

# Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development



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Azage Tegegne,\* Berhanu Gebremedhin, Dirk Hoekstra,  
Berhanu Belay and Yoseph Mekasha

\* Corresponding author: [a.tegegne@cgiar.org](mailto:a.tegegne@cgiar.org)

Improving Productivity and Market Success of Ethiopian Farmers Project (IPMS)—International Livestock  
Research Institute (ILRI), Addis Ababa, Ethiopia






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Box 30709, Nairobi 00100, Kenya  
Phone: +254 20 422 3000  
Fax: +254 20 422 3001  
Email: [ILRI-Kenya@cgiar.org](mailto:ILRI-Kenya@cgiar.org)

Box 5689, Addis Ababa, Ethiopia  
Phone: +251 11 617 2000  
Fax: +251 11 617 2001  
Email: [ILRI-Ethiopia@cgiar.org](mailto:ILRI-Ethiopia@cgiar.org)

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# Executive summary

Dairy production is an important component of livestock farming in Ethiopia. The huge and diverse livestock population, varied and favourable agro-ecology for dairying, increasing demand for dairy products in urban and peri-urban areas, long-standing culture of dairy products consumption, and favourable policy are indicators of the importance and potential of dairying in the country. However, productivity of dairy animals in general is limited. This results in shortage of supply of dairy products and requires the country to spend hard currency to import dairy products from abroad. It is, therefore, essential to explore the existing dairy production environment, analyse constraints of dairy production, identify opportunities for dairy development, and devise pertinent and workable strategies for sustainable market-oriented dairy development in the country. The Improving Productivity and Market Success (IPMS) of Ethiopian farmers' project implemented a series of thesis studies across its Pilot Learning *Woredas* (PLWs) and other sites in three Regional States representing different agro-ecologies and production systems to address the issue. The *woredas* included Bure, Fogera and Metema in Amhara Region, Shashemene and Mieso in Oromia Region, and Hawassa, Yirgalem/Dale and Dilla in Southern Nations, Nationalities and Peoples (SNNP) Region. This working paper is a synthesis of these studies and includes a description and performance of the dairy production systems, marketing/processing and input and service supply systems. It also suggests the ways forward for sustainable market-oriented dairy development in the country. To complement the synthesis, the paper also uses some selected findings of the project interventions on value chain development in 10 PLWs in four Zones.

Dairy production system prevalent in the PLWs is sedentary type and is broadly classified into rural, urban (represented by Shashemene, Hawassa, Yirgalem and Dilla) and peri-urban (represented by rural Peasant Association [PAs] around Shashemene, Hawassa, Yirgalem and Dilla). Dairy production systems are classified based on location, agro-ecology, production objective, resources, resource use, scale of production and access to inputs and services. The rural dairy production system is also further classified into highland (represented by Bure and Fogera) and lowland dairy production systems (represented by Metema and Mieso). Land holdings is almost negligible in urban dairy system of Hawassa but higher in the rural lowlands

(e.g. 8.46 ha in Metema) with variable land use patterns. The average livestock population is higher in rural lowland system followed by rural highland while smallholder urban and peri-urban producers have the least. The major dairy animals across all the production system are cattle, while camels and goats are also important milk producers in rural lowland agropastoral areas of Mieso. Dairying is entirely based on indigenous dairy animals in the rural highland and lowland dairy systems, mixed herd with some crossbreds in peri-urban systems and with moderate crossbreds in urban production systems. Indigenous cattle such as the Fogera breed which has potential for better milk production and adapted to grazing in waterlogged areas, dominate the highland system in Fogera. The main source of income in Fogera and Bure is sale of crops followed by livestock and on-farm activities. In Metema, it is sale of animals and crops while in Mieso it is sale of crops and milk. Sale of fluid milk is the major source of income in urban systems of Shashemene, Hawassa, Yirgalem and Dilla towns.

Natural pasture (grazing/hay) and crop residues are the major feed resources used as a basal diet for dairy production in rural and peri-urban dairy systems. Dairy producers in highland and peri-urban areas use non-conventional feed resources such as atella and enset leaf/ chorm to supplement dairy animals. Use of agro-industrial products as supplements to dairy animals is limited to urban and peri-urban dairy production systems due to its accessibility and keeping of improved genotypes. On the other hand, due to lack of awareness and inadequate extension service rice bran has not been used well in the rural highland system of Fogera. Different strategies have been employed by IPMS to improve feeding value of low quality feed resources and thereby improve milk production. Introduction of improved forage species such as Napier grass, Guatimala grass, and Rhodes grass either as pure stand or intercropped with cereals and tubers was successful. Rehabilitation of the communal natural grazing land following community-based weed clearance and enclosure for one rainy season have improved carrying capacity of the pasture and biomass dry matter yield. Urea treatment of low quality crop residues improved *in vitro* organic matter digestibility (IVOMD) by 54% and 60% in wheat and rice straws, respectively. Improvement in milk yield due to urea treated rice and wheat straw supplementation ranged from 1.16 to 2.35 kg/head per day in Fogera cows. Farmers also appreciated the positive effects of the use of different sized urea molasses blocks on the performance of their animals such as increased milk yield and improved growth rates. However, uptake of both technologies has been hampered by labour requirements/cost and availability of urea in the dry season. Feed marketing is not well organized and informal marketing is the dominant system across all the PLWs. The major feed resources marketed include grass hay, crop residues, green grass, while marketing of Napier and Rhodes grass is also practised in some parts of PLWs. Apart from basal diets, urban and peri-urban dairy production system markets agro-industrial by-products (AIBP) as well. The dominant feeding system in rural and peri-urban dairying system is grazing of private or communal pasture lands, while stall feeding dominates in landless urban dairy production system. Supplementation of dairy animals depends on the level of production in case of urban and peri-urban systems but on vulnerability of the different classes of animals and season in case of rural dairy production system.

Hand milking is the sole milking method and milking frequency was twice per day across all the production systems. However, milking frequency is reduced to once per day during the dry season in Mieso. Camels are milked three times per day during the wet season but this is reduced to twice per day during the dry season. Milking and milk handling utensils are cleaned and smoked with different herbs in all the PLWs. The method is believed to improve flavour, taste and quality and minimize spoilage. Traditional milk processing is the sole milk processing method practised across all the production systems.

The average milk production from indigenous cows was 1.85 litres/head per day and ranged from 1.24 in the rural lowland agropastoral system of Mieso to 2.31 in the rural highland system of Fogera. The average daily milk production for crossbred dairy cows was higher in urban (10.21–15.9 litres/head per day) than peri-urban (9.5 litres/head per day) systems. Lactation milk yield of indigenous dairy cows ranged from 271.4 litres/head in the rural lowland agropastoral system to 434.8 kg/head in the peri-urban system. However, lactation length of indigenous animals was shorter and ranged from 5.9 months in rural lowland transhumance system to 9.8 months in the rural highland dairy system of Bure. Average daily milk production from camels in Mieso ranged from 7.6 litres in the dry season to 13.2 litres in the wet season.

Consumption pattern and marketing of dairy products produced at home varied depending upon the amount of milk produced per household, dairy production system, market access, and season of the year, fasting period, and culture of the society. Rural dairy farmers have very little access to market fluid milk and milk is often processed into butter. The major dairy products commonly marketed include fresh milk, butter, ergo (fermented whole milk), cottage cheese and butter milk. Although marketing of milk is not common in Metema due to cultural reasons, it is well marketed in Mieso. The dominant milk products marketed across all the PLWs with the exception of urban and peri-urban system is butter followed by cottage cheese. In areas (e.g. rural highlands) where milk marketing is practised, the amount marketed is very small due to lack of surplus production, the desire to process into milk products and lack of access to market. In market-oriented urban and peri-urban system fluid milk marketing is dominant being higher in urban than peri-urban system. Although both formal and informal milk marketing systems do exist, the latter is the dominant system across all the production systems.

Efficient and effective input supply system and improved access for services is crucial for improved dairy development. Although access to services and inputs is diverse across the PLWs, it is generally rated as low.

There are ample opportunities for dairy development in the country. The large and diverse dairy animals genetic resources adapted to the wide and diverse agro-ecologies, establishment of several structures and service centres such as veterinary health and artificial insemination (AI) centres, extensive service of agricultural extension, high demand for consumption of

dairy products, huge human population with long-standing tradition of consumption of dairy products, high rate of urbanization and income growth, availability of trained manpower, research institutions and technologies shows that the country has good opportunity for dairy development. To realize these opportunities, the extension system should be reoriented and deliver demand driven and practical oriented dairy extension service to dairy producers that takes into account the different production systems, agro-ecology and market orientation. The capacity of all actors involved in dairy research, extension and development should be enhanced to bring the desired change in dairy development in the country. There is a need to establish dairy cooperatives, and capacitate the established ones to enable them play major role in input and output marketing and service delivery to dairy producers. Genetic improvement of indigenous breeds for milk production or introduction of new breeds has to be defined with due consideration to conservation of biodiversity, agro-ecology, production system, market demand and access and provision of inputs and support services. The efficiency and effectiveness of AI and veterinary health service should be improved to address the needs of dairy producers. Access to credit and land for dairying (including feed production) deserve due consideration. A mechanism should be created to convert manure into usable products (e.g. compost, biogas) and transform the challenges into opportunities.

There should also be a strong linkage among the different institutions involved in dairy development in the country, and networking mechanism should be created to share information on national research priorities, best practices and adoption of technologies, and advances in dairy development under tropical environment. It is also suggested that dairy development should be backed with strong policy to exploit the potential. Establishment of a coordination mechanism through public–private sector partnerships, such as a national dairy board, is crucial to develop, promote and regulate the dairy sector. The experience of IPMS on uptake of improved technologies (e.g. natural pasture development, urea treatment of crop residues, introduction of improved forage species, genetic improvement, etc.) by dairy producers should be scaled out to similar agro-ecology, production system (including the rural butter production system) and made sustainable. Also, the hormone assisted mass AI system should be improved/scaled out with a supporting action research program. In general, interventions along the value chain targeting production, input supply systems and service provision, product development and diversification of products for local and international consumers, quality control (inputs and outputs), and control of zoonotic diseases (e.g. Brucellosis, Tuberculosis), food safety, and minimizing post-harvest losses are essential for the development of a vibrant dairy sector.

# I Introduction

Ethiopia possesses the largest livestock population in Africa. Estimates for farmer holding in rural areas indicate that the country has about 50.9 million heads of cattle, 22 million goats, 26.0 million sheep and 2.3 million camels (CSA 2010/11). These estimates exclude the livestock population in pastoral areas, as there are no official statistics for the same. Earlier estimates indicated that the livestock sector contributes about 12–16% of the total GDP, and 40% of total agricultural GDP excluding the values of draught power, transport and manure, and contributes to the livelihoods of about 60–70% of the Ethiopian population (Winrock International 1992; Halderman 2004). A recent IGAD study by Behnke and Metaferia (2011) showed that the value of the animal draught power input into arable production is about a quarter (26.4%) of the value of annual crop production, and if the value of draught power services is included, the sector contributes up to 45% of agricultural GDP (<http://www.igad-lpi.org/publication>). These estimates, however, do not again consider the non-marketable values of livestock such as social, cultural, and religious values. Livestock serve as source of food, income, services, prestige and social status in the community.

In Ethiopia dairy production depends mainly on indigenous livestock genetic resources; more specifically on cattle, goats, camels and sheep. Cattle has the largest contribution (81.2%) of the total national annual milk output, followed by goats (7.9%), camels (6.3%) and sheep (4.6%) (CSA 2009). Despite its potential for dairy development, productivity of indigenous livestock genetic resources in general is low, and the direct contribution it makes to the national economy is limited. For example, in 2009 average cow milk production was estimated at only 1.54 litres/cow per day (CSA 2009), and the per capita milk consumption was only about 16 kg/year, which is much lower than African and world per capita averages of 27 kg/year and 100 kg/year, respectively (FAOSTAT 2009). A recent report by CSA (2010/11) indicated that the total production of cow milk is about 4.06 billion litres, and this translates to an average daily milk production/cow of 1.86 litres/day. The MoA (2012) also reported some improvement in per capita consumption of milk and estimated it at 19.2 kg.

Further, the annual rate of increase in milk yield (estimated to be 1.2%) lags behind the increment in human population (estimated to be about 2.7% per annum) (CSA 2008) and this resulted in large supply–demand variance for fresh milk (MoARD 2004). Azage (2003) estimated that if the current level of milk production would be maintained, then about 6 million tonnes of additional milk (4% increment in total milk production) is required per annum to feed the increasing human population and narrow the gap in milk supply and demand. Thus, the country has been spending foreign currency to import dairy products from abroad to meet domestic demand. For instance, the country spent about 3.1 million USD in 2001 for the same purpose, and this number increased to 9.3 million USD in 2008 (Haile 2009). The level of foreign exchange earnings from livestock and livestock products are also much lower than would be expected, given the size of the livestock population (Gebremedhin et al. 2007). Therefore, dairy production in Ethiopia is anticipated to increase rapidly in response to the fast growing demand for livestock products resulting from increasing human population, especially in urban areas, and rising consumer income, provided that appropriate interventions are made along the dairy value chain.

