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Transhumance cattle production system in North Gondar, Amhara Region, Ethiopia: Is it sustainable?

Improving Productivity and Market Success of Ethiopian Farmers

This working paper series has been established to share knowledge generated through Improving Productivity and Market Success (IPMS) of Ethiopian Farmers project with members of the research and development community in Ethiopia and beyond.

IPMS is a five-year project funded by the Canadian International Development Agency (CIDA) and implemented by the International Livestock Research Institute (ILRI) on behalf of the Ethiopian Ministry of Agriculture and Rural Development (MoARD).

Following the Government of Ethiopia's rural development and food security strategy, the IPMS project aims at contributing to market-oriented agricultural progress, as a means for achieving improved and sustainable livelihoods for the rural population. The project will contribute to this long-term goal by strengthening the effectiveness of the Government's efforts to transform agricultural production and productivity, and rural development in Ethiopia.

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Most of the project's activities are taking place in selected Pilot Learning *Woredas* (PLWs). The smallholder farmers and pastoralists in the PLWs are expected to increase market-oriented production and productivity through the project's interventions during the project life. The project staff and partners will study this process through action research and learning. Some complementary focused studies are also undertaken by the project and its partners, which help to understand the context and determine key factors influencing the adoption and impact of the interventions. The results of all these studies and some important concepts, tools, methods and approaches developed will be published in the working paper series and will also be disseminated through other appropriate channels.

Intended users of the research outputs are government, non-governmental and private sector and donor organizations that are involved in market-oriented development. They may use these learnings in their efforts to scale out this development process to other *woredas* in the country. Some lessons learned are also expected to be relevant for possible use in market-orientated agricultural development efforts in similar contexts outside Ethiopia.

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List of abbreviations

ACBIR	Andassa Cattle Breeding and Improvement Ranch
CI	Calving Interval
AFC	Age at First Calving
AFS	Average Family Size
AI	Artificial Insemination
ANOVA	Analysis of Variance
BOA	Bureau of Agriculture
CACC	Central Agricultural Census Commission
CC	Calf Crop
CI	Calving Interval
CSA	Central Statistics Authority
DMY	Daily Milk Yield
DOARD	District Office of Agricultural and Rural Development
EJAP	Ethiopian Journal of Animal Production
ESAP	Ethiopian Society of Animal Production
ETB	Ethiopian birr (USD 1 = ETB 8.75)
E.C.	Ethiopian calendar
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization of the United Nations Statistics
FMD	Foot-and-Mouth disease
GLM	General Linear Model
Ha	Hectare
HF	Holstein Friesian
HHC	Household Count
HH	Household
HHs	Households

HU	Hawassa University
ILCA	International Livestock Centre for Africa
ILRI	International Livestock Research Institute
ILDP	Integrated Livestock Development Project (North Gondar)
LL	Lactation Length
LSD	Lumpy Skin Disease
LY	Lactation Yield
m.a.s.l.	metre above sea level
MOA	Ministry of Agriculture
NSC	Number of Services per Conception
No	Number
SE	Standard Error
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
WA	Weaning Age

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Abstract

The study was carried out in three highland *woredas* (districts) of Chilga, Dembia and Gondar Zuria in north Gondar Zone, Amhara Region, Ethiopia. These *woredas* were purposively selected because of their long experience in transhumance cattle production system. The objectives of the study were to characterize the transhumance cattle production system, identify the major constraints and forward appropriate developmental interventions for the future. Informal and formal surveys were employed to collect qualitative and quantitative data. From these *woredas*, a total of 180 representative households from 9 rural *kebeles* were selected using systematic random sampling methods. Semi-structured questionnaires and topical guidelines (checklists) were used to collect data. The results revealed that livestock production system in the highlands is characterized by mixed crop–livestock production and rainy season transhumance production system. Transhumance production system was practised mainly into the lowland areas. The major reasons why cattle were trekked to the lowlands were availability of feed (99.2%), free land for stocking (92.4%), low disease risk (25.0%) and availability of non-waterlogged areas (0.8%). Preferred locations were Metema (84.0%), Armachiho (9.6%), and Quara (4.0%) *woredas*, while very low percentages considered Alefa and Chilga *woredas* (0.8% each). The months when cattle movement started were May (69.5%), June (29.6%) and April (0.8%), and the months of returned home were October (45.8%) and September (35.9%). Three major cattle trekking routes were identified, and the selection of routes depended on distance, availability of forage and non-crop covered areas. The first destination is Agamwuha *kebele* (Lemlem Terara) in Metema district, irrespective of the routes followed. About 60.3% of the cattle population of the three *woredas* was trekked to the lowlands during the rainy season. The number of cattle owners and the size of cattle population involved in one group were 4.3 ± 0.18 farmers and 58.8 ± 3.89 heads, respectively. The average daily milk off-take, lactation yield and lactation length of indigenous cows in the three studied areas was about 2.0 ± 0.07 litres, 540 ± 21.05 litres, and 8.9 ± 0.16 months, respectively. The mean age at first calving (AFC) and calving interval (CI) was 5.2 ± 0.30 years and 19.0 ± 0.38 months, respectively, while mean calf crop was 7.4 ± 0.47 heads. The average weaning age of calves was almost one year, being 11.6 ± 0.26 months. In the lowlands, milking, butter making and selling of dairy products were performed only by male herders. In the highland areas, butter (95.6%) was one of the most important saleable dairy products followed by raw milk (18.4%), fermented milk (*ergo*) and buttermilk (6.1%). However, during the transhumance period, butter (95.3%) was the major marketable commodity followed by raw milk (61.3%), buttermilk (18.9%) and fermented milk (14.2%). Highlanders also market dry cows, oxen, heifers and young bullocks during their stay in

the lowlands. The major constraints identified by the highlanders were conflict with the lowlanders, cattle theft, human and livestock diseases, and lack of markets. Most of the respondents (86.3%) estimated that the trend of transhumance has been increasing due to feed shortage (50.4%), expansion of crop cultivation (27.4%) and increasing cattle population (21.2%) in the highlands. Human population has also been increasing both in the highlands and lowlands, and the current infrastructure development in the lowlands (tarmac road, electricity, phone etc.) will further encourage more migration to the lowlands. The conflict over resources will intensify, probably leading to the demise of this production system unless alterative development strategies, such as intensification of the production system in the highlands and development of feed conservation and marketing in the lowlands are devised.

Key words: Transhumance, Cattle Production System, North Gondar, Ethiopia.

1 Background

Livestock production systems all over the world can be divided into four major categories: transhumant, agro-pastoralist, intensive crops and livestock, and peri-urban intensive systems. In addition, there are a few not-so-obvious livestock systems. 'Pure' nomads or transhumant do not have fixed settlement, but move between established territories and pastures. They are more common in Africa's arid and semi-arid regions than anywhere else. In Asia, they are found in India, Afghanistan, Pakistan, Iran and in the countries of the Arabian Gulf. In most countries, their population is relatively small in number, but they are well integrated into the local economy. For example, they make up only 2.2% of the population of Iran, but supply a major portion of the meat, wool and dairy products to the country. In Latin America, they are restricted mainly to the high-altitude zones of the Andes. For example, about three-quarters of the alpacas and half of the sheep raised by Peruvian peasants in the southern part of the country are owned by transhumant that live in the high altitudes (International Conference on Nomadism and Development 1992).

There are essentially two forms of pastoralism namely, nomadism and transhumance. Pastoral nomads follow a seasonal migratory pattern that can vary from year to year. The timing and destinations of migrations are determined primarily by the needs of the herd for water and fodder. These nomadic societies do not create permanent settlements, but rather they live in tents or other relatively easily constructed dwellings the year round. On the other hand, transhumance pastoralists follow a cyclical pattern of migrations that usually take them to cool highland valleys in the summer and warmer lowland valleys in the winter (Pamo and Pieper 2000).

Transhumance production system consists of a seasonal displacement of flocks from one area to another by herders who have permanent residences in search of better or suited grassland. It can be considered either as the next phase from the nomadism system towards a complete settlement or as an elementary form of the seasonal suitability or seasonal grazing system involving partitioning a rangeland into separate units on the basis of vegetation types. In general, mechanisms of transhumance are simple, in search of pasture and water (Pamo and Pieper 2000).

There are two types of transhumance cattle production systems in Africa: the dry season and rainy season transhumance (Pamo and Pieper 2000). Various motivations cause these movements especially that of the rainy season. Dry season movement is the most important due to lack of forage or water or both. Rainy season displacement is complex due to multiple reasons. Arabic herders of the Makari around Lake Chad migrate to

Nigeria where they remain during the wet season because of disease-bearing organisms such as tsetse fly or floods. They return when the wet season is over. In the Diamare division in North Cameroon, many herders move to the southwest because most of this division is under cultivation during this period and it is difficult to keep animals out of the farmlands.

Ethiopia is a tropical African country in which mobile pastoralism is dominant in the arid and semi-arid areas in the eastern, northeastern and southeastern parts of the country, while agro-pastoralism represents an increasing practice in the semi-arid areas in the northwestern, southern and eastern parts of the country. In general, they represent the major pastoral constituency in the Horn of Africa (Amaha 2006).

Ethiopia can be broadly divided into highlands (39%) and lowlands (61%) using 1500 metres above sea level elevation as a crude threshold. While the highlands typically have higher annual rainfall than the lowlands, this is not always the case. The highlands are characterized by relatively low mean temperatures during the growing period (Jahnke 1982). The highlands have climates that vary from semi-arid to humid (i.e. sufficient moisture for 90 to over 270 growing days per year) and contain nearly all of the important areas for cereal cultivation and mixed crop–livestock enterprise (Westphal 1975). By contrast, the lowlands are dominated by arid to semi-arid climates (i.e. up to 180 growing days and 700 mm of precipitation per year). The lowlands are home to a diverse array of pastoral people who depend to a high degree on livestock for their sustenance. These livestock, in turn, depend nearly exclusively on native vegetation for forage, and net primary production is highly variable over time and space. The lowland regions that support wildlife and extensive livestock operations on native vegetation can also be referred to as rangelands (Pratt and Gwynne 1977).

North Gondar is one of the Zones in the Amhara Regional State, which comprises highland and lowland agro-ecologies. Sedentary (mixed crop–livestock production) and mobile livestock production systems are practised in the Zone (ILDP Preliminary Field Report 1996). The former is commonly known in the highlands; while the latter is widely practised in the lowlands of the country. In the case of North Gondar Zone, both systems are practised in the highlands as well as in the lowlands. Among the lowland *woredas* of North Gondar Zone, Metema *woreda* is the main *woreda* that accommodates seasonal movement of the herds/flocks from the neighbouring highland districts. According to experts in the Metema *woreda* Office of Agriculture and Rural Development, seasonal movement of livestock has been practised in the area for a long time by the highlanders. Predominantly, farmers from three adjacent *woredas*, namely, Chilga, Dembia, and Gondar Zuria, seasonally move their cattle population to Metema (i.e. May to October and some times up to January) in search of feed.

According to ILDP Preliminary Field Report (1996), transhumance production system is a way of life for millions and has survived through many generations. The highlanders always moved their cattle to the neighbouring lowlands during the rainy season (*Kirat or Kabiro*) and to the highlands during the dry season (*Toka*). In recent years, however, it has been observed that transhumance production system has been declining mainly because of human population growth, increasing crop cultivation, increasing settlement activities, and conflicts in the lowlands.

There is limited understanding of this production system and the extent and implications of herd mobility in the life of a vast majority of the highlander farmers. Characterization of this system as one of the cattle production systems practised in the Zone will help to clearly understand the socio-economic implications and to design appropriate development interventions for the area. Therefore, this study was conducted with the following objectives:

- To characterize the transhumance cattle production system and assess the causes of mobility to the lowland areas
- To identify the major constraints of the production system and
- To forward appropriate developmental interventions for the future.

2 Literature review

2.1 Major livestock production systems

In most African countries, the livestock subsector comprises several or all of the following major small and large-scale production systems: (1) small-scale: pastoralism, agro-pastoralism, transhumance and mixed smallholder farming. (2) large-scale: ranching, large-scale commercial farming, co-operative farming, and state farming (ILRI 1995).

2.1.1 Pastoral production system

Pastoralism in Africa is practised predominantly by small family units. Herds and flocks are raised that vary considerably in size, from a few sheep and goats in the poorest families to many hundreds of cattle and/or camels in the wealthiest. The size of the herd/flock determines the share of feed resources obtained from pastures grazed communally under an open access or common property tenure system characterized by mobility (nomadism or transhumance) as a survival strategy (de Leeuw 1983**).**

In the lowlands of Ethiopia, pastoralist production system with no or little farming is practised and cattle and camels are kept to provide mainly milk. The climate in these areas is characterized by low, unreliable and unevenly distributed rainfall and by year round high temperatures. Animal production often concentrates around water points and herd size per family is usually large.

2.1.2 Agro-pastoral production system

Agro-pastoralism in Africa is carried out by pastoral families or their descendants who have, to varying degrees, settled and taken up cropping. Often inhabiting dry areas where cropping is a high-risk enterprise, agro-pastoralists live under conditions resembling those of the subsistence-oriented smallholder farmers. Apart from ethnic differences, the only major difference between the two groups in terms of production is the emphasis on livestock, which will be greater among agro-pastoralists, who frequently retain some degree of mobility as a survival strategy (ILRI 1995).

Cattle and cropping are complementary enterprises in the agro-pastoral system. Cattle provide milk, meat, draught power and manure. As in the pastoral community, large herds are a repository of savings and confer status and security on the owner. On the other hand, crops provide residues, which are used to feed cattle in drier periods of the year.

Cattle and small stock play a critical role in the agro-pastoralist household economy. Thus, their accumulation is sought. Unfortunately, as with pastoralists, such behaviour has resulted in serious overgrazing and overstocking of grazing lands in these regions. One result is poor average herd performance (Solomon et al. 1991).

2.1.3 Transhumance production system

Transhumance can be defined as 'a system of animal production characterized by seasonal and cyclical migration of varying degrees between complementary ecological areas and supervised by a few people, with most of the group remaining sedentary' (www.oecd.org/sah). Also the term 'transhumance' refers to regular seasonal movements of livestock between well-defined pasture areas (dry to wet season, or low to highland). It can cover a wide range of pastoral production systems, ranging from fully transhumant systems (such as among the northern Mauritanians and Namibians) to systems such as used by the Nilotic tribes of east Africa, the Berber of the High Atlas and herders in Morocco and Ethiopia. Transhumance also applies to settled populations who send their livestock short distances to pasture, such as in Zimbabwe. All these systems have several elements in common: (1) they rely on common property (pastures, forests and natural waters), (2) they normally occupy arid lands with less than 400 mm of annual rainfall, and (3) mobility is managed by herders, rather than by fencing (Niamir 1999). According to Pamo and Pieper (2000), there are two types of transhumance in Africa: the dry season and rainy season transhumance; and various motivations cause these movements, especially that of the rainy season.

Causes of wet season transhumance

Rainy season displacement is complex and there are multiple reasons for this. Arabic herders of the Makari around Lake Chad region migrate to Nigeria where they remain during the wet season because of disease-bearing organisms such as the tsetse fly or floods. They return when the wet season is over. In the Diamare division in North Cameroon, many herders move to the southwest because most of this division is under cultivation during this period and is difficult to keep animals out of the farmlands (Pamo and Pieper 2000).

