Development. The project is being implemented in 10 Pilot Learning Sites in 10 woredas (districts) in four regions of Ethiopia. In these pilot sites, stakeholder consultations led to identification of priority commodities for market oriented development and livestock has been identified as a priority in several woredas. Therefore the case study in Ethiopia was conducted in collaboration IPMS covering the 10 pilot sites and their hinterlands. Additionally, the export route connecting Djibouti has been partly addressed due to the competing demand for feed for export animals and Addis Ababa market was studied because of the presence of urban/peri-urban dairy as a major activity around the city facing severe feed problem. The study covered a broad range of feeds and their markets including crop residues, planted forages including dual purpose maize, milling by-products and manufactured feeds.

Tanzania has three major livestock production systems namely pastoral systems, agro-pastoral system and commercial ranching at a small extent. The pastoral system that deals

[3] The materials for this section have been derived from the four draft case study reports (Blummel and Partasarothy Rao, 2008; Gebremedhin et al., 2008; Massawe, 2008; Raha, 2008) and the discussion on these reports at a workshop held on 14-15 April 2008 at ILRI, Nairobi, Kenya. Dr Carlos Sere, Director General of ILRI, opened the workshop which was attended by seven contributors to the four case studies, and several ILRI scientists from different themes. Copies of the case study reports are available on request.

mainly with ruminants (notably cattle) supports nearly 43% of the national herd and derives its feed from the rangelands. Feed market as such is not an issue under this system. Agro-pastoral system supports 55% of the national herd and the system also includes other non-ruminant animals such as pigs and poultry. Commercial ranching is regarded as minor and accounts for about 2% of the total national herd. Livestock feed market plays an important role in agro-pastoral system where different types of animals are kept, especially in the very humid highlands where land is scarce, so majority of animals, particularly exotic and crossbreds dairy cows, are confined under zero grazing system. North East Tanzania falls under the very humid highlands and was therefore considered as suitable for the case study. The study primarily focused on the market for roughages but also covered aspects of manufactured concentrates.

In India, ILRI and ICRISAT have been involved with national partners in a number feed/fodder related research activities, especially in Andhra Pradesh, mainly focused on mechanism for feed quality improvement, identification of dual purpose crops as feed resources, fodder innovations to facilitate adoption of existing technologies etc. Urban/peri-urban dairy based on buffaloes is a major economic activity in and around Hyderabad, the capital of Andhra. These dairies depend on feed supplies, primarily sorghum fodder, from a large supply hinterland extending beyond Andhra. The supply channels can be broadly divided into three : a) chopped sorghum fodder in lorry loads from 400-500 km and is sold to traders through commission agents. Traders in turn sell to dairy owners and retailers; b) un-chopped sorghum fodder in lorry loads from a distance of 100-150 km and sold to retailers who sell the fodder after chopping them into small pieces; and c) un-chopped sorghum fodder coming from a distance of 50-100 km on cart loads and sold in informal fodder markets located in 3-4 places through middlemen who own the land where the carts are parked and prices negotiated. Over time the relative importance of the channels linking distant places has increased due to increased demand and supply shortages in the nearby areas. All three channels have implications for feed costs and prices in Hyderabad and the supply areas, and also for different actors in the chains- farmers, traders, commission agents, transporters, feed retailers and urban/peri-urban dairy produces This case study was conducted along with an ongoing activity looking into the characteristics of these channels, but with a greater focus on the first channel.

In Bangladesh, smallholder crop-livestock systems dominate who primarily raise animals for multiple benefits including milk, draft power and meat. They primarily depend on crop residues, collected grasses from crop fields and road sides as roughages and a small amount of milling by-products as concentrates. Several small milk sheds covering a small part of the country have evolved to serve Dhaka and other big cities. In these milk sheds commercial small scale dairy is raised using crossbred cows and milk is sold to milk processors through a network of collection points. These dairies depend on crop residues, grasses as well as concentrate feed ingredients for their feed supply. There are also large number of landless and near landless livestock keepers who virtually do not have any feed sources of their own so primarily depend on collected feed from common lands and road sides. Access to micro credit has increased the number of such livestock keepers without adequate provision of feed for them. Another rapidly growing economic activity is fattening animals – cattle and goats- for urban markets and for major festivals. All of these

production options have specific feed supply problems. Feed scarcity is a serious general problem in the country, which is sometimes exacerbated by serious monsoon floods affecting significant parts of the country. Such problems including seasonal and spatial imbalances have been mitigated in the past through markets though lack of good communication infrastructure limited long distance transportation until the recent past. However, feed supply channels covering longer routes are emerging, especially to link the dairy sheds with feed supply hinterlands. Therefore, the case study in Bangladesh covered several districts where small-scale commercial dairy is important and also districts which are considered cereal grain surplus hence feed surplus. The concentrate feeds are also given some coverage.

Generally, locations with intensifying market oriented smallholder systems were targeted in each case study country with a view to assess the feed supply chains connecting rural and urban/peri-urban production environments and markets. This was based on the premise that intensifying market oriented livestock production trigger a backward linkage by creating demand for feeds while in subsistence or semi-subsistence agriculture, on-farm crop-livestock interaction is the norm though there may be some local level farmer to farmer or market mediated exchanges of feeds to mitigate farm level supply-demand imbalances. Both traditional feeds like crop residues, tree fodder and meals as well as produced forage and manufactured concentrates were covered so long as they were used in the chosen systems and environments. The competition and complementarity between feed types were explored along with other questions on market characteristics and performance.