On the other hand, Ethiopia has a huge potential for dairy development in Africa. The large and diverse livestock genetic resources, existence of diverse agro-ecologies suitable for dairy production, increasing domestic demand for milk and milk products, better market opportunity, and proximity to international markets indicate the potential and opportunities for dairy development in the country. However, dairy development has been hampered by multi-faceted, production system-specific constraints related to genotype, feed resources and feeding systems, access to services and inputs, low adoption of improved technologies, marketing and absence of clear policy support to the sector.

Thus, in order to mitigate challenges that limit productivity and thereby exploit the untapped potential, it is necessary to characterize and analyse dairy production and marketing systems, identify major constraints along the value chains and devise pertinent and practical strategies to alleviate the problem and improve dairy production and marketing systems in the country. The Improving Productivity and Market Success (IPMS) of Ethiopian farmers' project, implemented by the International Livestock Research Institute (ILRI) on behalf of the Ethiopian Ministry of Agriculture (MoA), has undertaken a series of studies, which characterized smallholder dairy production and marketing systems in its PLWs and other sites in Ethiopia.

IPMS employed a participatory and market-oriented commodity value chain development approach to help boost production and productivity of smallholder farmers. This working paper is a synthesis of the results of the studies conducted by IPMS and provided information on the characteristics of smallholder dairy production and marketing systems, input supply and services, dairy technology and performance of dairy animals, and identifies major constraints that influence dairy development in the country. The paper also discusses the opportunities and suggests the ways forward for improved smallholder dairy development and market success.

## 2 Method of the study

This working paper is based on a number of thesis studies conducted in three regional states. The study areas included the districts of Bure, Fogera and Metema in Amhara Regional State; the districts of Shashemene and Mieso in Oromia Regional State; and the districts and towns of Hawassa, Dale/Yirgalem and Dilla in Southern Nations, Nationalities and Peoples Regional State (SNNPRS). The study areas were selected strategically to represent different agro-ecologies from the three regional states. Details on characteristics of IPMS Pilot Learning *Woredas* (PLWs) is available in [www.ipms-ethiopia.org](http://www.ipms-ethiopia.org).

Data collection procedures for the studies involved a combination of methods including review of secondary sources, diagnostic survey, participatory rural appraisal (PRA), focus group discussions, rapid market appraisal (RMA), monitoring and observations, and on-farm feeding studies. Data were collected from both primary and secondary sources. Data collection procedures were more or less consistent across all the studied areas with some unique features that have combined purposive and random sampling. The total number of respondents interviewed during the survey was 1410. Monitoring studies recorded the amount of milk and milk products produced, processed, consumed and delivered to the market following standard procedures. On-farm feeding trials generated useful information on the effect of urea treatment of low quality crop residues, and supplementation with AIBPs such as rice bran on performance of milking cows.

Data were also collected on the socio-economic characteristics of dairy producers and the pattern of dairy production, consumption and marketing and the opportunities and challenges of dairy production. Information on fodder production and management, housing of dairy animals, breeding, waste management and services rendered to dairy producers by the private and public institutions was also collected.

Data collected from the study areas were analysed using Statistical Analysis System (SAS) and Statistical Package for Social Science (SPSS) softwares. Appropriate qualitative and quantitative data analysis methods were used (SAS 1999; SPSS 2003). Analysis of variance was employed whenever appropriate.

The theses findings were supplemented with a review of project publications on livestock interventions, including PLW-specific and synthesized value chain commodity cases studies, articles and working papers.

# 3 Classification of dairy production systems

Dairy production is one of livestock production system prevalent in Ethiopia. Although there are different types of dairy production systems, they are broadly subdivided into pastoral, agropastoral and sedentary dairy systems. Pastoral systems are mainly found in the lowlands where livestock production is the dominant form of production to sustain the livelihood of pastoral society with no cropping, while agropastoral system combines both cropping and livestock production. In both systems, the production is based entirely on low input, with low milk yield, and little market orientation. The major sources of milk in these systems are indigenous cattle, camels and goats, whereas the contribution of sheep is small and also location specific. Sedentary systems are predominantly found in mid altitude to highlands, and in pockets in the lowlands. The IPMS studies and interventions focused on the sedentary dairy system.

Although the IPMS study sites may not be representative of the different sedentary production systems prevalent in the country, based on the information collected, three main sedentary dairy production systems could be identified; i.e. urban system, peri-urban system and rural systems (Table 1). Each of these systems is defined by its location, agro-ecology, their main production objective, resources and resource use, scale of production and management, market orientation, and access to inputs and services.

Urban dairy systems in general are located in cities and/or towns and focuses on production and sale of fluid milk, with little or no land resources, using the available human and capital resources mostly for specialized dairy production under stall feeding conditions. As compared to other systems they have relatively better access to inputs (e.g. feeds) and services (e.g. artificial insemination) provided by the public and private sectors, and use intensive management. The urban system of Hawassa, Shashemene, Yirgalem and Dilla is mainly based on cattle, both improved dairy cattle genotypes (crossbreds or high-grade) and indigenous cattle. Marketing of fluid milk in these towns is arranged through direct contact between producers and consumers, and/or involves wholesalers/processors, cooperatives, and retailers.



**Table 1. Dairy production systems based on characteristics of the study areas**

Production system	Study area	Elevation (masl)/ agro-ecology)	Production objective	Scale of production and management	Major constraints	Potential for livestock
Urban	Towns of Hawassa, Shashemene, Yirgalem and Dilla	1750	Income (sale of milk)	Keep both crossbreds and indigenous cattle; high input, use external input (AI, feed), in-door housing, stall feeding (intensive management); use separate house; milking predominantly handled by household wives; combination of early weaning and partial suckling; informal and formal marketing of dairy products; market-oriented	Feed, land for expansion, poor extension services, lack of efficient and effective cooperatives; waste disposal; shortage of improved genotypes; knowledge gap; seasonality in demand for milk; weak market chain; reproductive wastage; capital	Dairy
Peri-urban	Rural PA's of Shashemene, Hawassa, Dale and Dilla	1700–2600	Income (sale of milk, local butter), draught power, manure	Keep indigenous and crossbreds, medium external input (AI and feed), internal input; semi-intensive management; mixed crop–livestock; milking predominantly handled by household wives; informal marketing dominates; moderately market-oriented for milk	Feed; shortage of improved genotype; land shortage, shortage of input such as forage seeds, AI, extension; knowledge gap; weak market chain; reproductive wastage; capital	Dairy and beef
Rural highland	Fogera* Bure*	1774–2410 713–2604	Draught power, local butter sale and HH consumption, milk, manure, meat	Keeps indigenous and few crossbreds, low input, high human density; extensive husbandry; milking predominantly handled by males; informal marketing; not market-oriented for milk, moderately for local butter	Land shortage, feed and diseases, poor access to inputs and services, access to market, extension	Dairy, beef
Rural lowland	Mieso (agropastoral) Metema (transhumance)	900–1600; 550–1608	Milk, local butter, meat	Keep solely indigenous dairy animals, low input, low human density; extensive husbandry; informal marketing; mixed market orientation for milk and local butter	Water; access to market; shortage of feed, conflict over resources, extension services; disease	Beef and dairy

\*The studies of Fogera and Bure also contain small proportions of peri-urban and urban systems.

Peri-urban dairy system of Shashemene, Hawassa, Yirgalem and Dilla are located in rural PAs or at the periphery of these towns which have relatively better access to urban centres in which dairy products are highly demanded. Sale of fluid milk and some local butter are the main production objectives in this system. Besides dairy, animals are also kept for manure (fuel production and fertilize the soil) and castrated male animals are kept for draught power. Similar to urban dairy, in this system too, milk production in general is mainly based on cattle (both improved and indigenous).

However, it should be noted that the contribution of camel milk from peri-urban farms closer to cities such as Harar and Dire Dawa is becoming significant, although these areas were not included in this study. Peri-urban dairy farms in the current study sites, in general, operate at different scale of productions ranging from small to medium scale. They have access to land and usually practice mixed crop–livestock farming, which produces part of the feed in the form of crop residues and grazing. Peri-urban dairy producers in the studied PLWs can be classified as cereal crop–based system (dominant in Hawassa and Shashemene and Fogera districts) or enset and coffee-based system (dominant in Dale and Dilla districts). Access to inputs/ services and marketing is mainly through the public sector or collective action by producers and links with processors in urban centres. Commercial processing of local butter is handled at household level. Peri-urban dairy system in the PLWs is moderately market-oriented as compared to the same peri-urban systems operating in other parts of the country such as the Addis Ababa milkshed, which is largely market-oriented.

Rural highland dairy system of Fogera and Bure are located in rural mid altitude to highland agro-ecological set-up, which has limited access to urban centres where fluid milk is demanded. Emphasis in these systems is on processing of milk into butter and other dairy products for sale and/or home consumption. Besides dairy, animals are also kept for manure (fertilize the soil and fuel production) and castrated male animals are kept for draught power. The rural lowland dairy production system, in the context of the current study, occupies the low to midland agro-ecological set up of Metema (transhumance) and that of Mieso (agropastoral). Similar to the peri-urban producers, the rural dairy system in the study areas, in general, have access to land and practice mixed crop–livestock farming, which produces part of the feed in the form of crop residues and grazing. Producers in rural areas have limited access to inputs and services. Processing of (sour) milk into butter and cottage cheese is a household enterprise, and sale of butter is handled by the household themselves.

# 4 Dairy production systems performance and characteristics

## 4.1 Milk production performance

Milk yield performance of cows as reported by farmers varies across the different dairy production systems in the study area, mainly due to differences in breed and management. The average daily milk yield (DMY) performances of indigenous cows in PLWs was 1.85 litres/day, and ranged from 1.24 litres in rural lowland agropastoral system of Mieso to 2.31 litres in rural highland dairy production system of Fogera. This is slightly higher than the national average of 1.54 litres/cow per day reported for indigenous cows (CSA 2009). Lactation milk yield of indigenous cows ranged from 271.4 litres in rural lowland system of Mieso to 434.8 litres in peri-urban dairy system of Shashemene–Dilla milkshed, which could be due to variation in nutritional management and breeds. Lactation length of indigenous cows is short and ranges from 5.9 months in rural lowland system of Metema to 9.8 months in rural highland dairy production system of Bure.

Daily milk yield of crossbred dairy cows in urban dairy production system (towns of Hawassa, Shashemene, Yirgalem and Dilla) ranged from 10.21 to 15.9 litres/cow per day, and it was higher than 9.5 in peri-urban production system of the same milkshed. This is attributed to differences in exotic gene level of the crossbred animals and management. However, milk production from indigenous cows in peri-urban dairy system is similar with the other production systems in PLWs.

The role of camels as dairy animal is significant in rural lowland agropastoral system of Mieso, where they produce about 13.19 litres/head per day in the wet and 7.62 litres in the dry season. Camel milk supply to the household and the market becomes very important during the dry season when feed shortage becomes critical and milk production from cows is reduced. Although camels constitute part of the herd in rural lowland transhumance system of Metema, their use as milk producer is limited; instead they are used for sesame oil extraction and transportation.

Diversification of income is a coping mechanism practised by farmers/pastoralists in all the IPMS PLWs. In rural highland system of Bure and Fogera, the main source of income is from sale of crops followed by livestock and non-farm activities. In rural lowland dairy system of Mieso, the major sources of income was sale of crops and milk followed by live animals, while sale of animals and crops are the major sources of income in rural lowland transhumance sub-system in Metema. Moreover, due to limited access to market, fluid milk is rarely marketed in Metema, while butter has a better market. Dairying contributes to about 43.6–79.7% of the gross annual income in urban and peri-urban system of Shashemene–Dilla milkshed.

## 4.2 Household characteristics

The overall mean family size was different across the PLWs, and ranged from the lowest (4.9) in Yirgalem to the highest (7.2) in Hawassa (Table 2). Although data were not available for peri-urban system, the mean family size of rural system under the current study sites was moderate. The large family size recorded in PLWs is an advantage for the dairy producers to engage the labour force in different activities of dairying. With regard to educational status, the proportion of illiterates was higher in the rural lowland dairy system of Mieso and Metema than in the urban system of Shashemene and Yirgalem, but moderate in the rural highland dairy production system of Fogera and Bure. Unfortunately, most of the households sampled for the study were male headed households (77.5–97.4%). The average age of the household heads in the study sites ranged from 39.7 in Mieso to 51.9 years in Shashemene, and it was within the range of the productive age.