A special situation is also reported from Cameroon where transhumant movement occurs in response to topographical conditions. During the rainy seasons, the lowland plains become flooded restricting grazing to the plateau areas. As the dry season progresses, the quality of the grasses on the plateau declines and the animals are brought down to lush pastures on the flood plains (Stenning 1959). Similarly, in Nigeria, Stenning (1959) has

documented the carefully planned and slow movement patterns towards the Niger and Benue flood plains, to exploit produce exchange with sedentary farmers. Their move back to their wet season grazing area is dictated as much by disease avoidance (tsetse) as by the urge to be home for the first rains to plant millet and sorghum. The reverse is true for pastoralists living in Submontane areas like the Jos and Mambilla plateaus. Despite the favourable conditions for farming and trade on the Jos Plateau (due to a dense population employed in tin mining and other urban-oriented employment), the dry season move away from the plateau season southwards to thinly populated areas is an escape strategy to avoid over-grazing.

Avoidance and attraction are strongest for the Fulani in the Mali Delta. In this area, they have their permanent homes (in contrast to most other transhumant pastoralists who reside in their wet season grazing areas), their flood retreat rice farms, which they cultivate during the dry season with oxen from their own herds. During the same period they constitute itinerant (mobile) milk herds to travel around sedentary communities, providing milk in exchange for grain, securing instant movement of produce back to their villages by accompanying transport oxen. Their long-distant move away from their home base can better be termed an avoidance strategy than a movement dictated by the attractions of the upland pastures in Mauritania. The hazards of flooding which increasingly limit access to range resources combined with an increasing nuisance of biting flies, make the Delta inhabitable for stock. This has been shown by the low productivity of resident milk cows that are kept to feed home-resident pastoralists (Diallo 1983).

For many herders, the essential reason to change grazing orbits is to ensure access to better range resources in terms of quality and diversity. Twareg and Woodabe herders in Niger maintain that a semi-annual change of grazing location is beneficial to their stock. Moving north, higher quality forage and different species mixtures are obtained in particular for small ruminants and camels (Maliki 1982).

Causes of dry season transhumance

Dry season movement is the most important due to lack of forage or water or both (Pamo and Pieper 2000). According to Stenning (1959), as the dry season begins (October to end of December), the Fulani move their cattle down the valley of the Sokoto River, stopping along the way to graze crop residues from newly harvested fields. Those Fulani who practice cultivation then return to their own plots, while the others keep their cattle on the fields surrounding local villages in return for token gifts. As the main dry season continues, they tend to move their herds onto the flood plains, where their shelters are

simple windscreens. By January, they reach their dry-season grazing areas on the Gulba plains. Here, the camps are situated near sources of water, rather than near grazing, and the cattle have to travel long distances from the camps to their pastures, losing condition in the process. The grazing periods are interrupted, generally twice a day, to take the cattle back to be watered. As the dry season continues, the animals are dispersed in small herds to take the fullest advantage of the remaining grazing.

According to Stenning (1959), a pattern of transhumance occurs among other Fulani groups of the same lineage. These pastoralists move north during the dry season, digging shallow wells in the bed of the Gana river. When new grass is reported in the wet-season grazing area, they move back south. Transhumant patterns have been documented in some detail for the Wandu Fulbe of Nigeria, who move south to the flood plains of the Sokoto river and beyond during the dry season and return north during the rains. The distance covered during the average transhumant cycle is about 240 km, with approximately one-fourth of the groups moving over 320 km. The groups move according to certain seasons. During the wet *'dungu'* season (July to end of September), scattered pastoralist households come together to form larger camps. The rains begin during *'seeto'* (early May to June). When planting begins, the herds are moved away from the cultivated areas. Those Fulani who practice agriculture keep their animals nearby until after the millet harvest, while the more mobile Fulani start moving immediately towards the northern wet-season grazing area.

2.1.4 Crop and livestock production system

Mixed farming systems

Mixed farming systems are understood to exist where both livestock and crop production take place within the same locality, and where ownership of crops or land and livestock are integrated. However, where specialized livestock production takes place in the same locality as crop production, subject to resource sharing (e.g. grazing of residues), but under separate ownership, such systems may be included. Such flexibility is necessary because of the variety of arrangements that exist covering access to ownership, and management of land and livestock.

Highland livestock

Here, animals are part of a mixed subsistence farming complex. Animals provide inputs (draught power, transport, manure) to other parts of the farm system and generate consumable or saleable outputs (milk, manure, meat, hides and skins, wool, hair and eggs). The primary purpose of cattle keeping in most of the highlands is to produce oxen.

The low rates of reproduction and milk production of indigenous cows, both of which are directly influenced by nutrition levels throughout the cows' production cycles, result in low overall levels of conversion efficiency of feedstuffs into draught power. Draught power is the primary product of cattle enterprises. Farmers keep up to ten cattle to produce and maintain the pair of oxen conventionally used for cultivation (Gryseels and Getachew 1985).

In spite of their poor productivity, cattle play a very important role in the livelihood of the majority of people in the rural areas of the mid-altitude and lowland zones of Ethiopia. In mid-altitude areas where crop production is the primary occupation of the farming community, they are used as a source of power to cultivate farm. They also provide the main source of animal protein in the form of meat and milk. In this zone, cattle are a form of saving or investment readily converted into cash when the need arises. So, they contribute an important share of farm income (Legesse et al. 1987).

In the highlands of Ethiopia, livestock provide about 53% of the value of the total farm output (again excluding the value of draught power) and more than 80% of farmer's cash income (Gryseels and Getachew 1985). Draught power, notably in the central highlands, is a critical input, worth a great deal of value and playing a pivotal role in the prevailing traditional mixed farming system. Cattle manure provides an important fraction of domestic fuel needs in areas with limited fuel-wood supplies. Manure sales make significant contributions to cash incomes. Meat and milk are relatively less important products of cattle enterprises. In some farming systems, such as in western Shoa, selected fields are intensively manured by livestock penned overnight in the fields. However, little of the animal manure produced in the country is used intentionally as fertilizer for crop production (Gryseels et al. 1984).

Farmers keep sheep and/or goats as producers of cash and meat. The high rates of flock growth, relative to cattle herds, and the different grazing behaviour of small ruminants make them appropriate complements to cattle through most of the Ethiopian highlands. Small ruminants are the best stock to be sold in times of crop failure. They seldom receive special feeds and often are grazed together with cattle.

Livestock are also a major source of cash income. In large parts of the highlands, the sale of livestock and livestock products provide up to 80% of farm cash income in a normal year (Gryseels and Getachew 1985). In summary, livestock produce a range of intermediate and final products in the traditional farming systems of Ethiopia. Regional differences exist in the relative importance of these products, but in all the cases, the presence of livestock on smallholders' farms enables them to be more productive and stable over time than would be the case in their absence (Rodriguez and Anderson 1985).

Lowland livestock

Where animals are kept by pastoralists they do not provide inputs for crop production but are the very backbone of the life for their owners, providing all of the consumable saleable outputs listed above and, in addition, representing a living bank account and form of insurance against adversity (Alemayehu 1985). In the lowlands, the livelihoods of the pastoralists wholly depend on the milk obtained from cattle, goats and camels. Here also they are used as source of income (Legesse et al. 1987). In the lowlands, pastoralists derive well over 90% of their cash income from livestock (Anteneh 1989).

Crop–livestock interactions

Crop–livestock production systems are land-use systems in which livestock husbandry and cropping are practised in association. This association may be close and complex or livestock husbandry and cropping may be parallel activities without interaction, possibly not even belonging to the same management unit.

Crop–livestock interactions are few in the humid zone because animal diseases and cropping patterns based on root crops discourage animal production. Interactions become more frequent and more intense in the subhumid and semi-arid zones. The interactions are based on using animal traction, manure (in cropping) and crop residues (as livestock feed). Interactions are most frequent in highland zones, where cereals are the major crops grown. Interaction in the highlands involves intensive milk production, animal traction, manure production and sown fodder crops (Jahnke 1982). The higher the population pressure and the cultivation intensity the more value is placed on manure.

Livestock ownership is valued by farmers because it offers the following utilities: (1) investment capital, available for use in contingencies, relatively divisible; (2) individual wealth creation (including for women); (3) recurrent income (milk, meat and other products); (4) manure; (which, if supported by on-farm fodder, re-cycles nutrients at lower cost than inorganic fertilizers); (5) energy (traction, transport); and (6) productive uses for farm residuals (crop residues, browse, weeds, boundary plants, uncultivated grassland).

2.2 Feed resources in Ethiopia

The major livestock feed resources in Ethiopia are (1) grazing and browsing on natural pastures; (2) crop residues and agro-industrial by-products; and (3) cultivated pasture and forage–crop species (Alemayehu 1985).

2.2.1 Natural pasture and browses

Availability and quality of native pastures vary with altitude, rainfall, soil type and cropping intensity. The total area of grazing and browsing in Ethiopia is estimated at 62,280 million hectares, of which 12% is in the farming areas (more than 600 mm rainfall) and the rest around the pastoral areas (Alemayehu 1985).

Natural pastures which provide more than 90% of the livestock feed are very poorly managed in both ecological zones in Ethiopia. In the mixed farming mid-altitude areas, better soils are used for cropping and the main permanent natural pasture lands are found on the upper slopes of hills and seasonally waterlogged areas. In the lowlands where pastoralism is practised most of the land except for rivers, swamps, lakes and deserts contains natural pasture which may be associated with woodland in the wetter areas.

Considering the country as a whole, grazing lands contribute 53% of the total land area. Even though the amount of grazing area seems to be large, the yield and quality of the pasture is very low. Due to poor management and overstocking, natural pastures in both ecological zones are highly overgrazed resulting in serious land degradation, loss of valuable species and dominance by unpalatable species (Alemayehu 1985). In subhumid mid-altitude areas, natural pastures are dominated mainly by *Hyparrhenia* species, which tend to grow fast and become stemmy and fibrous within short period of time thus losing their palatability and feed value. In these areas, the overgrazed pastures are dominated by unpalatable *Sporobolus* and *Pennisetum* species. Herbage growth is luxuriant during the wet season and this gives large bulk of herbage during the dry season, which is burnt to encourage re-growth in subsequent rains. In semi-arid mid-altitude zones, rainfall is the major factor influencing primary productivity (Alemayehu 1985). Because of diversity of climate, a number of forage species, mainly grasses are found in both ecological zones. Natural grasslands of the highland areas are rich in legume species, while grasslands of the mid-altitude and lowland zones have lower proportion of legume. The proportion tends to decrease with decrease in altitude. The less abundant native legumes of the lower altitude have sprawling growth.

Grazing environments

Transhumance herding practices involve human control of both livestock access to plant communities within a given landscape and herd movement across landscapes to remote areas with seasonally limited forage supplies. Man exerts control over the nutrient acquisition process in these situations through constant observation of the grazing process coupled with knowledge of remote forage conditions far beyond the senses of the animal. Pastoral systems in fragile, highly variable ecosystems minimize risk to both livestock

and human populations by maintaining access to large areas of diverse landscapes and moving the stock to the best forage conditions throughout the annual forage production cycle.

Where human populations gather into permanent villages and physical land-use boundaries are ill defined, herding is required to prevent crop damage by livestock and to physically control forage utilization in the surrounding landscape. Decisions concerning intra-landscape plant community access by animals become more critical than in transhumance systems to prevent overuse of the geographically limited forage supply.

2.2.2 Crop residues

Cereal straw from teff, barley and wheat is the largest component of livestock diet in the intermediate and highland areas of Ethiopia. Straw is stacked after threshing and fed to animals during the dry season, as are pulse–crop residues (e.g. horse beans, chickpeas, haricot beans, field peas and lentils). At lower altitudes in the highland areas maize, sorghum and millet stovers occur to a greater extent than at higher altitudes. Teff is grown at intermediate altitudes and barley replaces wheat at the higher altitudes, where pulses are also grown to a great extent. The nutritive value of teff straw is equivalent to medium-quality hay and the residue of other cereal crops is only of poor to fair quality. On the other hand, pulse haulms are high-quality roughage with 5–8% protein content (Alemayehu 1985).

2.3 Conflict and risk managements

2.3.1 Conflict management

'Conflict management' is a term used to refer to both conflict prevention and conflict resolution (Cousins 1996). Conflict prevention is possible through development and enforcement of rules over natural-resource use, collective acceptance of such rules, and continuous negotiation of conflicting demands. The principles upon which conflict resolution are based include dialogue, consensus, facilitation, reconciliation, arbitration, mediation, and adjudication (Pendzich 1994).

According to Niamir (1999), environmental variability results in a high degree of conflict and competition among groups of land users, particularly during years of drought and shortage, or because of economic and political gain. In the past, conflicts were either resolved through customary resolution mechanisms, such as elders' councils and tribunals, or through warfare. The main objective of conflict resolution in a traditional system is not so much to restore the patrimony of the individual, but to restore stability and social cohesion. In the case of internal conflicts, customary judges attempt to

maintain a precarious balance between the interests of the individual and the needs of the community. They did not necessarily follow 'precedence' or a host of detailed legal texts and rules, but enjoyed considerable liberty in shaping each decision to the needs of the situation, using a few grand cultural principles or religious codes recognized by the social group (Ouedraogo and Rochette 1996).

External conflicts, i.e. inter group conflicts in the past were resolved either through mediation of a neutral ethnic group, or through the creation of an *ad hoc* 'parliamentary' body. For example, conflicts among the different ethnic groups are mediated by a group of men and women who have intermarried into each group, thus representing a relatively neutral body with vested interest in keeping the peace (Bond and Meier 2006). If external conflicts could not be resolved peacefully, war was the last recourse.

In recent times, the adoption of modern codes of law in Africa has not only perturbed the functions of the customary system, but has favoured sedentary modes of production over mobile ones. This is not only because of a cultural bias, but also because of the fact that sedentary rights can be more easily quantified: they have definite boundaries, are fixed in space and time, and produce easily measurable products per unit area (crops) for the purpose of calculating compensation. Those using the recent community-based natural resource management approach have also spent considerable energy on developing appropriate conflict-resolution mechanisms to fill the gap left by disintegrating customary systems (Bond and Meier 2006).

2.3.2 Risk aversion

Traditional strategies against losses

Pastoral adaptation to arid and semi-arid areas is based on a wealth of comprehensive and deep indigenous knowledge about the environment in which they live and the various risks it involves. They know the phases of the moon and its relation to rainfall, the quality and capacity of the watering points, pasturelands and the nutritional value of different grasses (UNDP 2002). According to the same report, their risk management and spreading techniques include: (1) diversification of animal species (cattle, camels, sheep and goats) each with its own needs and management systems so as to make use of the different ecological niches, (2) separation of livestock holdings into spatially separate units and places, and (3) mutual help, cooperation and joint movement, especially, if the herd of an individual within the tribe strayed or was stolen.

During their transhumance movements, pastoralists take with them veterinary drugs for the health care of the animals. Ownership of veterinary drugs is a priority after grain and sugar. They have considerable indigenous technical knowledge about symptoms of

animal diseases and drug use. For example, cattle owners often burn dung cautiously to repel insects and biting flies as part of disease control measures (UNDP 2002).