3.2 Methodology used

Overall, a participatory rapid appraisal approach was used for data collection in Ethiopia, Tanzania and Bangladesh while in India a combination of rapid appraisal and multiple visit data collection over a full year was used. A general check list covering the key issues and questions of interest was prepared as a guide which was adapted and modified to suit the local conditions and the scope of the study chosen to be pursued in the three countries except India where a different check list was used because of the coverage of a specific feed and its market. Key informant interviews and focus group discussions were held with relevant actors or stakeholders in feed production, processing and marketing as well as with livestock producers, extension agents and market officials or regulators, where appropriate. The number and type of interviews held varied between the four countries. These interviews were supplemented with observation of feed markets and exchanges by case study researchers. The collected information and data allowed qualitative description of the markets for various feeds and related issues and also some descriptive statistics to strengthen the qualitative descriptions. In case of India, some rigorous statistical test was performed on multiple visit data records to asses the relationship between feed quality and price.

3.3 Key findings

3.3.1 Feed demand-supply balances

National or aggregate level feed demand-supply situation has been marginally addressed in the Bangladesh, Ethiopia and Tanzania case studies and in all three cases, feed scarcity or deficit of different degrees in relation to need have been reported. The main problem in developing a clear picture about demand and supply of feeds is the paucity of data on key parameters on both demand and supply sides. In theory, physiological need for nutrition (energy, protein etc) in a given environment depends on species of animals raised, their sex and age distribution along with size or body weight and output produced e.g. milk, meat, power, These needs can be converted into equivalent dry matter of specific feed types available in that environment. Economic need or demand may deviate from physiological need if producers do not follow optimal feeding regimes either because of lack of knowledge or inadequate supply or high price or other reasons. Feed supply in a given environment may come from a variety of sources such as crop residues as joint or by-products, common lands, weeds from crop fields, milling by-products, planted forages, forest and trees. Quality of each feed type may also vary. Statistics on parameters on both supply and demand sides are inadequate and poor, and absent in some cases, in the study countries.

3.3.2 Types of feeds traded in the market

Among the roughage feeds, almost all types of feeds available in a given geographical area may be traded to some extent locally though in terms of volume, frequency and distance covered, principal crop residues dominate the market. In Ethiopia, standing grasses used to be sold for in situ grazing. With population pressure, area under grass has drastically declined and at present grass is marketed both *in situ* and after harvest. Crop residues and hay are the most marketed roughage feeds in Ethiopia. Among crop residues, teff, barley, wheat straws are marketed in the highland areas while millet straw and sorghum stover are the major marketed feeds in the lowlands. These are usually marketed in the local open market and at farm gate.

In Tanzania, maize stover and collected grasses from the range are the principal feeds traded in the market. Other roughages are also traded locally based on supply and demand.

In Bangladesh, rice straw is the principal feed marketed. In the past straw used to be traded only locally among farmers. Some times the exchange was in the form of barter e.g. the buyer would cultivate the land of the seller who might not have own draft power. Now rice straw is being transported over longer distances due to the improvement of communication infrastructure on the one hand and increased commercial livestock production- dairy and fattening - on the other. Planted forage like Napier constitutes a minute share of the feed resources and some of these are sold usually after harvest but occasionally in the field to be harvested by the buyer. Grasses are harvested from crop fields, road sides, and other common places by landless and poor people primarily for sale and a source of income.

In Andhra in India, sorghum stover is the main feed traded extensively though other crop residues such as millet straw, ground nut straw etc are also traded.

In the study countries- especially in Bangladesh and Ethiopia, some of the roughage feed materials have alternative uses as fuel, construction material, mattress/bedding material, packaging material for perishable products like fruits and vegetables or fragile products like ceramic utensils for long distance transportation. In the past, part of the crop residues used to be left in the field for mulching but this practice has almost disappeared in many places due to increased opportunity cost because of higher demand for feed and other uses. However, very little quantitative information is available about the nature and extent of alternative uses of feed materials in the case study countries. The degree of competition for alternative uses of feed materials has implications for location, volume and seasonality of supply as well as prices of the materials in the feed market.

Manufactured concentrate feeds are used in the commercial production of monogastrics but rarely or sporadically for ruminants in the case study countries. Rather ruminant livestock is supplemented with feed ingredients or milling by products, which farmers buy and mix themselves as required. No standard ration is usually followed but farmers develop their own feeding regimes based on experience (milk yield response for example), basic roughage used and input/output price ratios. For example, in India out of about 45 million tons of concentrate feeds used in the dairy sector, only 2 million tons is manufactured concentrate, the remainder is derived from feed ingredients. Most of the intensive urban/peri-urban dairy producers in Hyderabad do not even use any concentrate feed, rather they use carefully chosen sorghum stover as feed as there are quality difference between verities and season of harvest (more later). In Bangladesh, about 3.6 million tons of milling by products are principally used as concentrate feed ingredients by smallholder livestock producers and fish farms and part of it is also used by poultry feed manufacturers; no manufactured concentrate feed is available in the market for ruminant livestock. Small scale commercial dairy farmers spend 60-90% of their feed costs on concentrate feed ingredients but ordinary small-scale mixed farmers use such feeds sporadically. In Ethiopia, an estimated 500, 000 tons of agro-industrial by-products are produced by various processing mills, most of which is used as feed ingredients in the livestock sector. Such practices are common among smallholder ruminant producers in other developing countries. The rationale for using concentrate feed ingredients rather than manufactured concentrate, and whether the self made rations or feeding regimes are optimal are not well understood.