**Table 2.** Household characteristics in the study areas

Variables	Family structure (%)						
	Mieso	Metema	Bure	Fogera	Hawassa town	Shashemene town	Yirgalem town
Mean family size	6.62	5.57	6.22	5.14	7.2	6.1	4.95
Age category							
Mean	39.7	41.2	45.08	44.26	46.4	51.9	53.1
<15	68.8	47.7	46.2	–			
16–60	29.8	51.0	52.3	65.5			
>60	1.4	1.30	2.5	–			
Sex of family head							
Female	22.5	11.1	10	2.52	22.5	20	12.5
Male	77.5	88.9	90	97.48	77.5	80	87.5
Education							
Illiterate	80	54.8	31.5	31.67	30	22.5	22.5
Read and write	15	30.4	38.1	46.67	7.5	12.5	7.5
Elementary	4.2	13.0	19.9	17.5	10	27.5	17.5
High school	–	1.5	5.0	4.17	37.5	37.5	35
Diploma and higher	–	0.4	5.5	–	15	0	18

Sources: Belete (2006); Tesfaye (2007); Kedija (2008); Sintayehu et al. (2008); Woldemicael (2008); Adebabay (2009).

## 4.3 Land use, dairy animals, and household income

Land is one of the important resources for dairy farming. However, due to population pressure and urbanization land size per household and communal grazing land has been decreasing. Land holdings are higher in Metema and Mieso (rural lowland dairy production system), moderate in rural highland system of Fogera and Bure, and peri-urban system of Shashemene–Dilla milkshed, but limited to small backyards in urban dairy system of Shashemene, Hawassa, Yirgalem and Dilla towns (Table 3). This is consistent with previous findings in urban dairy system of the Addis Ababa milkshed (Yoseph 1999). The size of land allocated for grazing is very small compared to the land allocated for crop production in rural highland dairy production system of Fogera and Bure since crop production is the dominant production system in the area. However, dairy farms in rural lowland system of Mieso followed by Metema allocated relatively better size of land for grazing. The shortage of land reported in urban production system underlines the limitation of land to expand dairy production in urban centres. In general, land allocated for pasture/grazing is either small or is degraded with low biomass production, which cannot meet the nutritional requirements of animals across the PLWs.

**Table 3.** Average land use pattern and livestock population

Production system	PLWs	Average land use pattern (ha)			Average livestock population (n/HH)			
		Total (ha/HH)	Crops (ha/HH)	Grazing (ha/HH)*	Cattle	Sheep	Goat	Camel
Rural highland	Fogera	1.51–3.0	66.7%	6.6–16.6%	7.3	10.9	12.1	–
	Bure	1.3	92%	6.2%	9.02	2.49	0.43	0
Rural lowland	Metema	8.5	56.4%	17.6%	15.53	1.12	6.24	0.02
	Mieso	3.08	57.1%	42.8%	5.69	–	6.03	1.83
Peri-urban	Shashemene	1.97	na	na	3.34 (81%*)	na	na	–
	Dilla	0.87	na	na	1.51 (91%*)	na	na	–
	Hawassa	0.59	na	na	4.25 (92%*)	na	na	–
	Dale	1.12	na	na	3.13 (92%*)	na	na	–
Urban	Hawassa town	–	–	–	2.77	na	na	–
					(CrBr = 34%)			
	Shashemene town	–	–	–	2.82	na	na	–
					(CrBr = 40%)			
	Yirgalem town	–	–	–	2.98	na	na	–
				(CrBr = 38%)				
	Dilla town	–	–	–	3.41	na	na	–
					(CrBr = 26%)			

HH = Household; na = not available; CrBr = crossbred; \* = data presented in tropical livestock unit (TLU) and values in parenthesis shows percent of cattle out of the total herd size/household.

Sources: Belete (2006); Tesfaye (2007); Kedija (2008); Sintayehu et al. (2008); Woldemichael (2008); Adebabay (2009).

The dominant dairy animals across the PLWs are cattle (Table 3). In general, the composition of livestock and preference of livestock species kept by farmers/agropastoralists depends on the agro-ecology, production system and production objectives (ILCA 1990). The preference to a specific species of animals is aimed at matching with the prevailing environmental conditions, purpose, and as a means to judiciously use natural resources. Cattle ownership per household was lower in the urban and peri-urban production systems of Shashemene–Dilla milkshed as compared to the rural dairy production system (Metema, Bure, Fogera), with the exception of Mieso which has moderate size diversification of species of dairy animals, as observed in the current study, is a means to cope up with the change in climatic situations to ensure continuous milk supply throughout the year. The proportion of camels is, however, low in Metema, and they are mainly used for extraction of sesame oil. In general, camels, goats and cows are used for milk production in the lowland agropastoral system in Mieso; only cows are kept for milk production in the lowland transhumance system in Metema, in the rural highlands and in the urban and peri-urban dairy production systems.

The proportion of the milking cows in the herd ranged from 15 to 57.8% in the studied areas. The figure was higher in urban and peri-urban dairy production system of Shashemene–Dilla milkshed (50.7%) compared to rural highland dairy system of Fogera (21.9%) and rural lowland system of Metema (20%). The difference in the proportion of lactating cows in a herd among the production systems could be attributed to differences in production objectives. The higher proportion of milking cows in a herd in the urban and peri-urban system in the current study is consistent with the same system in Addis Ababa milkshed (Yoseph et al. 2003).

Dairy production in lowland dairy system of Mieso and Metema is exclusively based on indigenous dairy animals, although, farmers keep different breeds. In Metema, the indigenous cattle breeds mainly Agew, Simada and Fogera breeds are used. These breeds have been introduced from the highland areas of the region along with highlanders at a time when they settled in the lowlands (Metema) in search of land for agricultural activities (Azage et al. 2009). The lowland cattle breeds (Ruthana and Felata) form minor proportions and are mainly kept in extremely marginal areas of the district.

The proportion of crossbred cattle is very low in rural dairy production system, better in peri-urban and higher in urban dairy production system in the study areas. For instance, in the rural system in Bure the proportion of crossbred dairy cows accounts for about 7%, while it ranged from 26–40% in the urban system of Shashemene–Dilla milkshed. However, possession of crossbred and high-grade dairy cows in the latter system is still very low compared to the same production system but in different locations such as Addis Ababa milkshed which had 97.5% (Yoseph et al. 2003). In general, the higher number of crossbreds in the urban and peri-urban production systems could be due to better market opportunities for fluid milk and milk products and availability of AI services. However, the introduction of crossbreds has to be supported with other interventions such as better feeding, housing, health care, and extension services in order to exploit the genetic potential of the animals and thereby improve income of dairy producers.

## 4.4 Water sources for dairy animals

The water resources used by dairy farmers in PLWs varied depending on the agro-ecology and production systems. In rural highland dairy production system of Fogera, most of the sampled farmers use ground wells (49%) and rivers (47.2%) to water their animals. In rural lowland system of Metema, the major water resource for dairy animals is river, while the use of wells is limited (13.4%). In Mieso, ground wells as well as rivers are used. In the peri-urban dairy system of Shashemene–Dilla milkshed river (46%) followed by pipe water (24.2%) are the major source of water for dairy animals, however, the majority (71.8%) of the respondents in the urban dairy farming system (Hawassa, Shashemene, Yirgalem, Dilla) rely on pipe water.

Watering frequency of dairy cattle depends on access to water sources, the age structure of the herd, physiological stage of animals and season. In rural highland dairy system of Bure, watering frequency of calves on average is about 2.5 times per day. In rural lowland dairy system of Metema, watering animals is more frequent in the wet season (twice) than the dry season (only once). In the urban and peri-urban system (Shashemene–Dilla milkshed), about 36% of the households water their cattle once a day. Scarcity of water is severe during the dry season since rivers and wells dry out as reported by households in rural lowland dairy system of Metema and Mieso.

## 4.5 Housing

Dairy animals are often housed at night and the type of housing provided varied depending upon the classes of dairy animals, agro-ecology, production system, physiological stage of dairy animals. The types of houses provided, in general, varied from roofed to simple corral with no roof. For instance, in rural highland system of Bure, the majority of farmers keep indigenous cattle in isolated pens (57.3%), while some keep them in open paddock (25.3%). However, almost all farmers keep crossbred cattle in separate roofed pens irrespective of the production system. Indigenous animals are also herded in temporary mobile corrals on crop fields during the wet season to allow them to drop manure and urine in order to fertilize farmlands. In the rural lowland system of Metema, calves (93%) are housed under roofed shelter at night followed by goats (57.8%), while sheep get the least priority. However, housing livestock such as matured cattle, camels and donkeys is not common due to lack of experience, long tradition of keeping larger livestock in open corrals, and mobility of farmers in Metema.

## 4.6 Reproduction and breeding management

Reproductive performance is influenced by both genetic and non-genetic factors. In dairy animals, reproductive performance affects total milk production and calf crops obtained in the life time of dairy cows. Although data were not complete for all dairy production systems in PLWs, the existing information revealed that the age at first calving (AFC) of indigenous heifers is long, and ranged from 52 months in the rural lowland agropastoral of Mieso to 54 months in the lowlands of Metema. Calving interval was also long and ranged from 16 months in rural lowland system of Mieso to 26 months in rural highland dairy system of Bure. The difference could be explained mainly by environmental factors such as nutritional management.

In Ethiopia indigenous animals are the dominant source of milk across all the production systems with the exception of urban and peri-urban dairy system where improved crossbreds have significant contribution (Figure 1). Uncontrolled natural mating is the dominant form of animal breeding system practised under extensive husbandry in rural areas. Breeding soundness evaluation and screening best bulls for breeding purpose is uncommon. However, urban and peri-urban dairy farming system has better access to AI services. Currently, access to AI service is increasingly expanding in the highlands, though the efficiency and effectiveness is not satisfactory. In the rural lowland production system of Metema and Mieso natural mating is the only method since AI service is not available. In urban and peri-urban dairy system (Shashemene–Dilla milkshed), both natural mating and AI service are commonly used. In rural highland dairy system of Bure and Fogera, natural mating is the major breeding system with limited access to AI service. In the controlled (hand-mating) systems, farmers detect cows in heat and breed with the bull available in the village. Castration of bulls at an age of about 4–5 years is the common practices in the same system, since the primary purpose of keeping cattle is for draught power required for crop production. Such indiscriminate castration may leave behind inferior bulls for breeding.



**Figure 1.** *Fogera* cattle breed in Fogera (left), zebu in Mieso (middle) and crossbreds in peri-urban (right) used for milk production in PLWs.



In the rural lowland system of Metema, most farmers (73%) do not have their own bulls. They rely on bulls from other sources such as neighbours (39.5%) or use open mating in communal grazing (33.5%). The experience of sharing bulls among community members could be an entry point to introduce community-based cattle genetic improvement programs through improvement of the existing genetic resources or through the introduction of high performing and adaptive cattle genetic resources. In this regard, the IPMS project in collaboration with the Amhara Regional Agricultural Research institute (ARARI) and the Regional Bureau of Agriculture have attempted to introduce the Boran cattle into the rural lowland system of Metema using both natural mating and AI aimed at improving meat productivity and production and to respond to the increasing demand for live animals in the Sudan (Azage et al. 2009).

In the rural lowland system of Metema, the majority of farmers (62.7%) breed their cow with any available bull in the village. However, some farmers (10.8%) prefer to breed their cows with Ruthana breed bulls, which is originally from Sudan and others prefer to breed with other local breeds (26.5%). Ruthana breed is preferred by some farmers due to its docile behaviour, large frame size and higher milk yield. Coat colour of cattle is used as one of the selection criterion for selecting breeding bulls, where red, white, mixture of red and white are highly preferred.

In the urban and peri-urban systems of Hawassa, Shashemene, Dale/Yirgalem and Dilla AI service is accessible for about 50% of the respondents, although the contribution of natural mating is significant in peri-urban than urban areas.

## 4.7 Manure handling

Manure management varies according to dairy production systems (Figure 2). In the rural highland dairy production system of Bure and Fogera, dairy animals are tethered around the homestead and nearby farmlands or communal grazing area in order to take advantage of manure to fertilize the land. Manure is also used as a source of fuel in rural highland dairy system. In the rural lowland system of Metema, manure is poorly used (neither as fertilizer nor as fire fuel) as compared to the rural highland dairy production system which could be due to the availability of fire wood and better soil fertility. In the peri-urban dairy production system of Shashemene–Dilla milkshed, manure is used to fertilize crop lands particularly in the enset–coffee-based farming system of Dale/Yirgalem and Dilla districts. Paradoxically, about 47% of urban dairy producers in the same milkshed spend extra money to dispose cow dung from their farm, while 34% use it primarily for fuel. The experience from different production systems shows that manure is an important input for crop production and for nutrient recycling in the rural highland and peri-urban dairy production systems, but its importance is limited and challenges dairy farming in urban settings. Besides, manure is an alternative source of energy (in the form biogas), although this was not observed in the study areas.

This demonstrates that the extension system has to devise a mechanism whereby the excess manure from urban areas could be effectively and efficiently used.



**Figure 2.** Dried manure stored for sale as fuel (left) and as fertilizer (right).

## 4.8 Milking, milk handling and processing

Hand milking is the sole milking method practised across all the PLWs. Frequency of milking across the dairy production systems of PLWs is twice daily, with the exception of the rural lowland agropastoral production sub-system of Mieso where milking frequency is reduced to once a day during the dry season in order to cope up with feed shortage. However, unlike cows, camels are milked three times per day during the wet season and twice per day during the dry season in the rural lowland agropastoral production system.