Traditional sanctions and penalties

Traditionally, pastoralists should notify the Sheikh or Omda before entry of animals into the area to take the necessary precautions for safe passage of the animals between the agriculture lands. In case of livestock deviation from the route and causing of damage to the adjacent farms the pastoralist should pay compensation to the owner of the farm. The payment is in terms of cash or kind (animals). The value of compensation was traditionally determined by village committee headed by Omda or Sheikh and is based on (1) scale of crop damage, (2) crop stage of growth, (crops about to be harvested have higher compensation value), (3) price of the crop at the time of damage, (4) number of animals which entered the farm, and (5) the presence of the herdsman inside the farm. This is considered as an indicator of whether the practice of violations is intended or not; if intended the compensation is usually high. If the herdsman exerted an effort to drive the animals outside, the compensation paid is lowered (UNDP 2002).

If the livestock owner apologized, that will also be considered and he may receive a deduction of up to 50% of the total amount to be paid as compensation. He usually supports his apology by saying that animals are herded by boys who are young, immature, and ignorant of the rules that govern livestock movement in the routes and do not respect the elders. In some pastoral communities of Africa, the situation is largely changing, and going to the court rather than tribal chief is becoming the rule.

2.4 Transhumance routes

The transhumance route is a confined area of land, with some trees, grazing resources and water points surrounded on both sides by agricultural land where crop farming is practical during the rainy season. The routes followed are traditional and customary, known and agreed upon by the native customary administration system, with intervention from the local governments in cases of violations that lead to confrontations and conflicts between the groups sharing the resources.

The routes are usually demarcated by marks or pegs that are known to both the pastoralists and the resident farmers. These marks are either (a) tubular iron of 4 inches diameter buried deeply into the ground. The exposed length over the ground is about one metre painted in black and white to be seen clearly by the herdsmen, or (b) big trees painted in white on the stem, about two metres from the ground, which can easily be seen and recognized by pastoralists.

Overall, wet grazing areas have desirable characteristics, which are: (1) proximity and accessibility to roads and transport routes, (2) closeness to permanent villages and accessibility to large towns, and (3) location near or along the railway line or railway stations as in most cases (UNDP 2002).

2.5 Marketing of milk and milk products

There are three major land-based systems producing milk in sub-Saharan Africa (SSA), pastoralists, agro-pastoralists and crop–livestock farmers (Walshe et al. 1991), representing a descending scale of cattle wealth and therefore potential milk off-take. Household demand and market access determines actual off-take, which ranges from near zero to 500 kg per lactation (de Leeuw and Thorpe 1996). Thus, market participation and cattle density are the main determinants of milk supply, which varies from 2500 to only 80 kg/km^2, the latter in areas where farmers rarely milk their cows and/or cattle density is low. However, supplies rise to 64 tonnes of milk/km^2 in the densely populated highlands of Kenya, where farmers keep high-grade dairy cattle producing 820 kg/head per year (Peeler and Omore 1997).

An example of pastoralist systems is that practised by the Maasai in the sparsely populated semi-arid rangelands of Kenya. The Maasai live in extended families (10–15 people) with herds averaging 100–170 cattle and as many sheep and goats (Solomon et al. 1991). They produce and consume about 0.85 kg of milk per person per day, while the sale of livestock is the main source of income. As few grow crops, most foodstuffs are purchased. Milk surplus is shared with neighbours or exchanged in barter, but is rarely sold except by households living close (<5 km) to main roads and urban centres where there is demand for fresh and fermented milk and butter (Solomon et al. 1991).

Similar pastoral systems are found in Southern Ethiopia. Working among the Borana, Holden and Coppock (1992) reported that the frequency and amounts of dairy products traded depended on herd size and distance to the market: butter replacing liquid milk with increasing distance and women from households with large herds trading more often. Butter was sold to lorry drivers and bus passengers *en route* to Addis Ababa, some 500 km away.

A contrasting pastoral system is practised in the Gambia by herders, pastoralists who act as managers of communal herds, the cattle of which are entrusted to them by local farmers who each own a few head. Sale of milk is the major part of the herder's income, cows and calves are well managed and milk off-take per cow is > 400 kg per lactation,

or 40% above the yields in family herds of agro-pastoral communities living in a similar environment (Itty et al. 1993).

Increasing numbers of agro-pastoralists are found in sub-humid West Africa, where, for example in Nigeria, small groups of Fulani live among indigenous smallholder farmers, who keep small ruminants rather than cattle. Most Fulani crop small fields of 1–2 ha, earning their living mostly from sales of milk and live animals; although in Côte d'Ivoire some have become settled farmers growing cotton as a cash crop (Itty et al. 1994). Being the main supplier of milk in rural and often to urban areas, diverse trading patterns have evolved. In well-populated areas in Nigeria, for instance, Fulani women head-load 3–5 kg of milk to nearby villages, home delivering milk to their regular customers and selling any remainder on the local market at distances of 2–10 km (Waters-Bayer 1988). Depending on transport infrastructure, women may trade larger quantities, usually bulking up front neighbours and friends.

2.6 Smallholder milk processing

In the highlands of Ethiopia, milk produced by smallholders is used for family consumption. For butter making, milk is collected over a period of three or four days in a clay pot. When the milk has soured and sufficient milk has been collected, the clay pot is shaken back and forth until butter granules are formed. This method of butter manufacture may take from two to three hours, depending on such factors as temperature, the fat content of the milk, the acidity of the milk and the amount of milk in the clay pot. The time taken to make the butter together with the time involved in taking this butter to the market place is a considerable drain on the already limited time of the smallholder, or specifically on that of his wife and family (O'Mahony and Ephraim 1985; Zelalem and Inger 2000).

To reduce the time for processing the milk into butter and to improve the efficiency of the process, ILCA developed and modified a wooden internal agitator that can be fitted to the usual clay pot used by the smallholder. The use of this internal agitator has been shown to reduce churning time from an average of 139 minutes to an average of 57 minutes (59 churnings) while reducing the fat content of the buttermilk from an average of 1.1% to an average of 0.36% (O'Mahony and Ephraim 1985; Zelalem and Inger 2000). The buttermilk remaining after the butter is separated from the whole milk and is used to produce a cottage-type cheese (*ayib*) by heating the buttermilk and separating the coagulated fat and protein from the whey.

2.7 Constraints and opportunities of mobility

2.7.1 Opportunities of livestock mobility

Livestock mobility is one of the major ways in which African pastoralists have historically managed uncertainty and risk in arid lands (Bassett 1986). The literature evidence on other adaptive mechanisms includes herd diversification, stratification and drought-buffering mechanisms. According to Niamir (1999), mobility can address socio-economic objectives, such as access to a diverse range of markets, symbiotic interactions with farming communities (for example, exchanging manure for feed) and adaptive tool that serves several aspects of livestock production simultaneously. One benefit is the provision of fodder to livestock at minimal labour and lower economic cost. Extensive livestock-production, taking livestock to feed and water, is less costly than bringing feed and water to livestock, because of lower labour demand, and lower inputs (for example, housing and troughs).

Mobility (and the other side of the coin, dispersion) have been correlated with increasing the resistance of animals to diseases, and decreasing their vulnerability to outbreaks (Roeder 1996). Since the productivity of arid ecosystems is spatially and temporally variable and to a large degree unpredictable, mobility enables the opportunistic use of resources. This includes moving to minimize the effects and impacts of droughts, and being able to use underused pastures distant from settlements, or those that are only seasonally available.

de Haan (1998) described that the symbiotic relationship between peasants and Fulani pastoralists, including the bartering of goods, services as well as ways of sharing space, ensured the best living conditions in the fairly capricious, sub-humid and semi-arid climate. After the crop harvest, the cattle browsed the stubble-fields. Herds/flocks stayed overnight on request of a peasant on certain fields, depositing large quantities of dung, thus manuring the field. The peasant paid some cereals in return for this service.

There is evidence that in some areas under grazing of remote pastures, as a result of sedentarization, is a more serious problem than overgrazing (Galaty 1988). For example, biosphere (vegetal zones related to watering points) studies around agro-pastoral villages in northeastern Senegal showed that under grazing of distant pastures results in lower palatability of primary productivity, lower phosphorus content of topsoil, lower herbaceous density, and lower biomass production (Niamir 1987).

Various studies have shown that mobile production systems in Africa appear to be more economically efficient than sedentary systems, even more than commercial ranching.

If flexible access to different habitats and resources is ensured, higher populations of herbivores can be maintained in any given area (Westoby et al. 1989). For example, studies in Zimbabwe, Botswana, Uganda, and Mali show that overall returns per hectare (counting all products, not just meat) are higher in mobile pastoral systems than in agro-pastoral or commercial systems (Sandford 1983).

Traditionally, range improvement techniques relied on fire (Ware 1977); modifying the grazing behaviour, and therefore the animal–plant relationship; and changing the herd composition. For example, goats were used to control bush land (Legesse 1984). Many transhumant groups had range reserves that were used as fodder banks for bad times, or as deliberate enclosures for ensuring spontaneous regeneration (Odell 1982). None of these techniques is feasible unless herds are mobile. Mobility is an effective tool for range improvement, as it provides the herder flexibility to modify herds, and access to alternative pasture areas, while waiting for spontaneous regeneration of degraded pastures.

2.7.2 Constraints to livestock mobility and its impact on pastoralists

Increased and continuous grazing around settlement areas results in reduced vegetation and biodiversity and enhanced soil degradation. At the same time, lower grazing pressure in distant pastures results in an invasion of unpalatable plants. Settlement also results in a loss of traditional knowledge about and controls on range use, leading to less efficient management of the arid resources (Jacobs 1980). According to de Haan (1998), expanding cultivation exerts conflicts with farmers due to damage to crops and disappearing passages to grazing areas and watering points.

3 Methodology

3.1 Description of the study area

This study was conducted in four *woredas* (districts) of North Gondar Zone of the Amhara Region. These were composed of three highland areas represented by Chilga, Dembia, and Gondar Zuria *woredas* and one lowland *woreda*, represented by Metema (Figure 1). Chilga *woreda* is located west of Gondar town, 60 km on the way to Metema. It is situated south of Lay Armachiho, and west of Gondar town and Dembia, north of Alefa Takusa. Dembia *woreda* is located southwest of Gondar town, to the east of Alefa Takusa, to the north of Lake Tana, to the west of Gondar Zuria *woreda* and to the south of Chilga *woreda*. Gondar Zuria *woreda* is a newly established *woreda*, which is a part of the Gondar town, and it comprises the rural *kebeles* of the surroundings. These rural *kebeles* surround the town to the west, northwest, south and southwest parts. Metema *woreda* is located about 900 km from Addis Ababa and about 180 km west of Gondar town. The *woreda* has an international boundary of more than 60 km between Ethiopia and Sudan. It is found north of Quara and Alefa, west of Chilga which is south of Tach Armachiho *woredas* and east of the Sudan border.

3.1.1 Land area and human population

Data on the land area and human population of the three lowland districts and one lowland district are presented in Table 1. The total land area of the three highland districts is 5683 km^2, while Metema district alone covers about 70% of the three highland *woredas* together, with an area of 3995 km^2. According to CSA (2008), the highland districts are more densely populated than the lowland districts. Gondar Zuria, Dembia and Chilga *woredas* have 217, 260 and 75 inhabitants per km^2, respectively, while Metema *woreda* has 21 inhabitants per km^2.

Table 1. *Land area and human population in the study area*

Descriptions	Districts			
	Metema	Dembia	Chilga	Gondar Zuria
Land area, km^2	3995	1215	3181	1287
Rural population				
Male	33,338	144,438	112,016	126,872
Female	28,456	138,049	108,624	122,192
Subtotal	61,794	282,487	220,640	249,064
Urban population				
Male	11,603	15,513	8818	14,221
Female	9603	17,903	9433	15,550
Subtotal	21,206	33,416	18,251	29,771
Total population	83,000	315,903	238,891	278,835
Human population density, head/km^2	21	260	75	217

Source: CSA (2008).

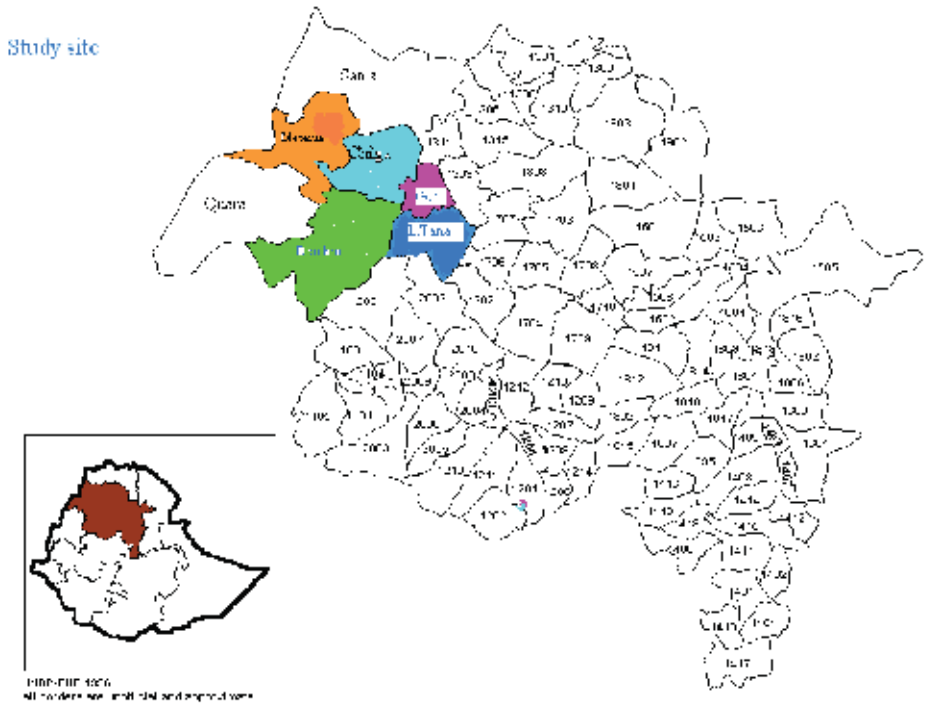


Figure 1. *Administrative districts of Amhara Region indicating the study sites—Metema, Chilga, Dembia and Gondar Zuria districts. Inset, Map of Ethiopia showing Amhara Regional State.*

3.1.2 Livestock population

Livestock resources in the study area are presented in Table 2. According to CSA (2008), in the highland *woredas* of Chilga, Dembia and Gondar Zuria, large ruminants are the dominant livestock population, while small ruminants and equines are the second and the third largest populations, respectively. Goats are important livestock species in Chilga. In the lowlands of Metema *woreda*, the livestock density is relatively small compared to the highlands (Table 2), and large ruminants are the dominant livestock species in quantity and small ruminants, particularly goats, are the second largest rearing stock. Among equines, donkeys are not reared by the community; rather only male donkeys are brought from the highlands for transportation use. There are few camels used for oil extraction from sesame. The overall cattle density in the highland districts is estimated at 92 heads/km^2, being the highest in Dembia (137 heads/km^2), followed by Gondar Zuria (110 heads/km^2) and Chilga (69 heads/km^2). The estimated cattle density in Metema however is only 26 heads/km^2.