3.3.3 Form and quality of feed traded

Roughage feeds are traded in a variety of forms and generally there is no formally defined quality or standard though local buyers and sellers use some informal indicators to differentiate quality to some extent. Among the four case studies**,** the sorghum stover market in Andhra in India shows the highest degree of sophistication in terms of organisation of the market channel and the standardisation of materials to achieve some degree of uniformity of products traded. Three main channels handle three forms of

sorghum stover. (a) Un-chopped stover purchased by traders from small farmers at a distance of 50-100 km, sometimes with help from agents, and brought to Hyderabad on cart loads and sold in informal fodder markets located in 3-4 places through middlemen who own the land where the carts are parked and prices negotiated. (b) Un-chopped sorghum fodder purchased by traders from farmers through middlemen at a distance of 100-150 km, transported in lorry loads and sold to retailers who sell the fodder after chopping them into small pieces. (c) Chopped sorghum fodder purchased from local traders at a distance from 400-500 km, transported in lorry loads and is sold to traders in Hyderabad through commission agents. Traders in turn sell to dairy owners and retailers.

There is seasonal variation in the types (varieties) of Sorghum stover supplied in the Hyderabad market. Analysis of samples of chopped sorghum stover collected monthly over 13 months from a panel of traders in Hyderabad showed that crude protein contents in all stover types were well below the approximately 7.5% widely considered the minimum requirement for rumen microbes to digest the feed efficiently. Still, significant differences in crude protein contents were observed between stover types for most months suggesting that the protein deficiency that need to be supplemented will vary depending on the type of stover. Significant differences in *in vitro* digestibility between stover types were observed for all months except for July. *In vitro* digestibility defines the proportion of a feed that can be utilized by the animal and difference between stover types collected in any one month varied approximately by 4 to 5 units except for July. But neither traders nor buyers undertake tests to determine protein content or in vitro digestibility or have such information a prior from anywhere to differentiate quality of the types of stover in the market to aid choice of the type to be purchased. Rather buyers judge quality based on experience i.e., observed milk yield response to different types of stover and use that knowledge in purchase decisions and traders infer quality differences based on intensity of demand for different types of stover.[4]

In Bangladesh, unchopped rice straw is exchanged by different actors in the supply chains and it is also usually fed unchopped. The unit of exchange varies depending on the point of exchange (farm gate, wholesale or retail point) and the volume involved. A whole heap may be exchanged at the farm gate based on visual estimation of the amount – weight or cartload or other carrier load such as a truck or a small van. At retail level, traders make small bundles of varying sizes for sale but are not weighed to determine actual weight. Quality is mainly differentiated by the variety of paddy, time or season of harvest, fineness/softness/thickness of straw, presence of dampness or mould. Planted forages like Napier is sold either from the field to be harvested by the buyer or harvested and sold in bundles. Collected grasses from crop fields, road sides or other sources are sold in bundles or in gunny bags of different size and weight. Quality is differentiated by the degree of maturity of the grass, single or multiple species in the bundle, and cleanliness or presence of mud.

[4] The literature on consumer perception on quality and safety of food shows that assessment of quality based on experience is one of several ways consumers judge and differentiate food quality and safety. For a review of concepts and methods on consumer perception on food quality determination, see Grunert (2005).

Milling by products of rice mills, pulse mills, oil seed mills and sugar mills are sold by the mills to feed wholesalers who in turn sell to retailers who sell to farmers as feed ingredients. There is no officially defined quality standard for such by-products and no objective basis is followed to determine quality and verify them. The rice milling technology used by many mills in Bangladesh generally do not separate bran from husk, so the quality of bran as feed from such mills is rather poor. Where bran and husk is separated, the quality is better but sometimes it may be lost due to adulteration (mixing husk with bran). Oil cakes are often adulterated by mixing different types of cakes with different feed values.

Sixteen sugar mills in the country produce about 85,000 tons of molasses of which about 30,000 tons is exported, a small portion is used in the alcohol making industry, a portion is sold for the feed market and the rest is wasted. Raw molasses is used for fattening cattle and semi-processed (boiled and drained to make thicker) ones for dairy cattle. Molasses is sold in loose form, in small tins of 20-30 kg and in drums of 270-300 kg. Handling inconvenience is a major hindrance for wider marketing of molasses. Urea molasses multiple block (UMMB) and urea treated straw technologies have been developed by researchers and successfully tested in farmer participatory projects giving the material free of cost. But effective efforts have not been taken to commercially produce the product and to motivate farmers to continue the use of this technology after expiration of the project. No private entrepreneurs have taken up the commercial production and marketing of UMMB even though there is shortage of quality feed in the country.

In Ethiopia, large commercial buyers engaged in cattle and sheep fattening business buy whole heap of straw based on visual estimation of the volume or weight, the transport in truck. Some also buy in the form of bales to be made by the buyer by using baling machines for convenience in transportation, storage and feeding. In local markets or at the farm gate, a donkey load weighing 20-30 kgs is generally used as the unit of exchange for cereal straw. For long distance transportation, traders bulk such small quantities into larger volumes. Different types of straws are preferred in different parts of the country- teff in some places while barley or wheat in another- due to differences in the output produced, e.g. teff straw is preferred for draft animals and wheat and barley straw is preferred for dairy animals, perception about quality or feed values of different straws, e.g. producers in Tigray believe barley straw is more nutritious than wheat straw, suitability of a particular straw for mixing with other feeds in the ration e.g. wheat straw is believed to mix better with agro-industrial by-products. Buyers also differentiate straw based on some attributes of the straw that represent certain quality, for example, red colour teff is considered more nutritious than white colour straw and method of threshing e.g. cattle threshed straw is considered softer and better than straw from threshed by combine harvester.