Hygienic milk production is important and should take into account the sanitation of the barn, personnel involved in milking and the utensils used to collect and store milk. Cleaning of the teats before milking contributes to hygienic milk production. However, it is not common practice to sanitize teats before milking in the rural dairy production systems, and the number of farmers sanitizing teats is few in urban dairy production system with the assumption that teats are cleaned when the calf suckles before milking. In fact calves are also allowed to suckle after milking to ensure complete milking.

Sanitation of the milking and milk storage utensils varied between PLWs. In the rural lowland system of Metema, nearly all the producers clean milking and milk storage utensils by smoking it with fruits locally known as *Lifa*. The method is believed to improve the flavour, taste and quality of milk and milk products, and extends the shelf life of dairy products. In the urban and peri-urban dairy system (Shashemene–Dilla milkshed), the majority (70%) of the producers clean milk utensils with cold or hot water followed by smoking with different aromatic plants like *Woirra* (*Olea africana*) and *Tid* (*Juniperous procera*). Only about 23% of the producers in the urban and peri-urban system clean milk utensils with water and detergents. Different types of utensils are used for milking, milk handling and processing in PLWs. For example, in the rural highland production system of Bure and Fogera, most farmers use gourds which is made of *Lagenaria siceraria* (Quel), locally known as *Gerera* for milking, while in the urban dairy

production system (e.g. Hawassa), most dairy farmers (92%) use plastic utensils. However, the use of clay pot or plastic containers is also common in the rural dairy production system.

The dominant milk processing method across all the PLWs is traditional home processing method and it involves processing of fluid milk into fermented or sour milk, butter and local cheese (*ayib*) (Figure 3). For example, in the rural highland system (Fogera), milk is fermented for 3 to 5 days before it is processed into butter and other milk products (Belete 2006). About 0.6 kg of butter is produced from 10 litres of milk (approximately 16.5 litres of milk is required to produce 1 kg of butter) through the traditional milk processing methods (refer [www.ipms-ethiopia.com](http://www.ipms-ethiopia.com) for traditional method of milk processing).



**Figure 3.** Traditional method of milk processing (left) and spiced cottage cheese (*Metata ayib*) (right).

Metata ayib (Figure 3) is a unique and specialty traditional cheese commonly produced and used at household level in Amhara Regional State. The main reasons for making traditional spiced Metata ayib are to extend its shelf life and to improve taste, aroma and colour. Up to 40 different types of spices and herbs are used in its preparation (see [www.ipms-ethiopia.com](http://www.ipms-ethiopia.com) for the list). Properly made Metata ayib could be kept for more than 10 years if tightly sealed and stored in a cool place, and valued by the community for its medicinal and cultural values.

## 4.9 Labour division and role of gender

Division of family labour and role of gender in dairying varies based on production system and market orientation. The dominant source of labour for dairy production across the PLWs is family labour while the contribution of hired labour is minimal. The experience in the rural lowland dairying system of Metema showed that both husband and wife (60.5%) are involved in managing income from crop and livestock sale. This is contrary to the findings reported for the highlands of Ethiopia where cash generated from sale of crops and larger animals is entirely handled and managed by the husband alone (Ayantu 2006). In the rural highland dairy system of Fogera and Bure, most of the time (97%) milking is the responsibility of adult males followed by women, boys and hired labour. In the rural lowland agropastoral production system of Mieso, however, women are responsible for milking of cows and goats, while men

handle camels. Similarly, in the urban and peri-urban dairy production system (Shashemene–Dilla milkshed), milking is predominantly handled by women (79.3%) followed by hired labour (9.3%), while the role of men and children is negligible. Dairy animal husbandry such as feeding, cleaning and management are mainly the responsibility of women in almost all the PLWs. In the rural lowland dairy system of Mieso, traditionally, women drench herbs to sick animals, as the male members of the household are responsible for collecting the herbs from the field, since almost all the animal health care rests on the shoulder of women.

# 5 Feed resources and feed improvement strategies

## 5.1 Feed resources for dairy animals

The major roughage feed resources for dairy animals across all the different production systems in the study areas included natural pasture/grasslands, crop residues, non-conventional feed resources (e.g. leaf and stem of enset, banana and sugarcane; crop thinning) and crop aftermath (with the exception of urban dairy producers). The contribution of these feed resources, however, depends up on the agro-ecology, the types of crop produced, accessibility and production system. Although information was not complete, dairy producers in the peri-urban and rural systems across all the production system ranked grazing natural pasture as their first priority followed by crop residues (Table 4). In the rural lowland dairy system of Mieso, most farmers (about 83%) practice over sowing their farmland with maize or sorghum and then thin out the young plants at knee height stage, locally known as chinki, to feed vulnerable and productive classes of dairy animals. Leaves of sorghum and maize are also stripped after setting seed and used as animal feed. Among crop residues used, sorghum stover is the major feed resources in the rural lowland dairy system of both Mieso and Metema, while teff, wheat and barley straw, and maize stover are important feed resources in the rural highland system of Bure and Fogera. Rice straw and bran are emerging feed resources associated with the expansion of rice cultivation in the wetlands of Fogera, albeit its use as livestock feed is limited due to lack of awareness and limited market orientation by dairy farmers. In the peri-urban dairy system (Shashemene–Dilla milkshed), maize stover is the most commonly used feed resources and most of the households use it during the wet and dry seasons. However, in the peri-urban with enset–coffee-based system of Dale/Yirgalem and Dilla, more diversified feed resources such as chopped leaf and stem of enset, thinned and/or whole maize plant and leaves from different fruits and trees are used. Roadside grazing was common in the urban dairy system of Shashemene–Dilla milkshed, which has limited land resources. Peri-urban dairy producers around Shashemene, Hawassa, Yirgalem and Dilla towns

depend on natural pasture hay and crop residues as the major roughage feed resources. Since urban dairy producers have no land, they purchase whatever feed available such as sugarcane and green grass although its availability is seasonal.

**Table 4.** Farmers’ perception in ranking major roughage feed resources in the study sites

Major feed sources	PLW			
	Peri-urban*	Mieso	Bure	Metema
Grazing natural pasture/road side	1	1	1	1
Crop residues	3	2	2	2
Crop aftermath	6	3	3	3
Pasture hay	4	5	4	4
Non-conventional (leaf and stems of enset, banana and sugarcane; crop thinning)	2	4	5	5
Improved forages	5	6	6	6

\* Peri-urban area of the Shashemene–Dilla milkshed.

Sources: Tesfaye (2007); Kedija (2008); Sintayehu et al. (2008); Adebabay (2009).

## 5.2 Feed improvement strategies/technologies

IPMS employed different strategies to improve the feed value of low quality feed resources across the different dairy production systems in the study areas, either through improvement of the basal diet (introduction of improved forages, rehabilitation of natural pasture and over-sowing, urea treatment of crop residues) or supplementation (use of AIBPs, non-conventional feed resources, urea molasses block).

**Introduction of improved forage species:** A number of improved forage species have been introduced to all the IPMS PLWs. The most successful grass species included Napier grass, Guatumala grass, Desho grass (*Pennisetum spp. Pedicellatum*), oats and Rhodes grass, which were introduced as pure stands or intercropped with cereal crops such as maize and sorghum (Figure 4). Pure stands of Napier grass, Guatumala grass and Desho grass have been introduced around water harvesting structures, in irrigated areas and in locations where physical soil and water conservation structures have been established through natural resources conservation programs. Good results have also been recorded when these grasses were intercropped with legumes such as *Desmodium uncinatum* (Silver leaf). Introducing legumes such as alfalfa, pigeon pea, cowpea and vetch has also been successful both as pure stand or intercropped with sorghum and maize. Legumes such as pigeon pea and cowpea are also used as food/feed crops. Sweetpotato is a unique root crop traditionally used as food/feed crop in Mieso, and is often intercropped with sorghum, maize, beans and chat (*Khata edulis*).



**Figure 4.** Napier grass intercropped with sweetpotato in Mieso (left) and pure stand Guatemala grass in Dale (right).

**Natural pasture improvement:** Natural pasture is the dominant feed resources for dairy animals in peri-urban and rural production systems. However, its productivity is hampered due to various factors, of which overgrazing and invasion by weeds deserve mentioning. The problems were identified by IPMS and strategy was devised to improve natural pasture in its PLWs. Through the effort and active participation of the community, about 269 ha of communal grazing land was cleared from the invasive weed called *Hygrophilla auriculata* (Amykila) and 90 ha of overgrazed land was protected from free grazing in the rural highland dairy system of Fogera. After two years of intervention, it was found that the incidence of the weed amykila was substantially reduced and the proportion of grasses and legumes species increased. For example, the composition of grasses, legumes and weeds after amikila clearance followed by enclosure in one of the communal pasture sites (Kuhar Michael) was 88.9, 6.8 and 4.3%, respectively, where the proportion of legumes was higher in private enclosed farm (16.7%) than communal grazing land. The productivity of communal grazing land was also less than privately owned pasture land. The benefit of enclosure avoided the reduction of forage yield by 30% and protected the disappearance of some palatable forage species. In general, amykila clearance coupled with pasture land enclosure improved the carrying capacity of grazing land. Thus, from the total exclusion area of 91.6 ha of pasture land about 688.9 t DM hay, which ranged from 6.99 to 10.48 t/ha, was harvested (Ashagre 2008; Gebremedhin et al. 2010).



**Figure 5.** Community-based weed (amykila) clearance campaign on communal grazing land (left) and rehabilitated communal grazing land one rainy season after weed clearance (right) in Fogera.



**Urea treatment of crop residues:** Crop residues are important source of feed commonly used by dairy animals across all the production systems considered in this study (Table 4). The ever increasing human population of the country puts pressure on grazing land and encourages the expansion of cropping land, which eventually leaves behind enormous quantity of crop residues for livestock. However, crop residues are characterized by high fibre fraction, low digestibility and low available nutrients such as crude protein and metabolizable energy, which hardly support dairy animal performance. Urea treatment of crop residues has long been suggested to improve the feeding value of low quality feed resources (Sundstol 1978). The technology was tested on-farm with indigenous lactating cows in the rural highland dairy system using wheat straw in Bure and rice straw in Fogera (Figure 6). The result showed that urea treatment of wheat straw increased *in vitro* organic matter digestibility (IVOMD) from 34.2% (untreated) to 52.8% (urea treated), and milk yield from 0.45 kg/head per day in the control grazing natural pasture alone to 2.8 kg/head per day in indigenous cows grazing and supplemented with urea treated wheat straw, with a net profit of 8.13 ETB/day (Adebabay 2009). In a related study urea treatment of rice straw increased IVOMD from 30.8% (untreated straw) to 49.4% (treated straw), average daily milk yield from 1.2 litres/day per cow (untreated straw) to 2.36 litres/day per cow (urea treated), and a net profit of 6.82 ETB/day (higher by 2.62 compared to feeding untreated straw) to indigenous cows grazing natural pasture (Teshome 2009). The IPMS experience shows that the major impediment to the widespread adoption of treating crop residues is its labour demand. This calls for the development of ways to reduce the demand for labour of such practices.



**Figure 6.** Urea treatment of rice straw (left) and sorghum stover (right).

**Non-conventional feed resources:** The availability of non-conventional feed resources varies depending upon the production system and agro-ecology (Figure 7). The most common feed resources under this category are atella (tella atella—residue of local brewery/beverage or katikala atella—residue of local liquor), pulse hulls, ensent leaf and chorm, crop thinning, pseudo stem and leaf of banana etc. Both tella and katikala are made of cereals (maize, sorghum, teff, wheat, barley, finger millet etc.) although the former passes through fermentation while the latter passes through both fermentation and distillation. Even though there are some differences, both have moderate to high crude protein and better energy and could serve as both protein and energy supplement to ruminants (Yoseph et al. 2002). Feeding of atella



is common in urban and peri-urban areas of Shashemene–Dilla milkshed as well as the rural highland (e.g. Bure) dairy production systems. Leaf and chorm of enset are usually chopped and fed to animals in the enset-based peri-urban dairy production systems in Shashemene. While enset leaf contains moderate to high crude protein, enset chorm has higher energy.



**Figure 7.** *Atella in urban (left) and chopped leaves and chorm of enset feeding (right) in peri-urban dairy production system.*

**Agro-industrial by-products (AIBP):** AIBPs include cereals flour mill by-products, such as wheat, maize, rice bran, wheat short, and wheat middlings, which are commonly used as energy supplements, and oil seed cakes such as noug, cottonseed, peanut, sesame cakes, which are mainly used as protein supplements. AIBP are characterized by high protein, digestible energy, and low fibre fraction, and when supplemented to dairy cows improve the use of low quality basal diet and thereby improve milk production. The use of AIBP is higher in the urban and peri-urban dairy production system of the Shashemene–Dilla milkshed, but either low or non-existent in the rural dairy production system considered in this study.