Table 2. *Livestock population (heads) in the study area*

Livestock species	*Woredas*				Total
	Metema	Chilga	Dembia	Gondar Zuria	
Cattle	103,756	218,038	166,046	140,287	628,127
Sheep	4956	10,684	8886	42,287	66,813
Goats	29,863	55,464	5427	38,895	129,649
Donkeys	7009	18,923	10,717	26,287	62,936
Mule	106	805	292	339	1542
Horse	–	8	–	1903	1911
Camel	446	–	–	–	446

Source: CSA (2008).

3.1.3 Land use

Area under cultivation is the highest in Metema, being double the area in Dembia and Chilga *woredas*. However, the percentage of land under cultivation is 23.6% in Metema; 32.9% in Dembia; and 18% in Chilga. About 71 and 25.6% of the land in Metema and Chilga, respectively, is covered by forest and grassland. The natural vegetation of Metema is predominantly composed of different acacia species with a lot of hyparrhenia grass under grown. Metema is one of the *woredas* where gum and incense is collected. The main specie for incense production is *Boswellia papyrifera*, while *Acacia seyal* and *A polyacantha* are used for gum production.

3.1.4 Climatic conditions

In the highland *woredas*, temperatures are mild and range from 11 to 32ºC. In the lowlands of Metema, however, minimum annual temperature ranged between 22ºC and 28ºC. Daily temperature increases during the months of March to May, where it may reach as high as 43ºC. Mean annual rainfall in the highland districts ranges from 995 to 1175 mm, while in Metema it ranges from about 850 to around 1100 mm. The highland *woredas* receive bi-modal rainfall, with the short rains from March to May and the long rains from June to September. Metema *woreda*, on the other hand, has uni-modal rainfall, and the rainy months extend from June until the end of September. However, most of the rainfall is received during the months of July and August. Rainfall during these months is at times erratic (IPMS 2005).

3.2 Sampling procedure

Three *woredas*, namely Chilga, Dembia and Gondar Zuria, were selected from the highland areas, based on their long experience of transhumance livestock production system. Metema *woreda* was selected from the transhumance receiving *woredas*

purposively. Through discussions with *woreda* Offices of Agriculture and Rural Development (DOARD), three sample *kebeles* were selected purposively from the four study *woredas* with the criteria of accessibility and having experience of transhumance practice. Accordingly, nine *kebeles* in the highland districts and three *kebeles* in the lowland, totalling 12 rural *kebeles* were considered for the study.

Lists of farmers, who have cattle, were taken from the respective rural *kebele* administrations, development agents, and finance and plan offices. Representative sample farmers were selected by using systematically random sampling method. Accordingly, 20 representative farmers from each *kebele,* totalling 240 households, were selected for the study.

3.3 Data collection techniques

Three types of data collection methods were employed for the study, i.e. formal and informal survey to collect primary data and secondary information for secondary data.

3.3.1 Informal survey

In order to understand the types and the nature of livestock production system, discussion was made with Zonal and *woreda* Agriculture and Rural Development Offices with the help of prepared topical guidelines (checklist). Moreover, in each *kebele* discussion was held with different community groups without discriminating against age and sex. The discussion was conducted with the help of topical guidelines (checklist).

3.3.2 Formal survey

Two types of semi-structured questionnaires were prepared, one for the transhumance receiving (lowland) *woreda* (Metema) and another one for the highland *woredas* (Chilga, Dembia and Gondar Zuria). The questionnaires were translated into Amharic, the local language. The investigators, *woreda* experts, development agents and enumerators participated in data collection. Inaccuracy in data collection was minimized through appropriate training of *woreda* experts and development agents and careful supervision by the investigators. The questionnaires were pre-testing on non-random households, and adjustments were made on important suggestions from key informants and the enumerators.

3.4 Types of data collected

Quantitative and qualitative data were collected by conducting formal and informal surveys. Data were collected on socio-economic characteristics (demographic nature,

education, ethnic and religion) of the highlanders, types of livestock production system, livestock holdings, characteristics of transhumance production system, time and causes of mobility, percent of livestock moved to the lowlands, nature of grouping while they travelled to the lowlands, cattle management practices, reproductive and productive performance, feed availability in the highland and lowlands areas, live animals and product marketing, opportunities and major constraints.

Secondary data were collected from relevant regional bureaus, zonal agricultural offices, districts agricultural and rural development office, ILDP project at Gondar town, Central Statistics Authority (CSA) and personal communications. Available literature and web pages were also searched to consolidate the document.

3.5 Data analysis

Data were analysed using Statistical Package for Social Sciences (SPSS 2003) version 12. Survey results were reported using descriptive and inferential statistics. The General Linear Model Procedure of the SPSS program was employed to evaluate the relations between dependent and independent variables. Tukey and LSD tests were employed to compare means of different variables. The general model used to see the difference between *woredas* was:

$$Y_{ij} = \mu + A_i + \varepsilon_{ij}$$

where,

Y_{ijk}	=	Dependant variable
μ	=	The overall mean
a_i	=	Independent variables (*woredas* where i = 3, Chilga, Dembia and Gondar Zuria).
ε_{ij}	=	Random error term

4 Results and discussion

4.1 Socio-economic characteristics of inhabitants in the highland *woredas*

4.1.1 Household characteristics

Data on family status, sex composition, educational status, religion, ethnic groups and major occupation of the respondent households are presented in Table 3. The overall statuses of the respondents in the family were 98.3% household head, out of which, 0.6% were housewives and 1.1% were male children. Overall, 94.4% of the households were male headed, and this did not differ between the three highland *woredas*.

Table 3. *Sex, education, religion and ethnic group of respondents in the study area*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC N = 60	%	HHC N = 60	%	HHC N = 60	%	HHC N = 180	%
Status in the family								
Head	59	98.3	59	98.3	59	98.3	177	98.3
Wife	0	0.0	0	0.0	1	1.7	1	0.6
Children	1	1.7	1	1.7	0	0.0	2	1.1
Sex								
Male	59	98.3	57	95.0	54	90.0	170	94.4
Female	1	1.7	3	5.0	6	10.0	10	5.6
Educational status								
Illiterate	20	33.3	30	50.0	26	43.3	76	42.2
Adult education	26	43.3	21	35.0	11	18.3	58	32.2
Primary school	11	18.3	9	15.0	17	28.3	37	20.6
Secondary school	2	3.3	0	0.0	5	8.3	7	3.9
Above secondary	0	0.0	0	0.0	1	1.7	1	0.6
Religious education	1	1.7	0	0.0	0	0.0	1	0.6
Religion								
Orthodox Christian	57	95.0	60	100.0	58	96.7	175	97.2
Muslim	3	5.0	0	0.0	2	3.3	5	2.8
Nationality/ethnic group								
Amhara	60	100.0	60	100.0	60	100.0	180	100.0
Major occupation								
Farmer	59	98.3	59	98.3	57	95.0	175	97.2
Civil servant	0	0.0	0	0.0	1	1.7	1	0.6
House wife	0	0.0	0	0.0	1	1.7	1	0.6
Handcraft	0	0.0	0	0.0	1	1.7	1	0.6
Student	0	0.0	1	1.7	0	0.0	1	0.6
Military	1	1.7	0	0.0	0	0.0	1	0.6

HHC = Household count.

Overall, out of the total households interviewed (N =180), 42.2% were illiterate, being highest in Dembia (50%) followed by Gondar Zuria (43.3%) and Chilga (33%) *woredas*. Relatively more households (43.3%) in Chilga attended adult education programs than those in Dembia (35%) and Gondar Zuria (18.3%) *woredas*. This is perhaps due to more participation of adults in education in rural areas than those around towns. More number of households in Gondar Zuria had primary and secondary school education compared to those in Chilga and Dembia *woredas*. This may be due to the fact that most of the *kebeles* in Gondar Zuria were closer to Gondar town, which has a better access to schools.

All the respondents in Dembia (100%) and most respondents in Chilga (95%) and Gondar Zuria (96.7%) *woredas* were followers of the Eastern Orthodox Christian church, while 5% in Chilga and 3.3% in Gondar Zuria were Muslims. Overall, 97.2% of the households were followers of the Eastern Orthodox Christian church and the rest 2.8% were Muslim. All the interviewed households were from the Amhara nationality. Overall, the major occupation of the respondents were farmers (97.2%), civil servant (0.6%), housewives (0.6%), handcrafts men (0.6%), students (0.6%) and military personnel (0.6%).

The overall average age of the household head was 46.2 ± 0.88 years, and ranged from 45.6 ± 1.33 to 47.5 ± 1.67 years (Table 4), and was comparable with the 44.3 years obtained for cattle keepers in Fogera district (Belete 2006). Children with less than 6 years of age accounted for 15.8% in Chilga, 13.9% in Dembia and 16.1% in Gondar Zuria, while the respective values for children between 6 and 15 years were 32.9, 31.9 and 30.3%. The proportion of household members in the different age categories was comparable between *woredas*. Overall, 50% of the household members were in the age group between 16 and 60 years, while 31.7% were between 6 and 15 years. About 15.2% of the household members were children with less than 6 years of age, while only 3.1% were above 60 years of age. In Ethiopia, all age groups who are above ten years old in the rural areas are involved in agricultural activities (CSA 2008). Thus, the above results indicate that family members in the productive age group were higher than that of the non-productive age groups and this in turn implies that households have good source of family labour for different farm activities.

As shown in Table 4, the overall mean family size was 7.4 ± 0.17 heads/household, and did not differ significantly among the three districts. The average family size obtained in the study area was comparable with the result (7.39 and 7.26 heads/household) obtained in the Shashemene–Dilla (Sintayehu 2007) and Wolayta (Ayantu 2006), areas, respectively. However, it was higher than the national average (5.20), reported by CACC (2002) and (5.70 ± 0.134) reported by (Tesfaye 2008).

Table 4. *Mean (±SE) age and family size of respondents in the study area*

Variables	Chilga	Dembia	Gondar Zuria	Overall
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
	N = 59	N = 60	N = 60	N = 179
Age, years	47.5 (1.67)	45.6 (1.59)	45.6 (1.33)	46.2 (0.88)
Family size				
Male	3.7 (0.22)	4.1 (0.24)	3.8 (0.24)	3.8 (0.14)
Female	3.6 (0.23)	3.2 (0.19)	3.9 (0.21)	3.6 (0.12)
Total	7.3 (0.29)	7.3 (0.27)	7.6 (0.29)	7.4 (0.17)

4.1.2 Land holding and land use pattern

Land holding and land use pattern of respondents in the study *woredas* are summarized in Table 5. The average land holdings per household in the highland *woredas* was 2.2 ± 0.18 ha and did not vary significantly among the three *woredas*. This result is smaller than the mean average land holding of 5.28 ± 0.215 ha per household in Metema district (Tesfaye 2008). The main land use pattern, in order of area coverage, was cereal crops, trees/fruit and grazing land (Table 5). The overall mean land use pattern per household was 2.1 ± 0.18 ha for annual cereal crops, 0.04 ± 0.01 ha for trees/fruits and 0.1 ± 0.01 ha for grazing land. The mean land use pattern per household in Chilga was 2.1 ± 0.50 ha for cereal crops, 0.1 ± 0.01 ha for trees/fruits and 0.1 ± 0.02 ha for grazing land. A similar pattern was observed in Dembia where 2.4 ± 0.11 ha was allocated to cereal crops, 0.02 ± 0.01, ha for trees/fruits and 0.04 ± 0.01 ha for grazing land. In Gondar Zuria, however, the mean area allocated to cereal crops was only 1.9 ± 0.10 ha per household, probably because of the relatively smaller land holdings in the *woreda*. Land allocated to trees and fruits and grazing land per household was 0.1 ± 0.01 ha and 0.04 ± 0.01 ha, respectively. Cereal crops production was the dominant land use pattern in all study *woredas*. Land used for trees/fruit and grazing land was relatively very small. This may be due to the influence of the subsistence crop–livestock mixed farming system already practised in most of the highlands of the country, which is characterized by dominance of cereal crops to ensure household food security.

Table 5. *Land holdings and land use patterns of respondents in the study area*

Variables	Chilga	Dembia	Gondar Zuria	Overall
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
	N = 60	N = 59	N = 60	N = 179
Average land owned, ha	1.5 (0.09)	1.9 (0.11)	1.3 (0.08)	1.6 (0.06)
Average land rented in, ha	0.8 (0.49)	0.6 (0.09)	0.7 (0.09)	0.7 (0.17)
Average total land holdings, ha	2.3 (0.50)	2.5 (0.11)	1.9 (0.11)	2.2 (0.18)
Land use pattern	N = 60	N = 59	N = 60	N = 179
Annual cereal crops, ha	2.1 (0.50)	2.4 (0.11)	1.9 (0.10)	2.1 (0.18)
Trees and fruits, ha	0.1 (0.01)	0.02 (0.01)	0.1 (0.01)	0.04 (0.01)
Grazing land, ha	0.1 (0.02)	0.04 (0.01)	0.04 (0.01)	0.1 (0.01)

4.1.3 Cattle holdings and purpose of rearing

Cattle holdings and herd structure in the three highland *woredas* are presented in Table 6. The overall mean cattle holding per household was 8.7 ± 0.48 heads, and did not differ significantly among the three *woredas*. This value of cattle holding is similar to the 8.01 heads/household reported for the Mekelle area (Negussie 2006). However, the current finding was much lower than the holdings in Metema *woreda* (15.53 ± 0.71 heads per household) reported by Tesfaye (2008).