Agro-industrial by-products are primarily used for fattening animals – both cattle and small ruminants- and for both domestic market (regular supplies to urban markets as well as for festivals), and export market. Adulteration of oil cakes by mixing different types of cakes is also common in Ethiopia.

In Tanzania, maize stover and harvested grasses are sold in bundles of different sizes. Normally they are not weighed. However, quality is differentiated by the maturity of grass, cleanliness, and species mix of grasses. Agro-industrial by-products are primarily used for feed manufacturing industries serving commercial poultry and pig production but a part is also sold as feed ingredients for cattle production. There are no clearly defined quality standards for feed ingredients.

3.3.4 Feed price variation by quality, space and time

Even though there are no officially defined standards and quality indicators of roughage feeds or for concentrate feed ingredients (in some countries there are quality standards for manufactured concentrate feeds), farmers and traders have some informal criteria and indicators of quality as explained earlier. Based on these quality differences, sellers also ask different prices and buyers offer different prices, and the equilibrium price most often depends on the volume of supply and demand in the market, the ability of the buyer to differentiate quality given that the seller most of the time tries to present everything as of better quality, and the relative bargaining power of the parties. Where quality indicators are more clearly observable or verifiable or known in other ways, e.g. through experience, the price differences by quality may be more clear and less subject to bargaining. For example, in the market for chopped sorghum stover in Hyderabad, a trader may offer different types (varieties) at different prices, and buyers buy them at different prices due to past experience about the quality differences. Year long monitoring of feed samples on the two quality indicators of sorghum stover sold by traders - crude protein content and in vitro digestibility- no significant relation (P = 0.62) was observed between crude protein content and price. In contrast variations in *in vitro* digestibility accounted for 75% of the variations in stover prices (Table 4). The difference in *in vitro* digestibility between types of stover of roughly 5 percentage units (range 46.9 to 51.7%) was associated with a price difference of close to 1 Indian Rupee per kg.

Table 4: Across month mean values for sorghum stover price and stover crude protein and *in vitro* digestibility, Hyderabad market, India

Stover type	Price (Rs/kg)	CP (%)	*In vitro* digestibility (%)
Andhra	3.52^{b}	3.69^{a}	50.0^{b}
Andhra HB	3.15^{cd}	3.88^{a}	49.3^{bc}
Balari HB	3.54^{b}	3.56^{a}	48.9^{bc}
Raichur	3.89^{a}	2.88^{b}	51.7^{a}
Railaseema	3.23^{c}	3.13^{b}	48.6^{c}
Telangana	3.06^{d}	3.06^{b}	46.9^{d}

Different superscripts indicate statistical differences at less than 5% level

Source: Blummel and Parthasarothy Rao, 2008

Green grasses- planted or collected- show a marked seasonal pattern in supply because of the seasonality of biological production cycle and unsuitability of such material for conservation and storage for a longer period. Silage can be made of grass for

conservation but is rarely, if at all, practiced by smallholder producers. Some grasses like Napier can be harvested year round though not necessarily at the same rate. Therefore, prices of green grasses show a seasonal pattern. If grasses are available when supply of straw is thin, grass prices can be high, if grasses are available along with straw, the price of grass may depend on relative demand prompted by feeding regimes followed by livestock keepers. Grasses can be transported over space if there is demand and costs of transportation permit such movement. On the other hand, cereal straws can be conserved and stored, hence supplied over time and space if required to smooth scarcity and price. Yet there are seasonal and spatial variations in prices. Prices are generally lower at harvest time and higher in off-season. Spatial price difference is mainly a function of the differences in the degree of scarcity and transaction costs of transferring feeds between locations.

In Bangladesh, paddy straw is readily available after harvest of Aus and Boro season harvest (April to June) and after Aman season harvests (November to January). Its supply is moderate during February, March and July, but supply drops drastically during August to October, when major floods may also occur worsening the already difficult situation. In 2005, in Pabna and Sirajganj average straw price per kg was around Taka 1.50 and that of rice bran was Taka 8.70-10.0 while in Mymensingh, across the Jamuna river, straw price was Taka 3.00 and rice bran was Taka 8.00 per kg (Raha, 2008). In 2007, significant spatial variation in prices of roughage feeds was observed (Table 5). In case of paddy straw, Dinajpur is generally considered a surplus area on the north-western fringe of the country while Bogra is considered a deficit area with emerging smallholder commercial dairy, and where straw is imported from Dinajpur.

In Hyderabad, India, types (varieties) of sorghum stover available in the market vary over months and for most of the fodder types prices are highest between July-November (Table 6).

Table 5: Spatial differences in selected feed prices in Bangladesh, 2007

Feed type	Market and district	Unit	Price per unit (in Tk)	Actual unit of sale
Paddy straw	Dinajpur	5 kg	11	*Ati(bundle),* 4 *ati*=1kg
	Rangpur	5kg	20	*ati,*3-4 *ati*=1kg
	Bogra	5kg	20 15	Loose (manually threshed) Machine threshed
Napier	Dinajpur	5kg	3.75	by weight
	Rangpur	5kg	5	by weight
Other green grass	Dinajpur	5kg	10	gunny bag
	Rangpur	5kg	6.25	gunny bag
	Bogra	5kg	8.35-10	*Ati*

Source: Raha, 2008

Table 6: Monthly availability and monthly mean price of sorghum stover from different cultivars traded by six fodder traders from November 2004 to 2005 in urban Hyderabad