In one of the on-farm feeding trials conducted to demonstrate the importance of rice bran in the rural highland dairy system of Fogera, supplementation of indigenous milking cows with rice bran increased the average milk yield by 23% compared to unsupplemented group under farmers' management condition. The control group not only had lower milk yield but also dried off early, especially in March and April when severe feed shortage occurred. High cost, limited access, low milk off take, and lack of awareness are the major reasons for the low utilization of AIBP in the rural dairy system.

**Urea molasses blocks (UMB):** Urea molasses block is one of the technologies available to improve feeding value of low quality feed resources and thereby improves performance of dairy animals. UMB provides fermentable energy, crude protein and minerals that are required for optimum performance. The technology has been introduced into a number of PLWs (e.g. Mieso) through IPMS, but with different levels of success. Although the composition of urea and molasses was consistent, the other constituents used to make the block do vary based on availability of raw materials. Therefore, UMB was made following the recommendations of ILRI and the Ethiopian Institute of Agricultural Research (EIAR) (see [www.ipms-ethiopia](http://www.ipms-ethiopia)).

org for UMB preparation). In general, farmers were fully involved in the preparation of the blocks using locally available materials, and made the blocks in different shapes, sizes and weight depending on the species of the animal targeted (e.g. smaller sizes for small ruminants) and also packaging for ease of transport (Figure 8). However, although, the perception of farmers towards the technology was positive, availability of molasses on the market may have an influence on the widespread use of UMB. This issue should be taken up by the research institutes and/or universities to search for alternative feed resources that substitute molasses.



**Figure 8.** Preparations of different sizes and shapes of urea-molasses blocks (left) and packed for sale (right) in Mieso.

### 5.3 Feed conservation practices

Feed conservation is one of the components of feed management to ensure year-round feed availability. Conservation of crop residues for animal feed is a common practice across all the study areas, but the methods of conservation vary among agro-ecologies and production systems, and types of crops grown (Figure 9). Farmers across all the PLWs stack crop residues and/or hay in an open space, but this might cause nutrient leaching due to excessive exposure to sunlight and rainfall.



**Figure 9.** Feed conservation practices in a form of kussa in Mieso (left), stack in Fogera (middle) and standing hay in Metema (right).

In the rural lowland with agropastoral system of Mieso, however, stovers of sorghum and maize are stacked on the farm field as *kussa* by systematically piling of the stover. The system uses harder stovers around the stack in order to protect the feed from direct exposure to

sunlight and rains, but hay making was not common. This practice might also cause wastage due to fermentation and insect pest damage. Due to poor storage system, farmers often fail to get adequate conserved feed to take them up through to the end of the dry season. As a result, during periods of feed shortage, farmers reduce milking frequency of their dairy cows from twice to once a day as a coping strategy.

In the rural lowland system of Metema, although hay making was common (practised by 75% of the sampled households), often the natural pasture is burned during the dry season to control ticks, or left as standing hay as an alternative feed conservation strategy. Seasonal labour shortage and lack of awareness have been reported to be the major problems for such practices and failure to harvest hay during proper time to main nutrient since it coincides with harvesting of food and other crops such as sesame.

In the urban and peri-urban dairy system of Shashemene–Dilla milkshed, hay and crop residues stacking were a common practice to conserve feed for dry season. Hay stacking was practised by 35.8% of the urban dairy producers in Hawassa, Shashemene, Yirgalem and Dilla. In this system, hay is transported using mule or donkey carts mainly from peri-urban areas. Smallholder dairy producers, who have no access for hay/crop residue stack in the urban system, incur additional cost to purchase the same feeds.

## 5.4 Feeding systems

Feeding systems in PLWs vary depending on the dairy production system and availability of feed stuff at the farm (Figure 10). In general, the feeding system in the rural (highland and lowland) dairy production system of the study areas is mainly free grazing whereas in urban dairy system of Shashemene–Dilla milkshed stall feeding dominates. Supplementation of dairy animals depends on the level of production in the case of urban and peri-urban system and on vulnerability of the different classes of dairy animals and season in the case of the rural dairy system in the study areas.



**Figure 10.** Stall feeding system in urban dairy production system (left) and outdoor feeding in Metema (right).

In the rural lowland agropastoral system of Mieso, oxen and calves and sometimes milking and pregnant cows are tethered around the homestead and provided with supplementary feeds (by-products, boiled sorghum grain mixed with salt, sweetpotato vines and tubers) while others are maintained under free grazing system. Tether feeding system was also common in the rural highland dairy production system of Fogera and Bure. In Mieso, although improved forages such as *Sesbania sesban* and *Leuceana leucocephalia* were introduced in the past, their use as livestock feed is limited due to lack of awareness by the agropastoralists. In the same system, during the wet season, thinning of sorghum and maize locally known as *chinki* are supplemented to vulnerable class of dairy and fattening male animals.

Supplementation of dairy animals with mineral is limited across all the dairy production systems in the study sites. However, soil salt, locally known as *haya* is fed to cattle more frequently in the dry season in rural lowland with agropastoral system of Mieso. In the rural lowland system of Metema, mineral salt is commonly offered for livestock during the wet season when feed is relatively abundant. Tree leaves, locally called *chara* and concentrate feeds are supplemented to emaciated dairy cattle (cows, calves) and to fatten oxen and steers during the end of the dry season.

In the urban and peri-urban system of Shashemene–Dilla milkshed, supplementary feed is mainly given to lactating cows only. In the rural highland system of Fogera, albeit the availability of AIBPs such as rice bran, supplementation with this feed resources was not practised mainly due to lack of awareness by farmers. Consequently, farmers commonly use this by-product as a source of fuel for cooking and/or sell to urban and peri-urban oxen fattening scheme located as far as 350 km such as Nekepmt and Dessie cities. This shows that the extension wing of the office of agriculture should be proactive and devise pertinent strategies to enable farmers better use the available feed resources and thereby boost milk production.

# 6 Characteristics of dairy consumption and marketing

## 6.1 General characteristics

Consumption pattern of milk and milk products produced at home varies depending upon the amount of milk produced per household, dairy production system and market access, season of the year, and fasting period (particularly for the followers of Orthodox Christian). Fresh and fermented milk, whey, cottage cheese (*ayib*) and butter are the most common milk products produced and consumed by the households in all the PLWs. In urban and peri-urban system and the rural lowland system of Metema dairy production systems only cow milk is consumed. Milk consumption from goats and camels in these systems is limited due to cultural taboo; however, camels and goats are important dairy animals that complement milk production from cows in the rural lowland agropastoral production system of Mieso. In the rural highland dairy production system of Fogera, out of the total milk produced daily, 20.6% is consumed by the households, while 65.5% is processed into milk products and used for home consumption and sale. In the rural lowland dairy system of Metema, about 18% of the milk produced is consumed within the household, while 63% is processed into milk products for home consumption and sale. In the agropastoral sub-system of Mieso, milk is often consumed in the form of *hoja*, a drink prepared from goat, camel or cow milk, diluted with water and boiled with coffee husk. In the peri-urban dairy system (Shashemene–Dilla milkshed), about 25% of households use milk for home consumption, while in the urban dairy production system (e.g. Hawassa), only 14.2% use milk for family consumption.

The major dairy products commonly marketed are fresh milk, butter, ergo (fermented whole milk), cottage cheese (*ayib*), and buttermilk. Marketing of milk and milk products varies depending up on the source of the milk, access to market, culture of the society, season and fasting period. Marketing of fluid milk is not common in the rural highland dairy production system of Fogera and Bure due to cultural reasons, while butter is commonly marketed,

even though it has low demand during the fasting period. In the rural lowland dairy system of Metema most producers market butter (90%), while selling whole milk is not common due to limited demand. On the other hand, in the rural lowland dairy system of Mieso, marketing of whole milk of cows, camel and goat is common as a result of local demand for fluid milk. Thus, the majority of producers sell whole milk (78%) and butter (67%). However, it is not culturally accepted to sell fermented milk. In the urban dairy production system (e.g. Hawassa), producers market most of the fluid milk (72%) produced per day.



**Figure 11.** Fluid milk marketing using cart in Hawassa (left) and Bajaj in Shashemene (right).

## 6.2 Marketing systems

In Ethiopia, milk and milk products are marketed through both informal and formal marketing systems. In the dominant informal marketing system, producers sell to consumers directly or to unlicensed traders or retailers (Figure 12). Price is usually set through negotiation between the producer (seller) and the buyer; this system is predominant in the rural dairy production system. In the formal marketing system there are cooperatives and private milk collecting and processing plants that receive milk from producers and channel to consumers, caterers, supermarkets and retailers; this system does exist in urban and peri-urban dairy system of Shashemene–Dilla milkshed, although the number of cooperatives is few and its performance is low (Woldemichael 2008). In the rural lowland agropastoral system of Mieso, dairy producers use two different milk marketing methods: traditional milk associations/groups and individual sellers. The traditional milk producer associations/groups are locally called *Faraqqa Annanni*, and are a traditional voluntary group that involves women who have milking cows or camels. Members are organized based on common interest of selling cow/camel whole milk, whereby milk is transported and sold by one of the member's thus reducing transport and marketing cost per unit of milk through economies of scale.





**Figure 12.** Traditional marketing of butter (left) and fluid milk (right).

## 6.3 Milk and butter marketing channels

The market channels of milk and milk products vary based on production system and type of the dairy product produced.

Milk marketing channels in urban dairy production system of Hawassa, Shashemene and Yirgalem involved 2–4 channels (Table 5). It is noticed that the role of cooperatives in the marketing channels is higher in Shashemene, as compared to Hawassa city, where the bulk of the milk is sold directly to consumers and private milk wholesalers and/or retailers.

**Table 5.** Major milk marketing channels in urban dairy system of Shashemene–Dilla milkshed

Milk marketing channels	Urban dairy system		
	Hawassa (%)	Shashemene (%)	Yirgalem (%)
I. Producer → Consumer	21	4.7	23.4
II. Producer → Wholesaler → Retailer → Consumer	60	–	–
III. Producer → Cooperative → Retailer → Consumer	2.2	46.9	–
IV. Producer → Retailer → Consumer	16	38	76.6
V. Producer → Cooperative → Consumer	0.81	10.4	–
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

Source: Woldemichael (2008).

Personal observations show that most fluid milk from the urban/peri-urban systems in these sites is sold through informal channels. The Bure study does, however, show that 40% of the milk from the urban/peri-urban producers is sold through the cooperative system.

Marketing of butter in the urban consumption areas of the Shashemene–Dilla milkshed involves actors from outside due to limited supply of local butter from urban and peri-urban production systems. Rural dairy producers in Shashemene and Dale supply about 46.2% and 41.7% of the total butter marketed in Shashemene and Yirgalem towns. Producers/itinerant

trader’s accounts for about 72.6% of total butter marketed in Hawassa, 31.1% in Shashemene and 42% in Yirgalem. It is noted that such butter comes from other milksheds such as Wolayita (Kucha, Areka, Gasuba and Waka), Sidama (Arbegona), Kofole in western Oromia and Addis Ababa (Woldemichael 2008).

In the rural lowland dairy system of Metema, several butter marketing channels have been identified including market agents selling butter to Gondar town and Tigray Region, which are located at a distance of about 160 and 240 km, respectively. Butter is also sold to Sudan legally, crossing the Ethiopian–Sudan boarder in Gelabat (Table 6; Tesfaye 2007). It has been very difficult to quantify the major contribution of each channel, but based on the response channels ii, iii and v have significant contributions.

**Table 6.** *Butter marketing channels in rural dairy system of Metema*

Butter marketing channels				
Producers	→	Consumers		
Producers	→	Itinerants	→	Consumers
Producers	→	Itinerants	→	Wholesaler/retailer → Consumers
Producers	→	Catering institutions	→	Consumers
Producers	→	Wholesaler/retailer	→	Consumers
Producers	→	Itinerants	→	Catering institutions → Consumers
Producers	→	Itinerants	→	Wholesaler/retailer → Catering institutions → Consumers

Source: Tesfaye (2007).

A similar marketing structure can be seen in Fogera, where butter produced in rural areas is sold and consumed locally but also sold in external markets (Addis Ababa) through a system of itinerant traders.

In the rural highland production system of Bure, the butter marketing channel is short and consists of producer → consumer (volume marketed is small and butter is used mostly for cosmetics) and producer → retailer → consumer (Adebabay 2009).

In general, prices of dairy products fluctuate and are influenced by a number of drivers such as season, distance and access to markets, fasting periods, festival and holidays, purchasing power of consumers; while quality, origin of the product, sales outlet (farm gate, delivery system or open market), and the production system are especially important for butter.



## 7 Inputs supply and services

Improved dairy production depends on better access to input supply and services, which include livestock extension service and market information, animal health services, cooperatives, credit, AI and feeds. A detailed description can be found in IPMS working paper no. 20 'Livestock input supply and service provision in Ethiopia: Challenges and opportunities for market-oriented development' ([www.ipms-ethiopia.org](http://www.ipms-ethiopia.org)). In the study sites, delivery and access to various services and inputs varied and some of the findings are summarized below.