Table 6. *Cattle holding and herd structure of the respondents in the study area*

Variables	Chilga	Dembia	Gondar Zuria	Overall
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Oxen	N = 60	N = 60	N = 60	N = 180
Local	2.2 (0.16)	2.0 (0.12)	1.8 (0.13)	2.0 (0.08)
Cross	–	–	0.02 (0.02)	0.01 (0.01)
Total	2.2 (0.16)	2.0 (0.12)	1.8 (0.13)	2.0 (0.08)
Cows				
Local	2.5 (0.37)	2.4 (0.25)	2.2 (0.23)	2.3 (0.17)
Cross	0.02 (0.02)	–	0.1 (0.05)	0.03 (0.02)
Total	2.5 (0.37)	2.4 (0.25)	2.2 (0.24)	2.4 (0.17)
Bull				
Local	0.1 (0.05)	0.2 (0.09)	0.4 (0.17)	0.2 (0.07)
Cross	–	0.1 (0.03)	–	0.02 (0.01)
Total	0.1 (0.5)	0.3 (0.09)	0.4 (0.17)	0.3 (0.07)
Heifers				
Local	1.2 (0.15)	1.6 (0.26)	1.4 (0.21)	1.4 (0.12)
Cross	–	–	0.02 (0.02)	0.1 (0.01)
Total	1.2 (0.15)	1.6 (0.26)	1.4 (0.21)	1.4 (0.12)
Young bullock				
Local	0.7 (0.11)	0.9 (0.12)	0.7 (0.13)	0.7 (0.07)
Cross	–	–	0.02 (0.12)	0.01 (0.01)
Total	0.7 (0.11)	0.9 (0.12)	0.7 (0.13)	0.8 (0.07)
Male calves				
Local	1.1 (0.18)	1.0 (0.17)	0.9 (0.13)	1.0 (0.09)
Cross	–	0.02 (0.02)	0.03 (0.03)	0.02 (0.01)
Total	1.1 (0.18)	1.1 (0.17)	0.9 (0.13)	1.0 (0.09)
Female calves				
Local	1.1 (0.19)	0.9 (0.16)	0.9 (0.15)	0.9 (0.09)
Cross	0.02 (0.02)	–	0.02 (0.12)	0.01 (0.01)
Total	1.2 (0.19)	0.9 (0.15)	1.0 (0.15)	0.9 (0.09)
Total calves	2.3 (0.30)	1.9 (0.27)	1.9 (0.23)	2.0 (0.16)
Average holding/household	8.9 (0.86)	8.9 (0.84)	8.2 (0.82)	8.7 (0.48)

Regarding herd composition, the overall average number of cows in the three *woredas* (2.4 ± 0.17 heads/HH), oxen (2.0 ± 0.08)/HH) and calves (2.0 ± 0.16) heads/HH) in the

herd was higher (P<0.05) than other classes of animals (Table 8). The average number of heifers was 1.4 ± 0.12 heads/HH), and they are used for replacement purposes. The average number of breeding bulls (0.3 ± 0.07 heads/HH) was the lowest in the herd as bulls are shared among households in the community for breeding purpose. Overall, the proportion of cows was the highest (27.0%) in the herd, which was higher than the 24.3% reported around Debre Berhan area in Ethiopia (Gryseels 1988). However, the value obtained in the study areas was much lower than the national average (42%) (Azage and Alemu 1998). Calves comprised 23.1% of the cattle herd in the studied *woredas* and this shows their importance in the herd in ensuring adequate replacement animals from own stock. As indicated in Table 7, the overall average number of milking cows was higher (1.3 ± 0.12) than dry cows (1.1 ± 0.09), and did not vary (P > 0.05) among the three *woredas*.

Table 7. *Lactation status of dairy cows during the study*

Lactation status	Chilga (n = 57)		Dembia (n = 60)		Gondar Zuria (n = 60)		Overall (n = 177)	
	Heads	Mean+SE	Heads	Mean+SE	Heads	Mean+SE	Heads	Mean+SE
Milking	85 (59.0)	1.5 + 0.27[a]	71 (49.7)	1.2+ 0.16[a]	74 (56.1)	1.3+ 0.18[a]	230 (54.9)	1.3+ 0.12
Dry	59 (41.0)	1.0 + 0.19[a]	72 (50.3)	1.2+ 0.16[a]	58 (43.9)	0.9+ 0.14[a]	189 (45.1)	1.1+ 0.09
Total	144		143		132		419	

Dairy cows holding with same superscript within the same rows does not significantly differ at 5 % level of significance, SE = Standard error. Numbers in brackets are percentages.

Table 8. *Objectives of cattle rearing in the highland districts and prioritized according to their importance*

Objectives	Chilga			Dembia			Gondar Zuria			Overall		
	N	WM	Rank	N	WM	Rank	N	WM	Rank	N	WM	Rank
Income	60	2.6	3	46	2.9	4	53	3.2	3	159	3.1	4
Milk	53	2.5	2	56	2.2	2	56	1.9	2	165	2.2	2
Drought	59	1.3	1	57	1.3	1	55	1.2	1	171	1.3	1
Manure	49	3.8	4	43	4.1	5	52	3.9	4	144	3.9	5
Meat	31	4.4	6	27	4.3	6	34	4.0	5	92	4.2	6
Social	4	4.3	5	14	2.6	3	NC			18	3.0	3

WM = weighted mean, NC = Not considered as an objective of cattle rearing.

The major objectives of cattle rearing in the highland *woredas* are presented in Table 8. According to the respondents, cattle are kept to fulfil multipurpose functions amongst which were source of draught power (ranked 1st), milk and milk products (ranked 2nd), social functions (as a gift) (ranked 3rd), income (ranked 4th), organic fertilizer (ranked 5th) and meat (ranked 6th). In all the districts, draught power and milk production ranked first and second, respectively.

4.1.4 Sources of income

The major sources of income and their ranks of prioritization in Chilga, Dembia and Gondar Zuria *woredas* are presented in Table 9. Comparatively, there were more diverse sources of income in Chilga and Gondar Zuria than in Dembia *woreda*. Among the interviewed farmers, selling of a commodity for cash was dependent upon the amount of money needed to cover their expenses. For example, in most instances, respondents sell cattle to cover large expenses, whereas they sell grain and/or butter for relatively smaller expenditures.

Table 9. *Major income sources used by the highlanders and prioritized according to their rank*

Major income sources	Chilga			Dembia			Gondar Zuria			Overall		
	N	WM	Rank	N	WM	Rank	N	WM	Rank	N	WM	Rank
Selling livestock	52	1.98	5	50	1.96	3	56	2.23	5	158	2.06	6
Selling crops	42	1.93	4	47	1.51	2	42	2.19	4	131	1.86	4
Selling eucalyptus tree	29	2.28	7	7	2.71	5	38	2.16	2	74	2.26	8
Selling milk and milk products	24	1.83	3	41	2.15	4	45	2.18	3	110	2.09	7
Income from wages	3	1.67	2	1	1.00	1	1	1.00	1	5	1.40	2
Selling honey	2	2.00	6	NC			NC			2	2.00	5
Income from handicrafts	4	1.50	1	NC			NC			4	1.50	3
Credit	1	3.00	8	1	3.00	5	3	3.33	6	5	3.20	9
Selling fruits and vegetables	NC			NC			2	1.00	1	2	1.00	1

WM = Weighted mean, NC = Not considered as income source.

4.2 Livestock production systems

Livestock production systems in the highland *woredas* are characterized by mixed crop–livestock production and transhumance production systems. All respondents in the studied areas exercised these two livestock production systems.

4.2.1 Transhumance production system

As discussed with the key informants and representative households, livestock are kept in different places during the different seasons. Livestock movement to other areas occurs both in the dry and the rainy seasons.

Dry season transhumance

As discussed with staff members of different *woreda* Offices of Agriculture and Rural Development and respondents in the three *woredas*, most farmers in the highland *woredas* keep their cattle in the extreme highland areas, wetlands around Lake shore and bottomlands during the dry season (Table 10). More number of respondents in Dembia

(38.3%) indicated that they keep their livestock around Lake Tana for pasture and water than those in Chilga (6.7%), while respondents in Gondar Zuria have no experience of taking their cattle to Lake Tana shore. Overall, most of the respondents (83.3%) keep their cattle near their village, while only 15% take their cattle to the wetland area around Lake Tana. Very few respondents (1.7%) keep their cattle in the bottomlands during the dry season.

Table 10. *Places of herding cattle during the dry season in the study area*

Location	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Place of herding	N = 60		N = 60		N = 60		N = 180	
Near villages	58	96.7	37	61.7	55	91.7	150	83.3
Wetland areas (Lake shore grazing)	0	0.0	23	38.3	4	6.7	27	15.0
Lowlands	2	3.3	0	0.0	1	1.7	3	1.7

HHC = Household count.

As shown in Table 11, the major reasons for keeping cattle near their village during the dry season were availability of adequate feed such as crop aftermath and residues (35.8%), ownership of few number of cattle by households (20.1%), lack of access to land in other locations (14.9%), high ambient temperatures in the lowlands (14.2%), shortage of herders (10.4%), fear of theft (3%) and need for cattle manure (0.7%).

Table 11. *Major reasons for not going any where during the dry season*

Reasons	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Reasons	N = 49		N = 34		N = 51		N = 134	
Few number of cattle	4	8.2	10	29.4	13	25.5	27	20.1
Have enough feeds	28	57.1	12	35.3	8	15.7	48	35.8
No where to go	11	22.4	5	14.7	4	7.9	20	14.9
High temperatures in the lowlands	0	0.0	2	5.9	17	33.3	19	14.2
Lack of cattle herders	5	10.2	3	8.8	6	11.8	14	10.4
Fear of cattle theft	0	0.0	2	5.9	2	3.9	4	3.0
Need manure	1	2.0	0	0.0	0	0.0	1	0.7

HHC = Household count.

Rainy season transhumance

As shown in Table 12, relatively more number of households in Chilga (91.7%) and Dembia (77.6%) districts keep their cattle in the lowlands (practices transhumance) during the rainy season than those in Gondar Zuria *woreda* (55.2%). This is perhaps because Gondar Zuria district is relatively far from the lowland areas than Dembia and Chilga *woreda*. Overall, most of the households (75%) keep their cattle in the lowlands,

whereas 25% of the households keep their cattle in their villages. The two main reasons why some of the respondents do not practice transhumance cattle production during the rainy season were ownership of few number of cattle (66.7%) and shortage of cattle herders (24.2%) (Table 13).

Table 12. *Locations of cattle herding during the wet season in the study area*

Locations of herding	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 60		N = 58		N = 58		N = 176	
Lowlands	55	91.7	45	77.6	32	55.2	132	75.0
Near villages	5	8.3	13	22.4	26	44.8	44	25.0

Table 13. *Major reasons for not going any where during the wet season*

Reasons	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 4		N = 11		N = 18		N = 33	
Small number of cattle	3	75.0	8	72.7	11	61.1	22	66.7
Shortage of cattle herder	1	25.0	1	9.1	6	33.3	8	24.2
Used as oxen for ploughing	0	0.0	1	9.1	0	0.0	1	3.0
Fear of theft	0	0.0	1	9.1	0	0.0	1	3.0
Exotic breed	0	0.0	0	0.0	1	5.6	1	3.0

Locations of cattle mobility in the lowlands

Locations of cattle keeping during the rainy season are presented in Table 14. Overall, Metema *woreda* (84%) was the most dominant option for transhumance cattle movement during the rainy season. In addition, Armachiho (9.6%), Quara (4.0%) and Alefa and Chilga (0.8% each) *woredas* are also used for transhumance cattle production system. Metema *woreda* is the most preferred location for transhumance cattle keeping by most of the respondents in Chilga (94.4%) and Dembia (87.8%) than those in Gondar Zuria district (60%). Secondary options form transhumance cattle production are parts of Chilga and Quara *woredas* for farmers from Chilga; Quara, Armachiho and Alefa *woredas* for farmers from Dembia; and Armachiho and Quara *woredas* for farmers from Gondar Zuria. The major reasons for selection of *woredas* were availability of good quality and adequate quantity of feed resources (91%), existence of relatives in the locations (5.7%) and closer distance (1.6%) (Table 15).

Group discussion with the key informants revealed that in the past, transhumant cattle production was limited to parts of Chilga and the borders of Metema and Armachiho *woredas* due to the relatively abundant feed resources and fewer human population. As the human population increased and the pressure on the available feed resource intensified, farmers started extending the transhumance cattle production system deep into the lowlands of Metema district.

Table 14. *Location for transhumance cattle production during the wet season*

	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 54		N = 41		N = 30		N = 125	
Metema	51	94.4	36	87.8	18	60.0	105	84.0
Armachiho	0	0.0	1	2.4	11	36.7	12	9.6
Quara	1	1.9	3	7.3	1	3.3	5	4.0
Chilga	2	3.7	0	0.0	0	0.0	2	0.8
Alefa	0	0.0	1	2.4	0	0.0	1	0.8

Table 15. *Major reasons forwarded for the selection of transhumance districts during the wet season*

Reasons	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 55		N = 39		N = 28		N = 122	
Good and adequate feed	48	87.3	39	100.0	24	85.7	111	91.0
Relatives in the lowland	4	7.3	0	0.0	3	10.7	7	5.7
Near by owned district	2	3.6	0	0.0	0	0.0	2	1.6
For ploughing and few people	1	1.7	0	0.0	0	0.0	1	0.8
Others	0	0.0	0	0.0	1	3.6	1	0.8

Major reasons for cattle mobility to the lowlands

Primary reasons

The major reasons for transhumance cattle production in the lowland areas are presented in Table 16. Overall, the main reasons were availability of feed (99.2%) and free land for stock keeping (92.4%) in the lowlands. Movement in search of feed was more or less comparable among the three studied areas, whereas access to free land for stock keeping was identified by relatively more proportion of respondents in Dembia *woreda* (97.9%) than in Chilga (92.6%) and in Gondar Zuria (83.9%) *woredas*. Moreover, about 25% and only 0.8% of households move to the lowlands due to the relatively lower disease burden in the wet season and in search of non-waterlogged area, respectively.

Table 16. *Major reasons for cattle mobility to the lowlands*

Major causes	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 54		N = 47		N = 31		N = 132	
In search of feed	54	100.0	46	97.9	31	100.0	131	99.2
In search of free area	50	92.6	46	97.9	26	83.9	122	92.4
In search of disease free area	6	11.1	16	34.0	11	35.5	33	25.0
In search of non-waterlogged area	1	1.9	0	0.0	0	0.0	1	0.8

Secondary reasons

The major secondary benefits gained by the highlanders while they are in the lowlands are presented in Table 17. Overall, most of the transhumant cattle producers (78.4%) indicated that they obtain extra benefits while they are in the lowlands. These were composed of respondents in Dembia (84.2%), Gondar Zuria (83.3%) and Chilga (71.4%) districts. Overall, the secondary benefits to the transhumance producers include sale of live cattle and sale of milk and milk products to the lowlanders (87.4%), income from wages (46.0%), use of rented land for crop production (19.5%) and renting out oxen to the lowlanders (5.7%).

Table 17. *Secondary benefits collected by the highlanders in the lowlands during the rainy season*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Any extra benefits?	N = 49		N = 38		N = 24		N = 111	
Yes	35	71.4	32	84.2	20	83.3	87	78.4
No	14	28.6	6	15.8	4	16.7	24	21.6
Types of extra benefits	N = 35		N = 32		N = 20		N = 87	
Selling live cattle and its products	28	80.0	30	93.8	18	90.0	76	87.4
Renting their labour	19	54.3	13	40.6	8	40.0	40	46.0
Renting land from lowlanders	11	31.4	4	12.5	2	10.0	17	19.5
Rent their oxen to the lowlanders	5	14.3	0	0.0	0	0.0	5	5.7

As indicated in Table 17, more respondents from Dembia (93.8%), Gondar Zuria (90%) and Chilga (80%) districts indicated that they benefit from the sale of live cattle and milk and milk products. Some of the respondents from Chilga indicated that they have more options of selling their cattle and products in the nearby highland areas as they are close to their highland villages. On the other hand, more respondents from Chilga district indicated that they engage themselves in crop production activities by renting agricultural land from the lowlanders and also benefit from renting their oxen to the lowlanders during the rainy season than those from Dembia and Gondar Zuria districts.

Discussion with key informants from the highland districts and with farmers at Metema district revealed that a pair of oxen is rented to the lowlanders for up to Ethiopian birr (ETB)[1] 1500 per month. After accomplishing the ploughing task, the oxen are fed well on good quality natural pasture and are either sold for attractive prices in the lowland or trekked back to their home in the highlands.

1. ETB, Ethiopian birr. During the study period, USD 1 was equivalent to ETB 8.75.

When did transhumance cattle production system commence?