	11/04	12/04	1/05	2/05	3/05	4/05	5/05	6/05	7/05	8/05	9/05	10/05	11/05
Type													
Andhra	3.4 (3)[1]	3.6 (3)	3.9 (3)	3.2 (6)	3.0 (3)	3.4 (1)	2.5 (1)		3.6 (3)	3.5 (1)	3.9 (1)	4.3 (2)	3.6 (1)
Andhra HB				3.0 (3)	2.5 (5)	3.0 (5)	3.0 (4)	3.5 (4)	3.4 (1)	3.4 (3)	3.6 (3)	4.3 (1)	3.5 (2)
Balari HB							2.9 (2)	3.3 (2)	4.0 (1)	4.3 (1)	4.0 (1)		
Raichur							3.5 (1)	3.9 (1)		4.3 (1)			
Railaseema							2.7 (1)			3.7 (1)			
Telangana	2.5 (5)	3.2 (3)	3.4 (3)	3.4 (1)	2.5 (1)	2.3 (1)	2.7 (2)	3.6 (1)	3.8 (2)	3.2 (1)	3.0 (1)	3.3 (5)	3.0 (6)
LSD	0.3	0.3	0.3	0.5	0.2	0.2	0.2	0.3	0.4	0.2	0.4	0.6	0.3
P	<0.0001	<0.0001	0.006	0.28	<0.0001	<0.0001	<0.0001	0.01	0.25	<0.0001	0.0002	<0.0001	<0.0001

[1]Number in brackets: number of traders selling the stover type in a particular month

Source: Blummel and Parthasarothy Rao, 2008

In Ethiopia, supply and price of all types of straw show significant seasonal and spatial variations. For example, Berhanu et al (2008) provided data from four markets showing that price of teff straw is low during October to January, which is the harvest season for teff, and supply drops and prices go up in other months (Figure 5). Similar examples are also given for several other markets and for other cereal straws.

In theory, in a competitive market for inputs and products, price of an input should be related to output price. Farm budget studies show that in smallholder production systems, feeds usually account for 50-60% of total cost of production of milk or meat (for example, Raha (2008) quoted results of several detailed dairy enterprise studies in Bangladesh). Some information about output and feed price and also feed cost per unit output in the case study countries are presented in Table 7. These figures confirm that in India and Bangladesh feed cost account for 50-60% of the output price, but in highland Tanzania, milk price: cost ratio is low. In Ethiopia, no precise estimates could be made with available data. These figures illustrate the difficulties of generating precise data on output and input price relationship where standard ration is not used. If manufactured feed is used as a ration, price per unit of feed and output: feed cost ratio is easy to establish. Where a mixture of different feeds and feed ingredients is used, and a particular feed item constitutes a variable share of the ration depending on the system of production, output produced (meat or milk) and the system of feeding (stall fed, partially stall fed etc), it is difficult to judge if the price of a particular feed item has any relationship with the output price though an approximate relationship between output price and feed cost per unit output may be determined. The second scenario is generally the case in most of the smallholder production systems or even in medium to large scale commercial production, in the developing countries. For example, in Ethiopia, beef and sheep fattening enterprises targeting export abattoirs or urban markets use 5-6 feed ingredients in a ration, and the components of the ration may vary depending on where the production unit is located. In some places, teff straw may be used as the base feed, in another maize grain with some kind of straw and other ingredients may be used while in another case wheat middling mixed with other ingredients may be used (Rich et al., 2008). It should also be noted that in theory price of an input depends on its marginal productivity, and establishing precise price-productivity relationship for a feed like straw or any other ingredient is problematic without the help of multivariate production function analysis.