**Livestock extension service:** Uptake of improved technology by dairy producers, among others, depends on effective and efficient dairy extension service. However, in the IPMS study sites dairy producers have, generally, low access to extension service. In the rural highland dairy system of Bure, although about 45.5% of the dairy producers report access to agricultural extension service, only 15% of them had training on dairy production. In the lowland dairy system of Mieso and the urban and peri-urban dairy production system of Shashemene–Dilla milkshed, access to extension services related to dairying is limited to 33% and 40% of the producers, respectively. The existing dairy extension service across all the study sites is limited to establishment of cooperatives, feed resources development and animal health care. The service is not adequately supported with practical demonstrations, which limit adoption of the technology by the farmers. Apart from extension agents, dairy producers across the study sites reported that they get information on dairy farming from other sources such as family, colleagues, personal experience, cooperatives, radio and NGOs. It was observed that 80% of the sampled respondents in the rural highland dairy system of Bure have radios. The IPMS project in collaboration with Farm Radio International (FRI) successfully tested the use of radio and this approach can also be used by the dairy extension system to develop and disseminate effective and participatory radio programs on technology transfer and uptake by dairy producers.

**Animal health services:** Most public veterinary clinics in the rural dairy system are located in district towns, which are far from most rural dairy producers. In most district towns private drug vendors/clinics can be found. However, veterinary drugs in private clinics are often too expensive for farmers to afford.

The main problems of access to animal health services mentioned by respondents in all studied areas are lack of veterinary supplies, distance from animal health centres, lack of skilled animal health technicians, lack of laboratory services, and lack of timely availability of veterinary supplies.

In the rural lowland dairy production system, private and public drug vendors supply drugs and paravets provide services at village level. In the rural lowland agropastoral production system of Mieso, 99% of the sampled respondents reported that they have serious problem in accessing veterinary services and they heavily depend on ethnoveterinary and indigenous knowledge in animal health care. The IPMS project therefore supported the strengthening of the paravet system in Mieso.

**Cooperatives:** These are dairy producer organizations that address access problems to market, handle input purchasing and distribution and output marketing after bulking and/or processing through collective action to achieve economies of scale. Cooperatives could take the form of formal and licensed cooperatives established to collect, process and sell milk as in Bure or traditional voluntary milk associations organized by the local community to sell milk as in the rural lowland system of Mieso. Although there are cooperatives in the urban and peri-urban dairy system of the Shashemene–Dilla milkshed, they are solely involved in collection and selling milk and are not involved in input/service supply. Besides, the amount of milk marketed per day through cooperatives in Hawassa was very small (only 0.56%) while it was moderate (58.3%) in Shashemene (Woldemichael 2008).

**Access to credit:** Access to credit can support agricultural production in general and dairy production in particular and thereby contributes to commercialization of smallholder agriculture. However, access to credit in the study areas is generally low, and varied across the production systems. In the urban dairy system of Shashemene–Dilla milkshed, although most dairy producers showed their interest to have access for credit to improve/expand dairy operation, only few (21.8%) had access so far. In the rural highland dairy system of Bure only 32.8% of dairy producers had access for credit. In the rural lowland dairy production system (Mieso), although farmers have access to microcredit via safety-net program of the government, it is limited to support only small ruminants and poultry. Besides, the credit targeted marginal and poor farmers and provides support to dairy goat production. To stimulate service delivery, the IPMS project provided credit from its innovation fund to the Bure Damot dairy cooperative in Bure to expand their businesses

**Artificial insemination (AI):** This technology is important to improve the genetic potential of indigenous animals and prevent transmission of diseases, which otherwise would be the case during natural mating. Dairy producers in the urban and peri-urban production system of Shashemene–Dilla milkshed have better access to AI than farmers in the rural highland and lowland production systems. However, the efficiency of the service has been reported to be poor (Adebabay 2009). Currently AI service has been expanding to highland agro-ecological set-up close to urban and secondary towns where consumption of dairy products is high although the level of adoption and efficiency of the operation is low. The IPMS project in collaboration with national and regional partners therefore initiated a program to improve

the effectiveness and efficiency of the AI system. The system is based on creating economics of scale by synchronizing the oestrus cycle of 'eligible' cows and heifers in villages with a dairy development potential, using hormones. This was followed by mass insemination by a team of specially trained staff. This approach also aims at matching subsequent milk production with available feed resources and milk market opportunities. Preliminary results of the new approach are encouraging in that response to hormone treatment was between 90 and 99% of the cows treated. Also effectiveness of AI treatment i.e. pregnancy doubled from around 30 to about 60%. Finally, the number of cows thus treated by an AI technician/week increased from 1 (national average) to 25–50. This system is very promising and therefore introduced for scaling up and out in the four project regions. Further improvements can be made through action research by enhancing the skills of livestock experts and AI technicians and improvements in dairy animal feeding and management.

### Feed marketing

In order to alleviate feed shortage from own production, dairy producers in different dairy farming systems purchase feeds from outside, especially in the urban system of Shashemene–Dilla milkshed. However, feed marketing is not well organized and informal marketing is the dominant system in all the study sites. Among the roughages, green grass, grass hay and crop residues of teff, barley, sorghum, maize, finger millet, rice, are marketed in small quantities (Figure 13). Recent development indicates that improved forages such as Napier grass and Rhodes grass are also marketed in some PLWs. These feeds are packed in different forms and transported by human, equine, camels, donkey carts and trucks (Figure 13). Concentrate feeds marketed are cereal bran (mainly wheat and maize) and oil cakes (noug, cotton, linseed, safflower and sesame). Feed marketing is common in urban (e.g. Hawassa) areas where dairy farmers have limited or no access to land for feed production. Thus, purchased feed is the major source of feed in this system. The practice of use of purchased feed in rural areas is rarely observed and often occurs during the drought years. For example, in Fogera only 5.5% of the households purchase feed, which is in the form of renting pastureland for free grazing and/or cut-and-carry feeding system. In the peri-urban system of Shashemene, Hawassa, Dale/Yirgalem and Dilla districts, about 53% of dairy producers use feed produced on-farm, while the remaining purchase from outside or use combination of own and purchased feed. However, since feed marketing system in Ethiopia is not well developed it becomes a crucial constraint to the expansion and development of the dairy sector.



**Figure 13.** Green feed (left), grass hay (middle), and crop residues (right) marketing for dairy animals.

# 8 Constraints to dairy development

Dairy production is constrained by multifaceted factors, though the nature and magnitude of the problems vary between production systems and agro-ecologies. Some are cross-cutting that can have influence on dairy production regardless of dairy production system and agro-ecologies; others are system specific. The major constraints are described below.

## 8.1 Feed and water

Feed shortage in terms of quality and quantity is the major constraint regardless of the dairy production system and agro-ecology. Feed constraints could be seen from different dimension in terms of quality and quantity and seasonal feed supply to meet the nutritional requirements of dairy animals. Both roughage and concentrate feeds are either too expensive or unavailable in sufficient quantity and quality to improve dairy production. The general belief that feed is abundant during the wet season is not true in all production systems and agro-ecologies. For example, in the rural highland dairy system of Bure about 35% of the farmers reported feed shortage between July and September, the main rainy season. In Fogera, farmers face severe feed scarcity during the wet season due to flooding of the natural pastureland. In addition, grazing lands in Fogera have been shrinking due to expansion of large-scale rice cultivation and the invasion by the noxious weed (*Asracantha longifolia*, amykila), overgrazing and mismanagement due to the free and uncontrolled use. In the rural lowland dairy production system, feed shortage is associated with low moisture availability and poor feed harvesting, conservation, management and utilization practices. For instance, in the rural lowland system like Metema, poor management and absence of proper conservation practices has created feed shortage during the dry season, although natural pasture seems abundant during the wet season. In the rural lowland dairy system of Mieso, unpredictable and unreliable rain, expansion of croplands and poor feed conservation techniques are the major problems for the shortage of feed.

Access to water during the dry season is a major constraint in most of the study sites. Besides, in the rural highland system such as Bure, infestation of rivers and ponds by leech (*alkit*) challenges dairy development in the area. In the low rainfall areas like Mieso where there is plenty of underground water resource, water resource development is crucial to dairy production.

## 8.2 Shortage of forage seed and planting materials

Diverse agro-ecology, soil types and production systems in Ethiopia provide good opportunity for the production of different types of forages for feeding livestock and also to develop forages as marketable commodity. However, lack of sustainable supply of forage seed and planting materials hindered development of improved forages in the country in general and in IPMS PLWs in particular. The involvement of the private sector in the supply of forage seed and planting materials has been weak.

## 8.3 Shortage of land

Shortage of land for dairy farming and feed production is a major problem in urban and peri-urban dairy farming system of Shashemene–Dilla milkshed. Dairy farms under this system are under tremendous pressure to expand dairying mainly due to rapid urbanization and population growth. Most urban producers (97%) keep their cattle within their own residence compound. Although urban expansion creates great opportunity for commercialization of dairy production, it has to be supported with appropriate policy framework to promote dairy development. Shortage of land is also the major constraint in the rural highland dairy production system.

## 8.4 Genotype related constraints and reproductive wastage

In Ethiopia, indigenous cattle breeds are the dominant source of milk and milk products. The number of crossbred cows is very low and is mainly concentrated in and around major urban and peri-urban centres. Indigenous cattle breeds are generally characterized as multi-purpose animals and managed in low input production system. These animals have been naturally selected for adaptive and not for functional traits, and they are inherently low milk producers. There is no controlled breeding method. For example, the indigenous Fogera cattle breed, a good dual purpose breed, is being indiscriminately crossed with other zebu cattle breeds.

Similarly, dairy producers in most PLWs breed their cows with any available bulls in the herd. There is also shortage of crossbred dairy animals in urban and peri-urban areas where the demand for milk and milk products is high. There is no breeding policy in place in the country to curb genotype related problems and thereby make genetic resource utilization sustainable. Delayed age at first calving, low calving rate and long calving interval in improved dairy genotypes have been reported as important problems in the urban and peri-urban dairy systems.

## 8.5 Poor access to inputs and services

Access to inputs and services includes extension, animal health, credit, market information, AI and dairy inputs. However, service delivery in the studied areas is not as effective and not up to the satisfaction of dairy farmers because the services rendered are very limited, untimely and irregular.

The extension service has not satisfied the needs of farmers in terms of providing need-based service, hands on training and subject matter coverage tailored to different dairy production systems and market orientation. The livestock extension service is by far secondary to crop extension. Although most dairy farmers get information on dairy cattle management practices, it was not supported with practical skills and demonstrations due to absence of demonstration sites. In the urban and peri-urban dairy system of Shashemene–Dilla milkshed, some dairy producers receive dairy production extension services, but it was not supported with practical demonstration. In the rural lowland agropastoral system of Mieso, most of the farmers reported that no regular visit was made by veterinarians. In the rural system of Fogera, farmers have limited awareness about improved dairy and forage production technologies. In fact most dairy producers started dairy farming without prior knowledge and skill in dairying as reported in the urban and peri-urban system.

Access to animal health service as well is low since the service is ill-equipped. In the rural lowland production system of Mieso and Metema, herdsman often equip themselves with common drugs and other supplies that are required to treat their animals. In Mieso, due to limited veterinary service, almost all the households use traditional treatments, herbs, to treat sick animals. There is also a serious shortage of veterinary experts and limited access to veterinary service. Poor veterinary service has also been reported in urban and peri-urban system of Shashemene–Dilla milkshed. In Fogera, shortage of veterinary experts, shortage of drug particularly at a time when diseases are rampant, long distance to access veterinary service, lack of laboratory and skilled personnel were reported to be the major problems.

Credit services offered to dairy production, in general, is by far minimal compared to crop production. In the rural highland system of Bure milk producers have little or no access to credit. In urban and peri-urban system of Shashemene–Dilla milkshed, only 12.5% of the

dairy producers have access to credit. On the other hand, about 25% of butter and milk traders in the same milkshed have shortage of working capital and need credit to expand and improve their business. In fact there is also lack of awareness on importance of credit among dairy producers as demonstrated in the rural dairy system of Bure and the urban and peri-urban dairy system of Shashemene–Dilla milkshed. In general, the credit system for dairy development is not well developed in all the PLWs.

Although AI service is available in most urban areas of Shashemene–Dilla milkshed, it is less available for most peri-urban dairy producers in the same milkshed. Currently, AI service has been expanding to different parts of the country. However, the efficiency and effectiveness of AI service in general is quite low due to various constraints. For example, dairy producers in Fogera and Bure reported that pregnancy rate to AI is low and they prefer to breed their animals naturally using crossbred bulls. There is no record keeping tradition at AI centres and thus information on pregnancy rate, number of calves born to AI etc. is not available (Belete et al. 2010). Farmers in Bure are reluctant to use AI and they reported that AI yields in high incidence of male animals than females (Adebabay 2009).