Comparatively Chilga district started transhumance cattle production system earlier than Dembia and Gondar Zuria districts. This is perhaps due to the fact that Chilga district is relatively nearer to the lowlands and some of its rural *kebele*s are located in the lowlands. The number of households that practised transhumance cattle production system from Dembia district increased between 1960 and 1980 E.C. more than in the other two districts. This is perhaps due to the increased flooding of the vast plains in the district coupled with feed shortage. Overall, as reported by the farmers and key informants, transhumance cattle production system commenced between 1941 and 1950 E.C. and increased until 1980 E.C. and has been decreasing since then. Most of the respondents (86.3%) in the studied areas estimated that the trend of transhumance production system as increasing, while 10.7% perceived it as decreasing. Very few respondents (2.3%) indicated that there has been no change (Table 18). As shown in Table 19, the major reasons for the perceived increase in transhumance cattle production as identified by the respondents were feed shortage (50.4%), land covered by crops (27.4%) and increased cattle population (21.2%).

Table 18. *Perception of farmers in the highlands on trends of transhumance production system*

Trend	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 54		N = 45		N = 32		N = 131	
Increasing	51	94.4	36	80.0	26	81.3	113	86.3
Decreasing	2	3.7	8	17.8	4	12.5	14	10.7
No change	0	0.0	1	2.2	2	6.3	3	2.3
I don't know	1	1.7	0	0.0	0	0.0	1	0.8

Table 19. *Major reasons forwarded by the highlanders for the increasing trend in transhumance cattle production system*

Reasons	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 51		N = 34		N = 28		N = 113	
Feed shortage	16	31.4	19	55.9	22	78.6	57	50.4
Land covered by crop	16	31.4	9	26.5	6	21.4	31	27.4
Increased livestock population	19	37.3	5	14.7	0	0.0	24	21.2
Flooding and waterlogging	0	0.0	1	2.9	0	0.0	1	0.9

Preferred months of cattle movement

Cattle movement to the lowland areas

Discussion with key informants revealed that farmers in the highland districts start community discussions about movement of animals with their villagers in church

gatherings and other social groupings around the Ethiopian Easter holiday between April and May. Most of the time farmers do not set specific time for the commencement of their movement, but first they study the rainfall pattern to start agricultural activities and eventually take collective decision on commencement and modalities of movement of animals. These community discussions included issues of continuous monitoring of the situation, identification of individuals and group formations, modalities of assistance among and between group members, animal identification, food supply systems, locations of grazing areas and contact people in the lowlands, duration of stay, safety and animal health issues. It was also interesting to note that even the cattle are conditioned to the movement and take initiatives to move to the lowlands between April and May.

The specific months and the reasons for selection of the months for commencement of cattle movement to the lowland are presented in Table 20. Comparatively higher proportions of households in Chilga (75.9%), Gondar Zuria (65.6%) and Dembia (64.4%) districts preferred to commence cattle movement in the month of May. On the other hand, the month of June was selected by comparable proportion of households in Dembia (33.3%) and Gondar Zuria (34.4%), but was lower in Chilga (24.1%). Overall, most of the inhabitants (69.5%) in the studied area preferred May as the primary month of trekking their livestock to the lowlands, while 29.6% of the inhabitants preferred June.

Table 20. *Commencement of cattle movement and the major reasons for the selection of specific months to trek cattle to the lowlands*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Months	N = 54		N = 45		N = 32		N = 131	
April	0	0.0	1	2.2	0	0.0	1	0.8
May	41	75.9	29	64.4	21	65.6	91	69.5
June	13	24.1	15	33.3	11	34.4	39	29.8
Reasons	N = 53		N = 41		N = 32		N = 126	
To get first shoots of grass (*Qabiro*)	36	67.9	17	41.5	10	31.3	63	50.0
Before the road developed mud	0	0.0	18	43.9	7	21.9	25	19.8
Before the area covered by crops	1	1.9	3	7.3	11	34.4	15	11.9
Severe feed shortage	12	22.6	0	0.0	2	6.3	14	11.1
Shortage of land for stocking	2	3.8	0	0	2	6.3	4	3.2
Heat load at the lowlands decreases	1	1.9	3	7.3	0	0.0	4	3.2
Free labour available at the lowland	1	1.9	0	0	0	0.0	1	0.8

The major reasons for the selection of a specific month for the commencement of cattle movement to the lowlands were to get first shoot of grass in the lowland (*Qabiro*) (50.0%), before the route gets muddy (19.8%), before the area is covered by crops (11.9%), severe feed shortage (11.1%), shortage of land for stoking at the highland (3.2%), less heat load in the lowland (3.2%), and availability of free labour (0.8%).

For about 67.9, 41.5 and 31.3% of the respondents in Chilga, Dembia and Gondar Zuria *woredas*, respectively, the major reasons for selection of a specific month for the commencement of movement of cattle to the lowlands was to get access to the first shoot of grasses, legumes, shrubs and trees. The reason for the higher percentage for respondents from Chilga is perhaps due the closer proximity of the lowlands than the other two districts. On the other hand, households in Dembia (43.9%) and Gondar Zuria (21.9%) indicated that they have problem of mud through their line of route than those in Chilga *woreda*. Besides, relatively higher proportion of households in Gondar Zuria *woreda* (34.4%) prefer to start earlier before their cattle trekking routes are covered by crops than those in Dembia (7.3%) and Chilga (1.9%), probably due to the long distance to the lowlands. As reported by the farmers, the decision on the commencement of trekking cattle to the lowlands also depends on the availability of feed and labour and on the number of livestock population.

Cattle movement back home

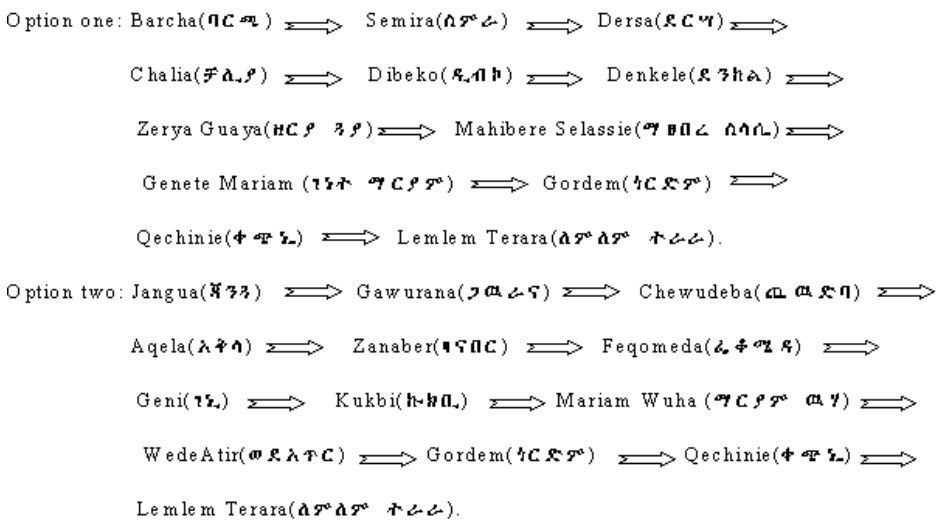
The time and the major triggering factors for cattle movement back home to the highlands are presented in Table 21. Overall, most of the respondents indicated that they return home in October (45.8%) followed by September (35.9%), while a smaller percentage (18.3%) travel back in November. Almost half of the respondents from Dembia (48.9%), about 32% from Chilga and a quarter from Gondar Zuria *woredas* commence their journey back to the highlands in September. October is the month when most of the transhumance farmers from Chilga (48%), Dembia (40%) and Gondar Zuria (50%) return home. Among those who return late, about a quarter are from Gondar Zuria, 20% are from Chilga and 11% from Dembia *woredas*. According to the respondents, the major reasons that trigger return home are high ambient temperature (43.0%), availability of crop aftermath in the highlands (25.1%), high infestation of flies in the lowlands (10.6%), drying up of muddy areas in the highlands (9.1%) and the need for labour resources for harvesting crops in the highlands (6.1%) (Table 21).

Routes of cattle movement to the lowlands

As reported by farmers and key informants, the transhumance commonly use three major lines of routes (options) while they travel to the lowlands (Figure 2). At the start of movement, most of the cattle are weak and emaciated because of shortage of feed. As a result, farmers opt to travel through the shortest possible route to locations which are considered important for their feed and water resources. These locations are used as resting places after trekking their cattle for long hours during the day. Farmers also indicated that the preference of using the resting places depends upon the location of the village in the *woreda*.

Table 21. *Months of cattle mobility and major reasons for mobility back to the highlands*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Months	N=54		N=45		N=32		N=131	
September	17	31.5	22	48.9	8	25.0	47	35.9
October	26	48.1	18	40.0	16	50.0	60	45.8
November	11	20.4	5	11.1	8	25.0	24	18.3
Reasons	N=53		N=44		N=29		N=126	
High ambient temperature in the lowlands	26	29.5	33	61.1	18	48.6	77	43.0
Available crop aftermath	27	30.7	10	18.5	8	21.6	45	25.1
Infestation of flies	14	15.9	4	7.4	1	2.7	19	10.6
Mud dried	13	14.8	3	5.6	1	2.7	17	9.5
Need labour for harvest in the highlands	1	1.1	4	7.4	6	16.2	11	6.1
Herders are students	3	3.4	0	0.0	0	0	3	1.7
Grass decreases in the lowland	1	1.1	0	0.0	2	5.4	3	1.7
Need milk and milk products	1	1.1	0	0.0	1	2.7	2	1.1
Fear of cattle thief	1	1.1	0	0.0	0	0	1	0.6
Water shortage	1	1.1	0	0.0	0	0	1	0.6



All places are located in Chilga and Metema *woredas*.

Figure 2. *Transhumance lines of routes while they trek their cattle to the lowlands.*

As shown in Figure 2 and Table 22, one of the most important primary destinations for most transhumance movement is Lemlem Terara, which is found in Agamwhua rural *kebele*. Farmers assemble their animals in Lemlem Terara, rest for a while and then decide

where to move depending on information collected from the local people. The decision is taken based on safety, availability of feed and water, reasonable comfort to the herders and access to services. Herders from Chilga have comparatively more rural *kebeles* to choose from compared to herders from Dembia and Gondar Zuria *woredas* due to the fact that Chilga is located adjacent to Metema *woreda* and most inhabitants have close relatives in the lowlands. Overall, the most preferred lowland *kebeles* by the highlanders are Agamwuha (26.2%), Das Gundo (14.3%), Awulala (10.7%) and Zebachbahir (10.7%). Very few herders stay in Shinfa (7.1%), Kokit (6.0%) and Kumer Aftit (6.0%) rural *kebeles*.

Table 22. *Preferable rural* kebeles *used by transhumant in Metema district*

Rural *kebeles*	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 45		N = 23		N = 16		N = 84	
Agamwhuha	8	17.8	5	21.7	9	56.3	22	26.2
Das Gundo	12	26.7	0	0.0	0	0.0	12	14.3
Awulala	2	4.4	5	21.7	2	12.5	4	10.7
Zebachbahir	1	2.2	7	30.7	1	6.3	9	10.7
Shinfa	4	8.9	2	8.7	0	0.0	6	7.1
Kokit	4	8.9	0	0.0	1	6.3	5	6.0
Kumer Aftit	3	6.7	0	0.0	2	12.5	5	6.0
Lencha	1	2.2	3	13.0	0	0.0	4	4.8
Gubaye	3	6.7	0	0.0	0	0.0	3	3.6
Meqa	3	6.7	0	0.0	0	0.0	3	3.6
Shashigie	0	0.0	1	4.3	1	6.3	2	2.4
Kemechela	2	4.4	0	0.0	0	0.0	2	2.4
Negadie Bahir	1	2.2	0	0.0	0	0.0	1	1.2
Metema Yohanes	1	2.2	0	0.0	0	0.0	1	1.2

Type and size of cattle trekked to the lowlands

As reported by farmers and key informants, the livestock species trekked to the lowlands are indigenous cattle only. However, donkeys accompany the herders and are mainly used as pack animals to transport luggage and supplies of the herders. Crossbred cattle are not trekked to the lowlands because farmers believe that they would not tolerate the stress of travel over long distance and will not withstand the high ambient temperature and diseases challenges than locals.

As indicated in Table 23, respondents indicated that out of the total number of cattle population in the highlands, 60.3% are trekked to the lowlands during the rainy season. The rest (39.7%) of the cattle population remains in the highlands for various reasons. Overall, from the cattle holdings in the highlands, about 97.6% of the heifers, 84.4% of the young bullocks, 82.1% of the dry cows, 70.9% of the calves, 62.3% of the milking cows and 21.7% of the breeding bulls (21.7%) are trekked to the lowlands. Only 6.7%

of the oxen are trekked to the lowlands due to the relatively higher animal power requirements for agricultural activities in the highlands. Farmers and key informants indicated that depending on the family size and availability of feed, 1 to 2 milking cows are kept per household in the highlands to ensure continued supply of milk for household consumption. The remaining milking cows together with the other cattle age and sex groups are trekked to the lowlands.

Table 23. *Types and size of cattle trekked to the lowlands during the rainy season*

	Chilga (N = 60)			Dembia (N = 60)			Gondar Zuria (N = 60)			Overall (N = 180)		
	NCHL	NCLL	%	NCHL	NCLL	%	NCHL	NCLL	%	NCHL	NCLL	%
Heifers	75	75	100.0	94	94	100.0	79	73	92.4	248	242	97.6
Young bullocks	43	39	90.7	51	40	78.4	41	35	85.4	135	114	84.4
Dry cows	64	47	73.4	73	67	91.8	58	46	79.3	195	160	82.1
Calves	135	99	73.3	115	89	77.4	111	68	61.3	361	256	70.9
Milking cows	85	50	58.8	71	53	74.6	72	39	54.2	228	142	62.3
Breeding bulls	7	2	28.6	16	2	12.5	23	6	26.1	46	10	21.7
Oxen	134	14	10.4	119	8	6.7	105	2	1.9	358	24	6.7
Total	543	326	60.0	539	353	65.5	489	269	55.0	1571	948	60.3

NCHL = Number of cattle types in the highlands, NCLL = Number of cattle types moved to the lowlands.

Cattle trekking and herding in the lowlands

Data on creation of cattle owners' groups, cattle trekking and herding systems in the lowlands by the highland herders are presented in Table 24. Respondents indicated that herders' groups are formed ahead of time at village level. The purposes of group formation are to minimize idle labour (48.3%), to protect their cattle from thief (35.0%), and a combination of the two (17%). Most farmers (73.5%) in Chilga indicated that they prefer group formation to optimize labour use than those in Dembia (31.1%) and Gondar Zuria (30.8%) *woredas*, suggesting that labour shortage is an important constraint in Chilga. Group formation to protect cattle from theft was identified as important by about 69% of the farmers in Gondar Zuria and 47% in the farmers in Dembia *woreda*, while only 6.1% of the farmers in Chilga considered it important. This is perhaps due to the relatively close proximity and social network of farmers in Chilga with the farmers in Metema compared to those in Dembia and Gondar Zuria *woredas*.