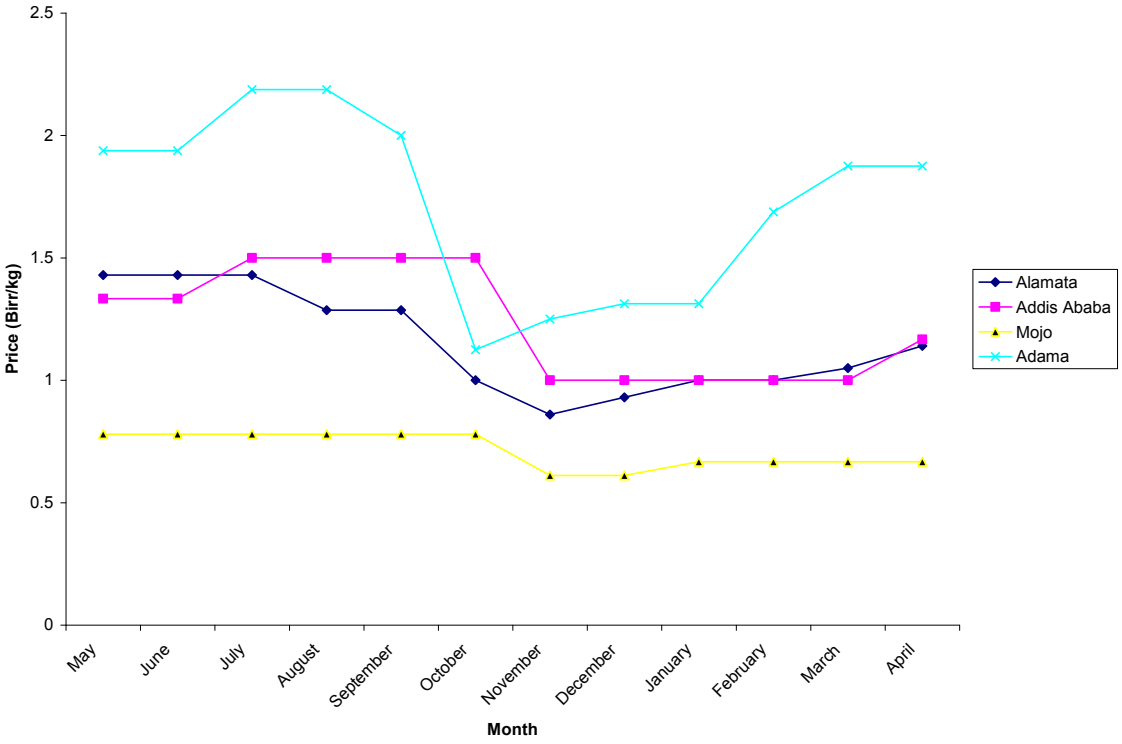

Figure 5. Seasonal variation in the retail price of loose teff straw in Alamata, Addis Ababa, Mojo and Adama markets

Source: Gebremedhin et al., 2008

Table 7. Relationship between feed price and output price

Country and animal type	Feed type and feeding system	Feed required per kg output	Output price/kg US$	Feed price/kg US$	Output price: feed cost
India					
Crossbred cow	Stall-feed sorghum stover as 50% complete feed block	1.1 kg/kg milk	0.43	0.14	2.9
Dairy Buffalo	do	1.7 kg/kg milk	0.60	0.14	2.5
Sheep	do	8.4 kg/kg wt gain	2.00/kg meat	0.14	1.7
Bangladesh					
Crossbred cow	Stall fed rice straw, green grass, concentrate	Concentrate 400g Straw 500g Green grass 1kg	0.32	0.25 0.04 0.04	2.0
Local cattle for fattening	Stall fed rice straw, green grass, concentrate, molasses	Rice straw 2.5kg Green grass 5 kg Concentrate 0.5kg Molasses 10gm	2.08/kg meat	0.04 0.04 0.25 0.20	4.7
Tanzania					
Crossbred cow	Maize stover, dry grass, planted forage	?? kg /kg milk	0.40	0.35	1.1
Ethiopia					
Local dairy cow	Pasture, straw, hay	Variable from place to place	0.42	0.21	na
Cross bred dairy cow	-Pasture, hay, straw, -Bran, seed cakes	Variable from place to place	0.42	0.21 0.26	na
Local cattle-meat	-Pasture, hay straw, -Bran, oil cakes	Variable from place to place	Birr 45/kg	0.21 0.26	na
Shoats-meat	Pasture and browse, pulse residue	Variable from place to place	5.25/kg meat	0.16	na

Another aspect of variation in the supply and price of feed is its long term trend. In many developing countries crop residues, especially cereal straws, remained the most important feed for a long time for an increasing ruminant livestock population. However, over the last two to three decades, the nature of crop residues available changed significantly due to replacement of traditional crop varieties by high yielding new verities with different harvest index or grain:straw ratios. For example Kelly and Parthasarothy Rao (1994) and Kelly et al.(1993**)** indicated that yield and quality of sorghum and millet straws sometimes played a role in the choice of new crop varieties for adoption by crop-livestock farmers in semi-arid India. This is reflected in changes in the relative prices of grain and straw. In the late 1970s, stover price was one fourth the grain price in Hyderabad, India, and at present it is about half the grain price (Blummel and Rao, 2008). It is possible that similar changes have occurred in intensifying crop-livestock systems in other countries.

3.3.5 Costs and margins in feed trade

While most feeds are traded and used locally, increasingly, well developed and established market chains for roughage feeds covering longer distances are emerging because of increasing commercialization of livestock production, spatial differences in the demand-supply imbalances or scarcity of feeds and improvement in communication infrastructure. At the local market level, few intermediaries may be involved in transaction, so transport cost of the seller to bring feed to the market and of the buyer to take the feed home may be the most important factors, other than the value of the feed material that may influence price negotiation and margin. Where long distance transportation and different value addition activities are involved, the costs and margins depend on a number of factors. Costs and margins at a particular location or point in the feed supply chain may depend on the length of the chain and the position of the point within the chain, the structure and conduct of the market at that point, i.e., the number and types of intermediaries involved in transaction and their trading behaviour, the distance from the previous point, transport cost from the previous point which itself is a function of the quality of road or other means of communication.

In Bangladesh, producers in Natore district get about 27% of the final retail price in Pabna district where feed is transported over about 100 km, and the retailers in Pabna get a net margin of the same magnitude as the producer in Natore, the remaining about 45% is covered by other value adding activities (Table 8).

In India, in a market chain for sorghum stover covering a distance of 80-100km linking rural crop farmers and urban/peri-urban dairy farmers in Hyderabad, producers get only 8% of the final price compared to 7% received by the feed supplier who collects unchopped stover from several crop farmers and delivers to the retail trader, and 54% is received by the retail trader who chops and sells the stover to dairy farmers; the remaining 30% is covered by value added activities of the different actors and their costs(Table 9). The retail trader has to cover his own costs – labour, any rental or opportunity cost for the feed store and the opportunity cost of capital- out of the margin. The low farmers' share of the final price illustrates the problem of marketing a bulky.