## 8.6 Diseases and parasites

Diseases in dairy animals affect reproduction, milk production, milk quality and cause mortality and morbidity. In the rural lowland dairy production system of Mieso and Metema, disease and parasite were ranked as the major problem by most of the farmers (about 66–86%). Thus, mastitis followed by anthrax were reported to be the major diseases in Mieso, while babesiosis and FMD were the major diseases in Metema. Similarly, tick infestation was reported to be severe in the rural lowland dairy production system of Metema. However, information on the list of specific diseases was not available from other dairy production systems. The major diseases and parasites in the rural highland system of Fogera included trypanosomiasis, schistosomiasis, fascioliasis, gastro-intestinal tract parasites and lung worms. Similarly, the major disease in the highland dairy system of Bure included respiratory diseases, pasteurellosis, lumpy skin disease, anthrax, malignant fever, tuberculosis, black leg and trypanosomiasis.

## 8.7 Marketing related constraints

Improving market access to dairy products creates an opportunity for enhanced dairy production. However, marketing and access to market have been reported to be the major problems in IPMS PLWs. Thus, in the rural highland dairy system of Bure and Fogera, milk marketing is a common problem, being the highest for Fogera (66.7%) than Metema. Distance to markets, shortage of milk and seasonal fluctuation in milk supply have been reported to be the major determinant across all the production systems. Besides, lack of training in milk

handling and marketing (24.9%), lack of access to market (21.2%), cultural taboo to sell milk (20.8%), spoilage of milk (19%), and high transport cost have been identified to be the major reasons for weak market access.

## 8.8 Lack of strong cooperatives and involvement of private sector

Dairy cooperatives have been established in a number of the study sites with the intention of facilitating and improving the bargaining power of members in milk marketing, supplying inputs with reasonable price and delivering services needed for dairy production. However, the efficiency and effectiveness of dairy cooperatives in meeting these objectives has been low. Most cooperatives lack clear vision and goal, are inefficient and ineffective, have limited knowledge and skill in dairy husbandry and dairy business, lack transparency and accountability and tend to be more dependent on support from the public sector and NGOs. Unlike cooperatives, the involvement of private sector in collection, processing and marketing of dairy products in the study areas is very weak.

## 8.9 Waste disposal

Waste from dairy farms is a serious problem, particularly in urban production system. Manure, however, complements crop production in rural dairy production systems. If not properly managed, manure is a source of bad odour and flies, source of conflict with neighbours, and source of zoonotic diseases. Dairy producers from urban dairy system complained that manure disposal incurs cost. Although urban dairy farming is recognized by public authorities in some urban centres, it was not encouraged in others and so there is lots of pressure and restrictions on dairy producers.

## 8.10 Policy support for dairy development

Although the country has favourable macro policy for agricultural development sector in general, there is lack of specific workable policy direction and support for dairy development.



## 9 Opportunities for dairy development

- Livestock genetic resources and production system: Ethiopia is endowed with large and diverse dairy animal genetic resources, which are widely distributed across the various agro-ecologies and climatic conditions prevalent in the country. The country with about 27 breeds of cattle (DAGRIS 2007), 14 breeds/types of goats and about 3 breeds/types of camels, is considered as a centre of diversity for farm animal genetic resources. Indigenous animals have evolved over time through natural selection and adaptation to the existing diverse ecological conditions of their habitat. Consequently, dairy production system in Ethiopia forms a continuum with pastoral form of production system dominating the lowland agro-ecological setup (livestock production is dominant to sustain the livelihood of society) to market-oriented urban and peri-urban dairy production systems that exists in mid to upper highlands. The potential of indigenous genotypes as dairy animals have not been fully explored. There are indications that milk yield among the indigenous animals is variable implying that there are opportunities for improvement.
- **Access to services and inputs:** Dairy development depends on reliable inputs and services such as AI, health service, and improved forage seeds supply. Currently, the number of AI service centres has been increasing and cover most urban and peri-urban areas, and some part of the rural highlands. This is an opportunity to improve the genetic potential of indigenous dairy animals in the areas where there is critical shortage of milk and milk products. Cognizant of the fact that diseases and parasitic infestations are economically important to reduce production, several public veterinary clinics have been established across the different dairy production systems in the country, although its efficiency of operation is low.
- **Agricultural extension service and technologies:** Agricultural extension service in Ethiopia started long ago although it has been delivered entirely by the government. Currently, almost all PAs have extension/development agents. Efforts have been made to provide extension services in the area of dairy production although livestock extension is underdeveloped compared to crop production. There are several technologies available for

use in the country. For instance feed conservation practices, introduction of forage legumes into cereal cropping system coupled with proper feeding systems, and over sowing natural pasture with legumes should be promoted to improve dairy production. Community-based communal grazing area improvement programs and appropriate conservation and feeding systems should also be promoted.

- **Demand for and consumption of milk:** Although, the contribution of cow milk is dominant, milk from camels and goats is also consumed in Ethiopia, especially in pastoral and agropastoral systems of production. Unlike camel milk, goat milk is commonly consumed in sedentary dairy production system as well, specifically in eastern and southern part of the country. In Ethiopia there is longstanding and strong culture of consumption of dairy products. In addition to raw milk, milk products such as butter, cottage cheese, fermented milk (yogurt), whey are also commonly consumed. The large human population (estimated at more than 80 million and expected to grow at 2.7% per annum) and very high rate of urbanization, improved income in some segments of the society, are also among the major driving forces that dramatically increase the demand for milk and milk products.
- **Income generation and employment opportunity:** Dairy farming supports livelihoods of society under low input production system; generates income and creates employment opportunity under market-oriented production system. Dairy farmers in urban, peri-urban and rural dairy production systems demonstrated strong interest to expand dairying as one of the means of income generating activity. Particular attention should be paid to increasing the role of women in dairy development, since the study shows that they play a major role in dairy production and marketing.
- **Service providers:** Currently the number of public universities has reached 31 compared to 9 universities 10 years ago, and most of them have programs to train students in the area of animal sciences and animal health at undergraduate level. The number of universities offering graduate programs and the number of students enrolled in the field of animal sciences at postgraduate level have also been increased significantly. Besides, Agricultural and Technical Vocational Education Training (ATVET) colleges are producing quite a large number of development agents to work at grassroot levels to meet the demand of farmers. This shows that there is potential of trained manpower to be involved in dairy development (either as producer or advisor to the farmers) in the country.
- **Research institutes and technologies:** In Ethiopia research on dairy started over five decades ago. Since then the dairy research system has passed through a lot of transformations. Today research on dairy is conducted in agricultural research institutions, universities with agricultural colleges, and non-governmental organizations. So far, several technologies have been generated in the country although there is a challenge in its dissemination. The existence of the various institutions involved in dairy research and development across the different parts of the country is an opportunity to come up with a solution for challenges that constrain dairy production and for low uptake of dairy technology in the country.

- **Indigenous knowledge:** The existence of diverse dairy production systems and agro-ecologies coupled with diverse flora species rendered the country to have indigenous knowledge, specifically in the area of livestock production and dairy processing. For instance strong indigenous knowledge exists in the preservation of milk in the agropastoral dairy system and milk products in the rural highland dairy system using various sources of herbs.

# 10 Ways forward

This synthesis working paper characterizes dairy production and marketing systems; evaluates supply and access to inputs and services, and dairy technologies; and assess performance of dairy animals, constraints and opportunities for dairy development based on IPMS experiences. The following strategies are ways forward for sustainable smallholder dairy development in the country.

- The existence of large and diverse dairy animal genetic resources, which are adapted to diverse agro-ecologies, is an opportunity that could be exploited for improved dairy development in the country. Introduction of better performing indigenous dairy animal breeds into similar agro-ecology, production system and better feed resources and management could be an alternative strategy to exploit the genetic resources and increase milk production. For example, introduction of the Ethiopian Boran cattle breed to the lowland areas (similar agro-ecology) of Afar, Amhara, Tigray and other parts of Oromia has already taken place. The suitability of the same breed into other parts of the country has also been studied using GIS (based on agro-climatic information), and showed that the Boran breed could be introduced into the pastoral areas of Afar, Somali, Oromia and SNNPR regional states. Similarly, the suitability of introducing Fogera cattle with relatively better milk yield into other parts of the country with similar agro-ecology and production system could also be looked into. However, it should be noted that suitability of the indigenous breed into a new environment should be studied before introduction of the breed. The experience with IPMS also demonstrated that milk production of indigenous adaptive cows was improved through improvement of the nutritional management (e.g. supplementation with urea treated maize stover) suggesting that the potential of adaptive indigenous animals could be enhanced using better management under their home ecosystem. Literature and previous experience have shown that there is variation in performance traits among indigenous animals, which calls for exerted effort for breed improvement through selection for rural highland and lowland dairy system. In urban and peri-urban dairy system where the demand for dairy products is substantially high and has better access for inputs and services such as AI, crossbreeding of indigenous animals with exotic high yielding dairy breeds should be strengthened as an alternative strategy for genetic improvement. Clear distinction has to be made between the fluid milk and

butter system in development interventions. There should be a breeding policy in place at a national level that gives direction with regard to pertinent breeding strategies suitable for different agro-ecologies and production systems in order to boost milk production in the country.

- The efficiency and effectiveness of AI services should be improved through capacity building of AI technicians and AI centres at district level, ensuring sustainable supply of the germplasm and liquid nitrogen, awareness creation on importance of AI and oestrus synchronization to achieve economies of scale for dairy producers.
- Efforts should be geared to build the capacity of the veterinary professionals, paravets in rural dairy system (e.g. Mieso) and service centres, and ensure sustainable supplies. Although not sufficient, there are private veterinary service providers mainly found in urban and peri-urban areas. They should be supported and strengthened to improve the service delivery system with proper regulatory mechanisms.
- A number of options exist to promote the use of improved forages through appropriate supply of forage seed and planting materials. These include farmer to farmer dissemination, use of FTCs as germplasm source and strengthening the private and public sectors.
- Several technologies have been generated concerning dairy development in the country. However, they have not been disseminated to beneficiaries efficiently and effectively because of loose linkage between research and extension, lack of innovative extension system, and lack of understanding on the diversity of dairy production system, agro-ecology, market orientation etc. Issues related to organization of the dairy/livestock extension system, extension approach specific to dairy/livestock under diverse environment, and capacity of extension agents suggest for reorganization of the system. Experience with IPMS on uptake of improved dairy technologies by dairy producers (e.g. developing degraded and weed devastated grazing land, urea treatment of crop residues etc.) through awareness creation, mobilization of the community, and demonstrations affirm that there is potential to improve dairy production provided that the available technologies are disseminated and adopted. Thus, the extension system should be revisited and deliver demand driven and practical oriented dairy extension service to dairy producers. As demonstrated in this report, dairy products are produced by different production systems for different markets and extension interventions should be tailored to such different systems. Moreover, the extension service needs to be adapted to support market-oriented dairy production, or the extension system should be adapted towards market-oriented extension service.
- Targeting women by the extension system is another crucial factor to increase adoption of technologies. In particular targeting women to develop the local butter-oriented production system through participation in capacity building and knowledge management should be encouraged.
- Capacity development of all actors involved in dairy research, extension and development at large is an indispensable task to bring the desired change in dairy development in

the country. The Growth and Transformation Plan (GTP) document of the government emphasized the shift from subsistence agriculture to market-oriented system, which definitely requires capacity development. Thus, the gap (knowledge and skill) of development agents should be identified and their capacity should be developed through tailor made trainings that would enhance their competency to support the transformation. Universities and colleges are also expected to develop their capacity to produce competent graduates equipped with the required knowledge, skill and attitude in dairy development focusing the diverse production system and value chains. The capacity of federal and regional research institutions should also be developed to conduct dairy research on nationally prioritized problems targeting diverse production systems, market orientation, and value chains. A system should be in place to motivate, reward and incentivize best performing individuals (e.g. development agents, researchers), and a mechanism should also be in place to retain competent professionals. Particular attention should also be paid to engender the capacity of research and extension staff to ultimately have a more gender balanced dairy development program.

- Dairy development provides numerous opportunities for the society through income generation, employment creation, supply of animal protein etc. The fact that there is huge gap between supply and demand in dairy products in the country opens door for expansion of dairy farm. However, establishment of dairy farm requires resources such as capital and land. Similar attention as is given to the establishment and development of small-scale and micro-finance enterprises should be given to encourage and support dairy farming especially in urban and peri-urban areas.
- In Ethiopia livestock research is undertaken by federal and regional research institutes, universities, and non-governmental organizations. Although various research works have been undertaken by these institutions in general, efforts made so far are not sufficient to bring the expected change due to technical and non-technical reasons including shortage of manpower, organizational setup, and lack of focus on the value chain. Currently, quite a number of relevant graduate research works is being undertaken by various universities. There is weak linkage among the federal and regional dairy research and development institutions, universities, non-governmental organizations and others working in the area of dairy research and development. Thus, future dairy research should focus on dairy value chains, support graduate research, build strong horizontal and vertical linkage among research institutions and extension system for development and better adoption of technologies.
- Although various research works have been undertaken by different institutions the information generated thereof could not be shared among stakeholders including policymakers. Establishment of networking would enable stakeholders to share information on recent development in dairying, identify national research problems and thereby exert concerted efforts to solve constraints of dairy development. Although dairy development ventures are not well organized at national level and scattered mostly at institutional level, there are best practices on how to better do things in respective institutions, and this could be identified and shared among the stakeholders through forging networking.