Table 24. *Herding and make groupings in the lowlands by the highlanders*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Grouping	N = 52		N = 45		N = 28		N = 125	
How many cattle owners grouped?	4.6(0.35)[a]		4.2 (0.19)[a]		3.8 (0.29)[a]		4.3 (0.18)	
Herd size of one group, Mean (SE)	45.9 (4.00)[a]		72.3 (8.44)[b]		60.7 (6.29)[ab]		58.8 (3.88)	
Importance of grouping	N = 49		N = 45		N = 26		N = 120	
Appropriate use of labour	36	73.5	14	31.1	8	30.8	58	48.3
To protect from theft	3	6.1	21	46.7	18	69.2	42	35.0
Both	10	20.4	10	22.2	–		20	16.7
Types of relation for grouping:	N = 52		N = 44		N = 25		N = 121	
Relative	35	67.3	29	65.9	14	56.0	78	64.5
Neighbours	9	17.3	4	9.1	6	24.0	19	15.7
Both	8	15.4	11	25.0	5	20.0	24	19.8
Who treks to the lowland?	N = 53		N = 45		N = 30		N = 128	
HHH	21	39.6	17	37.8	14	46.7	52	40.6
Young children	13	24.5	16	35.6	9	30.0	38	29.7
Relatives	13	24.5	12	26.7	6	20.0	31	24.2
Hired labour	3	5.7	–		1	3.3	4	3.1
Neighbours	1	1.9	–		1	3.3	2	1.6
Number of trekkers, Mean (SE)	3.0 (0.27)[a]		3.3 (0.73)[a]		2.7 (0.32)[a]		2.8 (0.16)	
Who herds in the lowlands?	N = 50		N = 45		N = 29		N = 124	
Relatives	17	34.0	20	44.4	15	51.7	52	41.9
Family member	31	64	24	53.4	15	51.7	71	57.2
Young children	17	34.0	16	35.6	10	34.5	43	34.7
HHH	12	24.0	8	17.8	3	10.3	23	18.5
Hired labour	3	6.0	–		2	6.9	5	4.0
Neighbours	1	2.0	1	2.2	–		2	1.6
Number of herders (Mean (SE)	2.0 (0.11)[a]		2.2 (0.18)[a]		2.5 (0.27)[a]		2.2 (0.10)	

HHC = Household count; HHH= Household head; SE= Standard error; Variables with same superscript within the same rows does not significantly differ at 5% level of significance.

As indicated in Table 25, most of the respondents used to select relatives (64.5%) than neighbours (15.7%) while forming herders groups. This is probably because farmers believed that cattle will be safe and properly kept if they made grouping with relatives. On the other hand, about 20% of the respondents indicated that they form herders groups with both relatives and neighbours. Overall, the mean number of individuals involved in one herder group was 4.3 ± 0.175 (Table 24), and was higher (P>0.05) in Chilga (4.6 ± 0.35) than in Dembia (4.2 ± 0.19) and in Gondar Zuria (3.8 ± 0.29) *woredas*.

Table 25. *Relationships of highlanders with the lowlanders*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Do have relation?	N = 54		N = 45		N = 30		N = 129	
Yes	25	46.3	27	60	20	66.6	72	55.8
No	29	53.7	18	40	10	33.3	57	44.2
Types of relation	N = 25		N = 27		N = 20		N = 72	
Family	19	76.0	9	33.3	7	35.0	35	48.6
Others	6	24.0	18	66.7	13	65.0	37	51.4
Do you give gift?	N = 29		N = 28		N = 21		N = 78	
Yes	22	75.9	28	100.0	21	100.0	71	91.0
No	7	24.1	0	0.0	0	0.0	7	9.0
Types of gift?	N = 22		N = 28		N = 21		N = 78	
Crops	13	59.1	16	57.1	16	76.2	45	57.7
Onions	13	59.1	12	42.9	1	4.8	26	33.3
Pepper powder	3	13.6	11	39.3	NC	0.0	14	17.9
Providing labour	6	27.3	4	14.3	1	4.8	11	14.1
Money	NC	0.0	2	7.1	2	9.5	4	5.1
Hopes (*Gesho*)	3	13.6	NC	–	NC	–	3	3.8
Milk	NC	–	NC	–	2	9.5	2	2.6
Shiro powder	NC	–	1	3.6	NC	–	1	1.3
Potato	1	4.5	NC	–	NC	–	1	1.3
Lend out oxen	NC	–	1	3.6	NC	–	1	1.3
Heifer	1	4.5	NC	–	NC	–	1	1.3

HHC = Household count, NC = Not considered as the types of gift by the highlanders.

As shown in Table 24, the overall average size of cattle herd kept per herder group was 58.8 ± 3.88. The size of the cattle herd in one group, however, was significantly higher in Dembia (72.3 ± 8.44) than in Chilga (45.9 ± 4.00), while it was intermediate in Gondar Zuria (58.8 ± 3.88), but not significantly different ($P > 0.05$) from herd sizes in Chilga and Dembia *woredas*.

As indicated in Table 24, cattle are trekked to the lowlands by different members of the household and these are composed of household heads (40.6%), children (29.7%) and relatives (24.2%). Only a small proportion of farmers use hired labour (3.1%) and neighbours (1.6%) (Table 24). According to key informants, at the time of trekking, body condition of animals is poor and some animals are so emaciated that they have difficulty in making the long journey. This makes the trekking difficult and takes longer time due to frequent resting on their way. Due to these reasons, some household heads travel to the lowlands ahead of time to identify areas with good feed resources and resting places.

Overall, the average number of individuals per trekking group was 2.8 ± 0.16 (Table 24), and did not differ significantly ($P>0.05$) among the three *woredas*. The overall average

number of herders per group in the lowlands was 2.2 ± 0.10. The average number of herders per group from Gondar Zuria (2.5 ± 0.27) was higher than those from Dembia (2.2 ± 0.18) and Chilga (2.0 ± 0.11) *woredas*. According to key informants, the number of trekkers per group were greater than the number of herders per group, and this is due to the need for more care to weak animals *en route* to their destination. About 57 and 52% of the respondents also indicated that their cattle are looked after in the lowlands by their family member and relatives, respectively. Respondents also revealed that young children (34.7%) and household heads (18.5%) are primarily responsible for herding the cattle. Very few respondents (4%) use hired labour for keeping their cattle in the lowlands.

Relationship of highlanders with the lowlanders

The types of relationships the highlanders have with the lowlanders are presented in Table 25. About 55.8% of respondents had different kinds of relationships with the lowlanders, whereas 44.2% had no relationship at all. Overall, 48.6% of the inhabitants in the highlands had family relationships;[2] whereas 51.4% of the inhabitants had other types of traditional (kinship) relationship[3]. Most of the respondents (76.0%) in Chilga district had family relationship with the lowlanders other than those in Gondar Zuria (35.0%) and Dembia (33.3%). This is perhaps due to the fact that Chilga district is adjacent to Metema district and most of the inhabitants live and work in Metema district. During focus group discussion, it was pointed out that the main objective of making relationship with the lowlanders was safety and access to grazing areas.

It was interesting to note that the transhumant from the highlands carry some gifts to the lowlanders. Out of the total respondents interviewed, 91% indicated that they often carry gifts to the lowlanders, while 9% did not practise this. All the respondents in Dembia and Gondar Zuria districts and most in Chilga (75.9%) indicated that they present different types of gifts to the lowlanders. About 24% of the respondents in Chilga district had no experience of presenting gifts (Table 25). Key informants in the highlands indicated that the objectives of providing gifts to the lowlanders were to strengthen their relationships with the lowlanders. The major types of gifts were different types of crops (57.7%), onion (33.3%), pepper powder (17.9%) and labour (17.1%). Very few provide money (5.1%), hopes or '*gesho*' (3.8%), and milk (2.6%).

2. Family relationships includes brother, sister, father, uncle etc.

3. Other relationships represent Abeleje, Mizie, Tute Metabate etc.

4.2.2 Cattle management

Feeds and feeding system by the highlanders

The major feed resources used by the highlanders at their home places are presented in Table 26. Overall, the major feed resources used in the highlands were crop residues, hay, natural pasture, oil seed cake and cereal concentrates. Among the major feed resources, hay was given first rank in Chilga and Gondar Zuria *woredas*. However, crop residues ranked first in Dembia and second in Chilga and Gondar Zuria *woredas*.

Table 26. *Major feed sources and its ranking by the highlanders at its home places*

Major feed sources	Chilga			Dembia			Gondar Zuria			Overall		
	N	WM	Rank	N	WM	Rank	N	WM	Rank	N	WM	Rank
Crop residues	58	1.97	2	59	1.56	1	54	2.019	2	177	1.78	1
Hay	53	1.55	1	44	2.59	3	57	1.68	1	154	1.89	2
Natural grazing land	47	2.34	3	58	1.81	2	44	2.36	3	149	2.14	3
Oil seed cakes	19	3.32	4	7	3.57	5	42	3.38	4	68	3.38	4
Concentrates	8	4.00	5	16	3.44	4	10	4.30	5	34	3.82	5

WM = Weighted mean.

As indicated in Table 27, a higher proportion (84.3%) of the respondents experienced feed shortage, whereas 15.7% indicated that they had no shortage of feeds. In the highlands, 46.4% of the respondents use improved forages. The types of improved forages used by the highlanders were *Sesbania sesban* (77.1%), vetch (36.1%), *Ficus thonningii (chibeha* in Amharic) (15.7%), Napier grass (10.8%) and oats (8.4%) (Table 27). The major reasons for not using improved forages were shortage of land (56.3%), lack of knowledge (34.0%) and unavailability of seed (4.9%). Shortage of land was more critical in Gondar Zuria (70.0%) than in Chilga (53.6%) and Dembia (42.9%) districts. Lack of knowledge on forages was the highest among respondents in Dembia (54.3%) than those in Chilga (35.7%) and Gondar Zuria (15.0%) districts. As discussed earlier, 84.3% of the respondents in the highlands face shortage of feeds and they fill the gap by purchasing different feeds like hay, oilseed cakes and other concentrates.

Breeding system

Data on breeding system, experience in animal selection and sources of bull for natural mating in Chilga, Dembia and Gondar Zuria are presented in Table 28. Out of the total households interviewed, 98.3 and 13.4% practised natural mating and artificial insemination, respectively. Relatively more respondents use their own bull for breeding in Gondar Zuria (47.2%) than in Dembia (46.4%) and Chilga (28.6%) *woredas*. On the other hand, proportionately more households used either neighbour's bull or relied on

open mating in Chilga (64.3 and 14.3%), respectively, and Dembia (57.1 and 7.1%) *woredas*, respectively. Use of own breeding bull for mating may be associated with awareness of selecting the best cattle type. In general, most of the respondents (59.4%) do not have their own bull; and they relied on bulls that belonged to their neighbours in the village (57.6%) or left their cows for open mating in communal grazing areas (11.5%).

Table 27. *Experience of cultivating improved pasture, feed shortage and feed purchasing at the highland area*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Experience of feed shortage?	N = 59		N = 59		N = 60		N = 178	
Yes	53	89.9	49	83.1	48	80.0	150	84.3
No	6	10.2	10	16.9	12	20.0	28	15.7
Cultivating improved forage	N = 59		N = 60		N = 60		N = 179	
Yes	33	55.9	25	41.7	25	41.7	83	46.4
No	26	44.1	35	58.3	35	58.3	96	53.6
Types of cultivated forage	N = 32		N = 26		N = 25		N = 83	
Sesbania	27	84.4	24	92.3	13	52.0	64	77.1
Vetch	16	50.0	5	19.2	9	36.0	30	36.1
Ficus thonningii (Chibeha)	4	12.5	1	3.8	8	32.0	13	15.7
Napier grass	5	15.6	4	15.4	NC		9	10.8
Oats	6	18.8	NC		1	4.0	7	8.4
Reasons for not practising improved forage?	N = 28		N = 35		N = 40		N = 103	
Shortage of land	15	53.6	15	42.9	28	70.0	58	56.3
Lack of knowledge	10	35.7	19	54.3	6	15.0	35	34.0
No seeds available	1	3.6	NC		4	10.0	5	4.9
No shortage of feeds	2	7.1	1	2.9	2	5.0	5	4.9
Experience of feed purchasing?	N = 59		N = 59		N = 60		N = 178	
Yes	52	88.1	51	86.4	56	93.3	159	89.3
No	7	11.9	8	13.6	4	6.7	19	10.7

HHC = Household count, NC = Not considered.

Farmers who use artificial insemination do crossbreed their local animals with Holstein Friesian breed for dairying purposes. According to the respondents, the percentage of farmers that have access to artificial insemination service was 20.7% in Dembia, 13.4% in Gondar Zuria (13.4%) and 8.6% in Chilga (8.6%) *woredas*. Discussion with key informants revealed that progress on the use of artificial insemination service is limited and has not progressed as expected. A high proportion (63.1%) of the respondents does not use AI technology due to lack of knowledge. Other reasons for not using AI were accessibility (9%), problem of heat detection (7.2%), high feed requirement and less disease resistance of crossbred cows (5.4%) and the small body size of the local cows (3.6%).

Table 28. *Proportion of households that practice different types of breeding and source of breeding bull in the highland districts*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Type of breeding	N = 58		N = 58		N = 56		N = 172	
Natural	58	100.0	56	96.6	55	98.2	169	98.3
AI	5	8.6	12	20.7	6	10.7	23	13.4
Experience in using AI	N = 46		N = 54		N = 37		N = 137	
Yes	6	13.0	11	20.4	4	10.8	21	15.3
No	40	87.0	43	79.6	33	89.2	116	84.7
Reasons for not using AI	N = 35		N = 37		N = 39		N = 111	
Lack of knowledge	19	54.3	27	73.0	24	61.5	70	63.1
No option	4	11.4	NC	–	6	15.4	10	9.0
No interest	1	2.9	1	2.7	6	15.4	8	7.2
Heat detection problem	2	5.7	4	10.8	2	5.2	8	7.2
High feed consumption and low disease resistance	4	11.4	2	5.4	NC	–	6	5.4
Bred at the lowlands	4	11.4	NC	–	1	2.6	5	5
Small size of cows	1	2.9	3	8.1	NC	–	4	3.6
Source of bulls	N = 56		N = 56		N = 53		N = 165	
Neighbours	36	64.3	32	57.1	27	50.9	95	57.6
Own	16	28.6	26	46.4	25	47.2	67	40.6
Open mating	8	14.3	4	7.1	7	13.2	19	11.5

HHC = Household count.

4.2.3 Productive and reproductive performance of cattle

Milk yield

Data on milk off-take from indigenous cows in Chilga, Dembia and Gondar Zuria are presented in Table 29. The average daily milk yield per cow in Chilga (2.4 ± 0.11 litres) was significantly higher ($P<0.05$) than those in Dembia (1.7 ± 0.11 litres), while the average daily milk yield in Gondar Zuria (2.0 ± 0.13 litres) did not differ from that of cows in Chilga and Dembia *woredas*. The overall average milk off-take from indigenous cows was 2.0 ± 0.07 litres/head/day. The value obtained in the current study is comparable with the average daily milk off-take of 2 litres reported by Brokken and Senait (1992) for local cows in Ethiopia. Moreover, comparable result (1.9 ± 0.05 litres per head/day) was obtained in Metema (Tesfaye 2008). In contrast, Lemma et al. (2005) reported lower average milk off-take of 1.0 litre for local Arsi cows in East Shoa Zone of Oromia Region.