Table 8 Costs and margins of dry paddy straw trade (one truck load of 6 tons)

Particulars	Taka	Percent
Purchase price of straw in Natore from producer	4000	26.7
Truck fare from purchase place to sales place (Bera)	3000	20.0
Labour for loading & unloading the truck (Purchase/sale point)	2000	13.3
Rent to Ezaradar (auctioneer) at the procurement point	300	2.0
Brokerage	100	0.7
Labour for selling straw (for 3 days @ of Tk.150 /day)	450	3.0
Law enforcing agency	300	2.0
Rent for the space and for auctioneer	620	4.1
Total cost	10770	71.8
Retailer's net margin	4230	28.2
Sales price = 6000 kg @Tk.2.5 per kg or 100 per 40 kg	15000	100.0

Source: Raha, 2008

Table 9: Marketing costs and margins per lorry load of stover in a market chain in Andhra Pradesh, India

Particulars	**Amount in Rs. (%)**
Price paid to farmer for 4.5 tons (@ 40 paisa per kg) by middlemen	1800 (8.3)
Charges to middlemen to identify the farmers who are willing to sell the stover. (This amount ranges from Rs 50 to 250 per lorry load)	150
Rental charges for hiring lorry	1100
Driver charges	150
Diesel for lorry for collection from village and transporting to Hyderabad (80-100Km)	1800
Labour cost to carry the stover from field and loading in lorry (8 labour @ Rs 200 per head)	1600
Labour charges for unloading the stover at buyer shop (these charges are deducted during final payment from amount paid to supplier (@ Rs 240 per lorry)	240
Sub total marketing costs	5040 (23.2)
Total purchase and marketing costs	6840 (31.5)
Supplier's margin	1530 (7.1)
Sales revenue in Hyderabad (= feed trader's purchase cost) (6.5 tons due to added water before leaving purchase location minus 3 quintals due to weight loss during transport = 6.2 tons x Rs 1350/ton)	8370 (38.6)
Feed trader's chopping cost (6.2 tons x Rs 0.25 per kg)	1550 (7.2)
Feed trader's gross margin	11780 (54.3)
Feed trader's sales revenue (6.2 tons x Rs 3.50 per kg)	21700 (100.0)

Source: Blummel and Partasarothy Rao, 2008

commodity like stover over a long distance. Chopping stover at the purchase location might reduce labour cost to some extent due to lower rural wage rate but would increase volume, hence transport cost unless the chopped straw is baled/packed to compress volume. Whether these options are economic is unclear

4 Summary of recommendations

In most developing countries, feed scarcity is presented as a general problem without adequate objective information about the characteristics of supply and demand. Without such information, appropriate long term strategies for addressing problems of feed scarcity can't be developed and implemented. Alongside research on feed technology, feed/fodder market research can aid in understanding key problems of feed availability and shortages, in developing feed technology dissemination strategies targeting potential adopters and in identifying investment options for viable new feed technology options. In order to fill this knowledge gap, case studies were conducted in representative countries in South Asia (Bangladesh and India) and East Africa (Ethiopia and Tanzania) to generate some preliminary results and evidence on feed market characteristics and performance in a set of diverse situations, which will allow development of more precise questions and hypotheses for development of a full proposal to undertake a study on feed markets in Sub-Saharan Africa and South Asia. Based on the findings of the case studies and a discussion workshop on the case studies, several issues have been identified for the four case study countries as priority issues for detailed research. These are summarised in Table 10. Relevant similar issues may be investigated in other geographic regions such as West Africa, where some differences in the specific issues for the semi-arid and sub-humid environments need to be recognised. The case studies highlighted some common pattern but also specificities with respect to the nature of feed supply, demand, prices, quality-price relationships, market mechanisms and actors involved. Cross learning from these common and different characteristics can be a useful way to minimise duplication research efforts and scarce research resources to find better options for feed production, utilization and marketing.

In addition to the specific issues identified and summarized in Table 10, a number of other generic issues need detailed research for addressing the problems of feed scarcity on a long term basis. These are presented below.

In the developing countries lack of objective information on supply-demand imbalances in different feed resources is a major problem in developing appropriate strategies for addressing the problem of feed scarcity. A recent study on feed grains in China reviewed flaws in the past demand and supply projections and concluded that while fully accurate information on all parameters may not be available, a high degree of accuracy of information on major parameters will be required to develop a realistic picture of supply-demand imbalances as a basis to design strategies to address resulting problems (Zhou et al, 2008). This is also true for feeds in general. Improvement of quality of statistics is a continuous and iterative process. Careful examination of adequacy, quality and problems with existing information and incremental efforts to solve them by targeting key problem areas will eventually lead to overall improvement of the picture. Feed market research

Table 10. Possible study focus in selected countries in a research proposal on feed markets

	India	Bangladesh	Ethiopia
Location and target production system and species of animals	Semi-arid. Urban/peri-urban dairy and rural mixed farms; dairy cow, buffalo, small ruminants	Mixed crop-livestock farms, small scale commercial dairy, beef fattening	Mixed crop-livestock in highlar fattening for export, Smallholder peri-urban dairy, ca and seep/goat fattening
Feed materials/ technologies to be investigated	- Promotion of identified varieties of food-feed crops (sorghum, millet, maize, groundnuts, pigeon pea) - Feed processing (demonstrating potential, problems of promotion and scaling up, role of producer groups)	- Identification of paddy varieties for better quality straw from existing sources - identification of new feed options (planted fodder, fodder trees, fodder in horticulture garden) - Ways of improving quality of concentrate feed ingredients (milling byproducts)	- Identify varieties of teff, whea barley, maize as food-feed crop - promotion of varieties through developing seed systems - Management of communal pastures (better management op like enclosures, introduction bet pasture varieties)
Market and institutional issues to be investigated	- Understanding demand at current cost regimes and supply constraints; quality differentiation; competing uses; size, scale and risk of feed business; demand for resources in feed production - Links between fodder and manufactures feed trade, exchange mechanism (value chain or disjointed supply chain), - Role of business development services (BDS), private investors' incentives and producer organizations	- Understanding demand for straw and concentrate feed ingredients, marketing constraints for feeds - Economics feed production and of value adding activities - Role of public and private sector institutions in research and dissemination and problems of promotion/ dissemination	-Understand competing uses of materials - Input-output linkages, quality differentiation - Market exchange mechanism a role of information system and producer organisations

Source: Workshop deliberations on feed market case studies, 12-14 April, ILRI, Nairobi, Kenya.

under representative diverse production systems and market conditions will generate information for extrapolation at national level to undertake scenario analyses under alternative set of assumptions.