- Cognizant of the fact that milk is a perishable commodity and access to inputs, services and market is a challenge for smallholders, cooperatives have been established by smallholder dairy producers in some study areas. Cooperatives benefit producers through finding better market price for the product, reduce costs of marketing for their produce and for obtaining inputs, and make the market for their goods more secure. However, the type, efficiency and effectiveness of the cooperatives in the study sites are not strong and are mostly limited to milk collection and marketing. Thus, cooperatives should be strengthened through capacity development, and other relevant supports should be made available for improved smallholder dairy development. Dairy cooperatives need support to be transparent, business-oriented, participatory and accountable. Smallholder dairy producers should be made aware about the importance of cooperatives. The role of cooperatives should also be extended to supply inputs and services to producers at reasonable price, and value adding venture of commercial milk processing.
- While cooperatives can assist farmers in marketing and processing of milk products and supplying inputs and services, private sector businesses can also be involved in strategic location to create hubs for dairy development.
- The process of dairy production leaves behind enormous quantities of manure which could be used as a source of organic fertilizer (nutrient recycling) in case of rural and peri-urban dairy production systems, and as a fuel across all the production systems considered in this study. However, manure disposal becomes a challenge and incurs much cost in urban dairy system. Thus, pertinent strategy could be devised to link urban dairying with peri-urban system whereby manure produced in urban dairy system could be made available for rural dairy producers. A system could also be devised to convert manure into biogas, which could serve as a source of energy for dairy producers. It is also important to look for availability of efficient and less costly mechanisms of manure disposal system. Since the suggested interventions require awareness and resources, concerted effort should be exerted by stakeholders involving dairy producers, concerned authorities, cooperatives, and non-governmental organizations.
- Productivity of dairy animals highly depends on the supply of adequate and quality feed resources. However, the bulk of feed resources used across all the study sites is crop residues, which is low quality. Although grazing of natural grasslands is dominant in the rural and peri-urban dairy systems, the biomass yield and quality is limited due to over grazing and encroachment with weed and less desirable species. The experience of IPMS demonstrated that the nutritional value of crop residues could be improved through various ways such as urea treatment; and supplementation with the same increases milk yield in cows. It was also shown that biomass yield and quality of natural grasslands of degraded and overgrazed land were improved through weed clearance and enclosure in Fogera area. It is, therefore, suggested that these technologies should be scaled out to similar environment, and if coupled with proper feed conservation techniques, would undoubtedly contribute to improved dairy production in the country. However, it should be noted that improved technologies such as urea treatment of crop residues is labour intensive and calls for pertinent strategy to overcome the problem.

- There are a number of governmental and non-governmental initiatives to develop the dairy in the country. However, there is very little coordination and complementarity among them. Therefore, establishment of a coordination mechanism through public–private sector partnerships, such as a national dairy board, is crucial to develop, promote and regulate the dairy sector.
- Dairy farming has several opportunities for dairy producers and economic development of the country at large. To realize this dairy development requires policy support. The fact that the country is spending hard currency to import dairy products to meet the national demand despite the potential it has for dairy development and the contribution of dairying to socio-economic development of the country underpins the importance of workable policy direction to promote dairy development in the country.



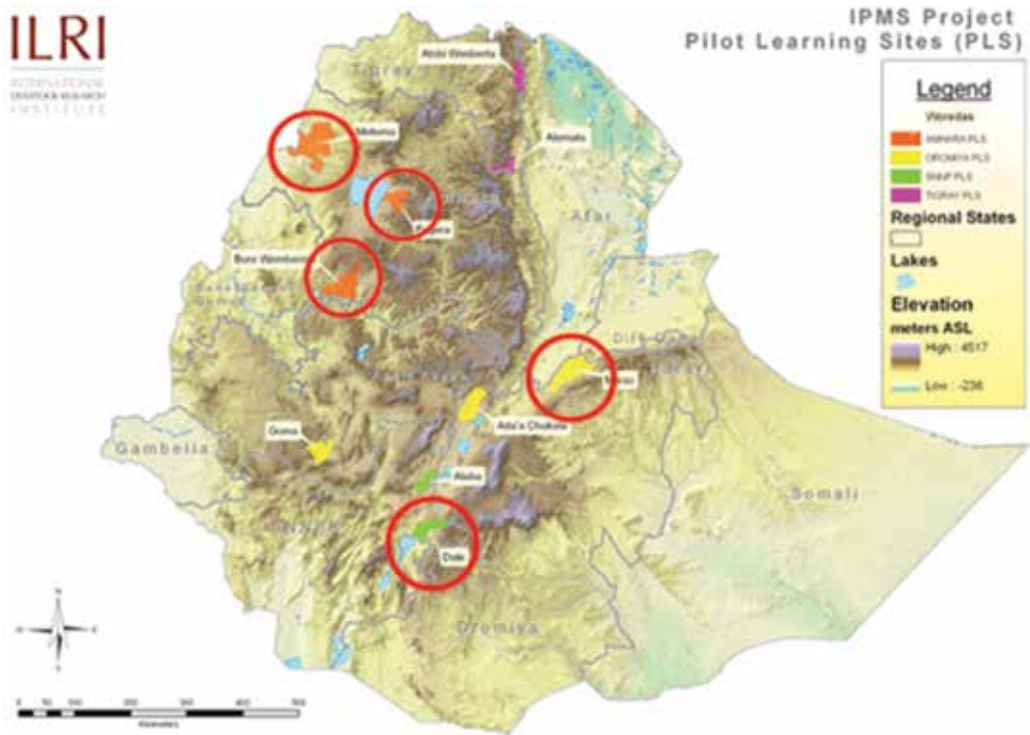
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# Annex—Pictures



IPMS Pilot Learning Woredas (PLWs) used for dairy production and marketing systems studies



Natural pasture grazed by community herd during the dry season in Metema (left) and communal natural pasture grazing land in water-logged areas of the Fogera plains (right)



Maize and grass roots used as livestock feed in Mieso (left) and green maize stover transported to Hawassa town (right) for marketing as livestock feed



Feeding chopped false banana (enset) leaves and pseudo-tuber (left) and Napier grass to local cows in Dale (right)



A wooden feeding trough for roughage and concentrate feed



Large areas of communal grazing land infested by the noxious weed *Asracantha longifolia* locally known as amykila in Fogera





Various types of supplementary feeds from by-products of traditional alcoholic drinks (atella) used to feed dairy cows



Cereal bran and oil cakes (noug cake, cotton seed cake) used to feed dairy cows



Teff being threshed using livestock and teff straw piled properly for livestock feed



Baling grass hay using a manual baler (left) and baled grass hay (right) in Metema



Burning natural pasture during the dry season in Metema



Demonstration sites on amykila weed clearance in Fogera



Community-based weed clearance campaign on communal grazing land in Fogera



Over-sowing natural pasture (left) and recovery after enclosure (right) in communal grazing area in Mieso



Pure stand of Napier grass (left) and intercropped with *Desmodium uncinatum* (Silverleaf) (right)



Napier grass grown around water harvesting structure in Mieso (left) and Desho grass (*Pennisetum spp. Pedicellatum*) in Dale (right)



Pure stand of Rhodes grass in backyards in Bure (left) and Dale (right)





Intercropping of pigeon pea with maize (left) and sorghum (right) in Mieso



Intercropping of maize with Rhodes grass (left) and sweetpotatoes (right) in Mieso



Napier grass intercropped with maize (left) and cowpea in a maize farming system (right) in Mieso



Intercropping legumes with maize in Bure (left) and integration of alfalfa in maize farming system in Mieso (right)



Tree legumes in backyard in Mieso (left) and used as wind break in Bure (right)



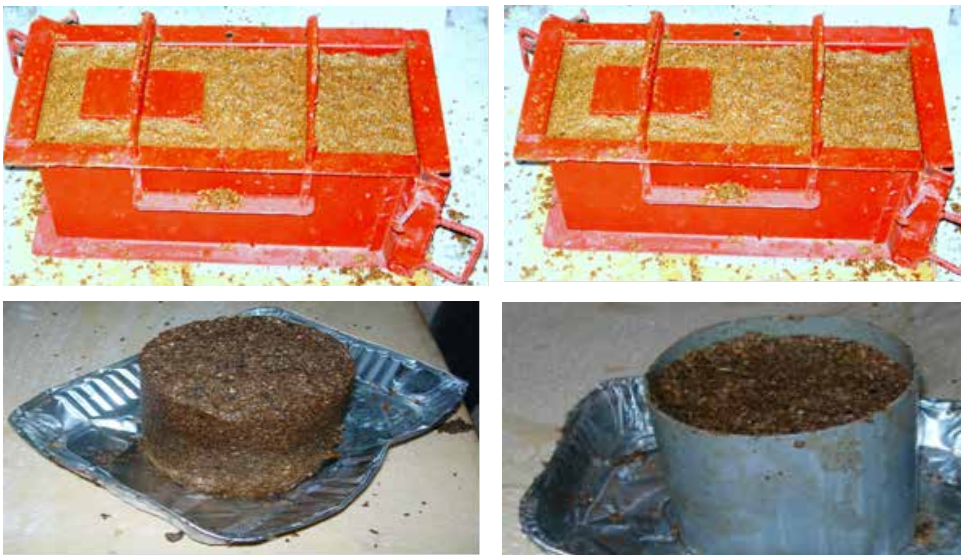
Integration of tree Lucerne in Bure (left) and Napier grass into crop farming in Mieso (right)



Pure stand of green (left) and mature (right) oats



Urea treatment of sorghum stover after chopping in Mieso



Preparations of different sizes and shapes of urea-molasses blocks in Mieso



A rural shop selling different sizes of urea molasses blocks in Mieso (left) and concentrate feed store owned by the Bure Damot dairy cooperative in Bure (right)





Various types of feeds available for dairy animals from the newly established Alema Koudijis feed plant in Bishoftu (Debre Zeit)



Sweetpotato tuber for human and beef animals and vines fed to cows in Mieso



Cut and carry feeding using Napier grass (left) in Mieso and grasses (right) in Fogera



Stall feeding crossbred cows in urban and peri-urban production systems in Dale (left) and feeding pseudo-stems of false banana to a milking cow in the Shashemene-Dilla milkshed (right)



Green grass (left) and teff straw (right) marketing



Green maize stover and Napier grass marketing



Dry maize and sorghum stover marketing



Loose (left) and baled (right) grass hay marketing



Feed marketing in Metema (left) and hay being transported on donkey carts to Hawassa town (right)



Watering points for local animals



A young girl providing water to a zebu calf in Mieso (left; note the green feed in the background) and a young boy herding calves in Metema (right)





Young local calves in the field during the wet season (left) and tethered around the homestead during the dry season in Metema



A poor housing condition for crossbred cattle at Bure (left) and a better housing condition for lactating cows (right)



Improved Boran cow used in many parts of the country (left) and a typical zebu cows used for milk production in Mieso PLW (right)



Hand milking a cow (left), a wooden milking utensil and traditional milk and milk products containers (left)



Livestock keepers proudly demonstrating decorated traditional milk and milk products containers in Mieso



A well decorated milk container used while travelling



A wooden stick (locally known as mesbekia) used to thoroughly mix sour milk (ergo) before making butter



Fresh butter produced in Fogera (left) and flavoured cooking butter (right)





Local cheese (ayib) produced in Fogera.



Marketing dried manure for fuel from rural to urban areas



Manure for use as fertilizer (left) and a biogas unit for light (centre) and cooking (right)



Transporting milk from peri-urban area to urban centre (left) and empty plastic containers on top of a bus after milk marketing (right)



Packing and transporting butter covered with leaves of false banana (enset) in Dale



Women selling milk using plastic containers originally used for cooking oil in Mieso (left) and traditional butter marketing in Dale (right)



A statue at the ILRI Addis campus depicting the important role of women in livestock production and management



Commercial concentrate feed and forage seed suppliers



Formal pasteurized milk marketing around Addis Ababa by various milk processors



Formal pasteurised milk marketing in Mekelle (left), Gondar (centre) and Hawassa (right) cities





Various brands dairy products (milk, yoghurt and cheese) in the formal market in major urban centres



Cooperative AI service (left) and private concentrate feed suppliers (right)



A rural shop for forage seed (left) and on-farm Rhodes grass seed production (right)



A cooperative concentrate feed shop (left) and a rural shop for veterinary drug supplies (right)



Community-based animal health workers (CAHWs) or paravets ready for field operations (left) and providing vaccination service in Mieso (right)



FTCs as demonstration sites and sources of forage seed and planting materials (Dale)

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