Fodder and feed markets will be increasingly important for smallholder systems as they intensify due to population pressure on land, more market orientation of producers and the need to be competitive in the livestock product market by producing more output from fewer animals with better feeds. National and international research institutions have developed many feed production and utilization technologies – grasses, legumes, dual purpose crops, rations based on agro-industrial by-products etc- but they have been rarely adopted by smallholder producers. Such technologies and rations have been produced and recommended without assessing the nature of their demand, or the nature of demand for feed/fodder in general. Understanding the dynamics of feed markets – the nature of supply, demand and prices- under different production systems, scarcity levels, market conditions, policy and institutional environments will be helpful for improving feed technology research, designing feed technology diffusion strategies targeting potential adopters, and improving feed/fodder market organization and efficiency.

Efficacy of current practices with respect to conservation, storage and processing technologies for different feed resources, and trade and marketing of those feeds to mitigate spatial and temporal imbalances in feed supply and demand is not well understood. Recent rise in feed prices in the world market may open new avenues for feed supply due to changes in spatial economics of feed transport and also through research on new feed options, storage and treatment. In order to increase quantity and improve quality, various options need to be considered including

- crop and forage breeding taking into account harvest index or grain: straw ratio, their market prices and producers' criteria for adoption
- improved manufacture of feeds taking into consideration feed responses, producers' preferences for complete feed vs feed ingredients and their rationale for sub-optimal use of improved feed
- on farm planted fodder and improved fodder management options.
- better use of existing resources such as better management of communal resources through appropriate institutions for collective action, and better handling and storage of feed materials such as cassava peels. Other examples may include the economics of collection of prosopis seeds from the range for processing as nutrient rich feed for commercial livestock production, or small scale manual straw/hay baling technique to facilitate transport of such feeds may be helpful for investors as these hitherto uneconomic or otherwise unattractive techniques may become economic and attractive under favourable policy and market conditions.

Knowledge about incentives and disincentives of various actors in the feed related activities in making investment to improve feed supply – in terms of quantity and quality- is also very poor. A particular feed technology or ration may or may not be scale neutral, so it is important to understand the distributional consequences, i.e., who in the supply chain - from producer to the ultimate user- will benefit how much from a potential option if wide adoption is to be expected. Productivity improvement in smallholder production systems

will depend a great deal on how easily and economically the spatial and temporal imbalances in supply-demand are smoothen. Better understanding about feed markets and related institutions with specific reference to exchange mechanism, information system, producer organizations and local processing infrastructure will be useful for improving market performance. While more knowledge about the efficacy of current institutions and practices will be useful, finding new options and understanding their economic and institutional potential and constraints will also be required to widen the portfolio of choices to meet feed scarcity. Such knowledge will be especially required by private and public sector investors to make choices about investment in commercialization of viable feed production, conservation and processing technology options.

An important issue on which feed market research may provide guidance is the trade-off in the use of scarce resources – especially land and water- in the production of feeds in different production systems with different levels of resource scarcity. It has been reported recently that feed production consumes more than 95% of the water used in livestock production and that water productivity is low in those systems with high reliance on planted fodder/irrigated forages. In contrast, livestock systems that rely on crop residues and underutilized biomass show long term high water productivity (Singh *et al.* 2004; Peden *et al*. 2007). The implications of such physical productivity differences will depend on relative prices of land and water on the one hand and crop and feeds on the other. Apart from the relative scarcity of land and water, the consequences of climate change and environmental degradation are likely to drastically change the relative economics of different crop and livestock activities, and of individual enterprise within crop and livestock sectors. Therefore, alternative options for feed production and utilization may have significant influence on the way scarce resources are used and relative economics of various enterprises. Such knowledge will be highly useful for livestock development strategy choices.

One of the after effects of floods is high morbidity and mortality of livestock due to feed scarcity (Jabbar, 1990). Droughts have similar consequences. A recent study in semi-arid India (Andhra Pradesh and Madhya Pradesh) found that 8% of the farmers sold stock due to feed shortage resulting from a drought during or the year before and another 5% sold stock due to drought without giving specific reason, while some farmers in some areas increased stock during the drought years due to greater access to feed resources (Akter et al., 2008). It is doubtful if the full extent of relationship between drought, feed shortage and livestock ownership and productivity has been revealed in this study. Food security after natural disasters – floods or droughts- is a frequently studied subject of research around the globe but little attention is given to study the problem of feed security and its possible solution under similar conditions. Feed market or lack of it may play a key role in resolving feed scarcity in disaster prone areas. Studies on food and feed security, and the role of food and feed market in resolving these problems need to be undertaken in an integrated manner because these are very related and complementary as livestock is a source of livelihood security for many people, and addressing feed security may be an important pathway or entry point to ensure food security in disaster prone areas.

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