The overall average lactation yield of indigenous cows was 540 ± 21.05 litres per head (Table 29). The average lactation yield obtained in Chilga (698.5 ± 34.15 litres/head) was significantly ($P<0.05$) higher than those in Gondar Zuria (512.8 ± 36.31 litres/head) and Dembia (405.5 ± 27.65 litres/head) *woredas*, though the difference between the latter

two was not significant. The value obtained in the current study is higher than the average reported by Ababu et al. (2004) for local cows (399.5 litres/cow/lactation) in Degem *woreda*. In addition, Azage and Alemu (1998) reported lower (213 kg) lactation yield vale as a national average for indigenous cows. Tesfaye (2008) also reported lower lactation yield (324.0 ± 10.27 litres per head) in the lowlands of Metema district. On the other hand, the result from the present study is lower than the average lactation yield of 672 kg reported for Barca cows (Million and Tadelle 2003).

Table 29. *Productive and reproductive performance of indigenous cows in the study area*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)
DMY (litre)	58	2.4 (0.11)^{a}	57	1.7 (0.11)^{b}	56	2.0 (0.13)^{ab}	171	2.0 (0.07)
LY (litre)	58	698.5 (34.15)^{a}	57	405.5 (27.65)^{b}	56	512.8 (36.31)^{b}	171	540.0 (21.05)
LL (month)	58	10.1 (0.29)^{a}	57	7.9 (0.17)^{b}	56	8.6 (0.29)^{b}	171	8.9 (0.16)
WA (month)	56	12.3 (0.45)^{a}	57	11.5 (0.43)^{a}	55	10.9 (0.44)^{a}	168	11.6 (0.26)
AFC (year)	58	5.0 (0.18)^{a}	58	5.0 (0.09)^{a}	57	5.7 (0.89)^{a}	173	5.2 (0.30)
CI (month)	56	19.6 (0.62)^{a}	57	18.6 (0.68)^{a}	54	18.9 (0.68)^{a}	167	19.0 (0.38)
CC (No)	56	6.6 (0.19)^{a}	57	8.4 (1.37)^{a}	55	7.2 (0.21)^{a}	168	7.4 (0.47)

Values with the same superscript within the same rows do not significantly differ at 5 % level of significance. Superscript ab does not significantly differ with both superscript a and b within the same rows at 5% level of significance. HHC = Household count; DMY = Daily milk yield; LY = Lactation yield; LL = Lactation length; WA = Weaning age; AFC = Age at first calving; CI = Calving interval; CC = Calf crop.

Lactation length

As indicated in Table 29, the overall average lactation length of indigenous cows was 8.9 ± 0.162 months, and was significantly longer ($P<0.05$) in cows in Chilga (10.1 ± 0.0.29 months) than those in Dembia (7.9 ± 0.17) Gondar Zuria (8.6 ± 0.29) districts. The difference between the latter two districts was not significant. The average lactation length obtained in the present study is higher than the values reported by Mulugeta et al. (1993), Ababu et al. (2004) and Tesfaye (2008) for local cows at Bako Agricultural Research Centre (6 months), northwest Shoa (183 days) and Metema district (5.9 ± 0.14 months), respectively. The present result was, however, comparable with the values (5 to 12 months with an average of 9.5 months) for local cows in East Shoa Zone of Oromia (Lemma et al. 2005). Other higher values of 450 days for the Friesian–Boran crossbred cows at Cheffa farm in Oromia (Gebeyehu and Hegde 2003) and 474 days for cows with 7/8 and 15/16 Friesian inheritance was reported (Gebeyehu 2005).

Weaning age

As indicated in Table 29, the average weaning age of calves was 11.6 ± 0.26 months, and did not differ significantly ($P>0.05$) among *woredas*. This value is longer than the weaning age of 9.9 ± 0.28 months reported in Metema *woreda* (Tesfaye 2008).

Age at first calving (AFC)

The overall mean age at first calving of local cows was 5.2 ± 0.299 years, and did not vary among the three *woredas*. The value obtained in the current study was comparable with the values (60 months) reported for Horro cattle at farm level (Gizaw et al. 1998). In contrast, lower values have been reported for Zebu cows in Metema (4.54 ± 0.05 years) (Tesfaye 2008), for Fogera cows (47.61 months) at Metekel ranch (Addisu and Hegede 2003), for Zebu cows (49.5 ± 3.34 months) in Mali (Wilson 1986). Mukasa-Mugerwa (1989) reported AFC of 44 months for Zebu cows in tropical regions based on published literature.

Calving interval

The overall mean calving interval of indigenous cows was 19.0 ± 0.38 months (Table 29), and did not vary among the three *woredas*. The value obtained in the present work was comparable to the result reported for Zebu cattle in Metema (17.9 ± 0.31 months) (Tesfaye 2008), at Metekel ranch for Fogera cows (559 days) (Addisu and Hegede 2003) and in Degem district for local cows (563 days) (Ababu et al. 2004). In contrast, the overall mean calving interval was higher than the 12.2 months for Horro and 12.9–15.1 months for Arsi cows in Ethiopia (Mukasa-Mugerwa 1989). On the other hand, the mean calving interval was lower than the 665 ± 202.2 days reported for locals in Mali (Wilson 1986).

Lifetime calf crop

The overall mean calf crop number for the indigenous cows in the studied areas was 7.4 ± 0.47 heads (Table 29), and did not vary between Dembia (8.4 ± 1.37 heads), Gondar Zuria (7.2 ± 0.21) and Chilga (6.6 ± 0.19 heads) districts. The overall mean value was comparable with the result of 7.5 ± 0.13 heads for Zebu cows in Metema (Tesfaye 2008). In contrast, lower value of 3.58 was recorded at Cheffa farm in Oromia Region (Gebeyehu 2005). Similar studies in Ethiopia showed that local cows with 50, 75 and 87.5% Holstein Friesian blood level on the average produced 4.7, 3.4 and 2.0 calves in their life time, respectively (Ababu et al. 2004).

4.2.4 Live cattle and animal products marketing

Live cattle marketing

Overall, about a quarter of the respondents in the three highland districts have experience in marketing of different types of cattle during their stay in the lowlands (Table 30).

However, the percentage was higher among respondents from Gondar Zuria (46.2%) than those from Chilga (24.1%) and Dembia (12.5%) districts. The remaining three-fourth of the respondents trekked all their cattle back to the highlands at the end of the rainy season.

Table 30. *Experience of cattle marketing, types of cattle marketed and reason for selling while transhumant are found in the lowland area*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Experience of cattle selling	N = 54		N = 48		N = 26		N = 128	
Yes	13	24.1	6	12.5	12	46.2	31	24.2
No	41	75.9	42	87.5	14	53.8	97	75.8
Types of cattle sold in the lowlands	N = 13		N = 6		N = 12		N = 31	
Dry cows	7	53.8	5	83.3	9	75.0	21	67.7
Oxen	9	69.2	2	33.3	7	58.3	18	58.1
Heifers	1	7.7	0	0.0	5	41.7	6	19.4
Young bullock	2	15.4	1	16.7	0	0.0	3	9.7
Milking cows	1	7.7	0	0.0	1	8.3	2	6.5
Pregnant cows	1	7.7	0	0.0	0	0.0	1	3.2
Calves	0	0.0	0	0.0	1	8.3	1	3.2
Major reasons for selling	N = 12		N = 5		N = 12		N = 29	
Attractive price	5	41.7	0	0.0	5	41.7	10	34.5
Improve the stock	5	41.7	2	40.0	2	16.7	9	31.0
Shortage of cash	2	16.7	3	60.0	5	41.6	10	34.5
Types of buyers in the lowlands	N = 9		N = 6		N = 12		N = 27	
Traders	6	66.7	3	50.0	9	75.0	18	66.7
Farmers	3	33.3	0	0.0	10	83.3	13	48.1
Urban consumers	1	11.1	3	50.0	0	0.0	4	14.8
Butchers	1	11.1	0	0.0	1	8.3	2	7.4

HHC = Household count. Milk and milk product marketing.

Among those who experienced marketing of cattle, 67.7 and 58.1% of respondents sold predominantly dry cows and oxen, respectively (Table 30), while only 19.4 and 9.7% marketed heifers and young bullocks, respectively. On the other hand, even though milking cows, pregnant cows and calves were considered as a marketable commodity, their percentage was minimal. The main reasons for sale of cattle were attractive prices (34.5%) to solve their cash shortage (34.5%) and to improve their stock (31.0%). Oxen fetch higher prices in the lowlands due to the cross border trade to the Sudan. Dry cows are mostly sold due to old age and when there is a need to improve the stock. The major types of cattle buyers in the lowlands were traders (66.7%), farmers (48.1%), urban customers (14.8%) and butchers (7.4%).

In the highlands

Experience of milk and milk product selling and the types of products provided to the market by the highlanders are presented in Table 31. Overall, most of the respondents

(86.4%) in the highland districts had experience of selling different dairy products to consumers, traders, and catering agents. All respondents in Dembia and Gondar Zuria and 64% of those in Chilga district had experience of selling milk and milk products in the highlands. However, 36% of the respondents in Chilga district had no experience of selling milk and milk products around their home place probably because of their distance from main urban centres.

Table 31. *Experience of milk and milk products marketing and the types of products marketed by the highlanders while in the highlands*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%		
Experience of milk and milk products marketing?	N = 50		N = 52		N = 30			
Yes	32	64	52	100	30	100	N = 114	86.4
No	18	36	0	0	0	0	N = 18	13.6
Dairy products marketed	N = 32		N = 52		N = 30		N = 114	
Butter	31	96.9	50	96.2	28	93.3	109	95.6
Raw milk	4	12.5	10	19.2	7	23.3	21	18.4
Ergo	0	0.0	3	5.8	1	3.3	4	3.5
Butter milk	0	0.0	2	3.8	1	3.3	3	2.6

HHC = Household count.

Butter was cited as the most important marketable dairy product for the respondents in Chilga (96.9%), Dembia (96.2%) and Gondar Zuria (93.3%) On the other hand, comparatively higher percentage (23.3%) of the respondents in Gondar Zuria experienced raw milk selling than those in Dembia (19.2%) and Chilga (12.5%) districts. Overall, as reported by most of the households (95.6%), in the highland, butter was one of the most important saleable dairy products when they are found in the highland area. Very few number of households (6.1%) provided fermented milk (*ergo*) and butter milk to the market.

In the lowlands

Overall, most of the transhumant (92.2%) had experience of selling milk and milk products during their stay in the lowlands (Table 32). All respondents from Dembia and Gondar Zuria districts have experience in dairy marketing. In Chilga district, however, about 18.4% of the respondents tended to transport their dairy products, mainly butter, to their homestead in the highlands as their district is closer to Metema.

Table 32. *Experience of milk and milk product selling and the types of products provided to the market by the highlanders during their stay in the lowlands.*

Variables	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
Experience of milk and milk products marketing?	N = 49		N = 38		N = 28		N = 115	
Yes	40	81.6	38	100	28	100	106	92.2
No	9	18.4	0	0	0	0	9	7.8
Dairy products marketed	N = 40		N = 38		N = 28		N = 106	
Butter	38	95	38	100.0	25	89.3	101	95.3
Raw milk	32	80	20	52.6	13	46.4	65	61.3
Ergo	10	25	6	15.8	4	14.3	20	18.9
Butter milk	6	15	5	13.2	4	14.3	15	14.2

HHC = Household count.

Butter was the most important marketable dairy product in the lowlands, being the highest for respondents from Dembia (100%), followed by those from Chilga (95%) and Gondar Zuria (89.3%) districts. On the other hand, about 61.3% of the respondents market raw milk to the lowland community, with the highest being for those from Chilga (80.0%) followed by Dembia (52.6%) and Gondar Zuria (46.4%) districts. Some 18.9 and 14.2% of the respondents also market buttermilk and fermented milk (*ergo*), respectively. Key informants suggested that raw milk marketing was considered as the best options, provided that there is adequate market. This was because it could be easily disposed, without the need for making fermented milk and processing into butter making. It was also noted that at times conflict with the lowlanders leads to looting of dairy products and destruction of milk processing equipment from temporary camping sites of the transhumant.

4.3 Constraints to cattle production

4.3.1 In the highlands

Overall, the major constraints identified and prioritized according to their importance in the highland areas were shortage of land, theft, livestock diseases, human diseases, tick infestation, bloating and fly infestation (Table 33). Human disease was ranked fourth in Chilga and Dembia districts, while it was ranked sixth in Gondar Zuria district. This is perhaps due to better access to human health services in Gondar Zuria than in Chilga and Dembia districts. Moreover, tick infestation was ranked fourth in Gondar Zuria and fifth in Chilga and Dembia districts.

Table 33. *Major problems as prioritized by respondents of Chilga, Dembia and Gondar Zuria districts while they are in the highlands*

Major problems	Chilga			Dembia			G/Zuria			Overall		
	N	WM	Rank	N	WM	Rank	N	WM	Rank	N	WM	Rank
Animal diseases	43	2.4	3	47	2.6	3	33	2.6	3	123	2.5	3
Human diseases	20	3.1	4	30	2.6	4	16	4.0	6	68	2.9	4
Shortage of land	51	1.6	1	46	1.9	1	51	1.7	1	148	1.7	1
Theft problem	29	2.1	2	29	2.4	2	37	2.2	2	95	2.2	2
Tick problem	29	3.5	5	43	3.7	5	36	3.0	4	108	3.4	5
Bloating	3	3.7	6	NC	–	–	1	3.0	5	4	3.5	6
Flies	10	4.5	7	27	4.4	6	11	4.4	7	48	4.4	7

WM = Weighted Mean, NC = Not considered as a problem.

As indicated in Table 33, shortage of land was the most important constraint identified in the highland areas. The total average landholdings in the highland areas was 2.2 ha including the current rented in land. Out of these total average landholdings, 96% was cultivated during the rainy season and only 4.5% was left for grazing and hay making. During the rainy season, all livestock concentrate on a small communal grazing area nearby the villages. Due to overgrazing, the area becomes muddy and most grass species have disappeared. This has created serious and severe shortage of livestock feeds during the rainy season. This is one of the reasons why the highlanders practice transhumance system during the rainy season. Bloating was also mentioned as one of the most important problems in the highland areas. Bloating results when livestock consume predominantly trifolium species before the bloom stages. According to farmers, avoiding grazing early in the morning or using cut and carry feeding after wilting the legumes minimizes the risk of bloating. However, these options also have some practical problems. Grazing land management and forage development strategy should be given due attention to ameliorate the situation.

4.3.2 In the lowlands

Overall, out of the total households interviewed (N = 124), the major constraints identified and prioritized by the transhumant highlanders were conflicts with the lowlanders, cattle theft, different human diseases, livestock diseases, tick infestation, flies infestation and milk and milk products market problem (Table 34). Respondents from Chilga and Dembia districts identified similar ranking for the first four problems, i.e. conflict, theft, human diseases and cattle diseases.

Table 34. *Major problems as prioritized by respondents of Chilga, Dembia and Gondar Zuria districts during their stay in the lowlands*

Major problems	Chilga			Dembia			G/Zuria			Overall		
	N	WM	Rank	N	WM	Rank	N	WM	Rank	N	WM	Rank
Animal diseases	32	2.9	4	26	3.2	4	13	2.2	3	71	2.9	4
Tick infestation	22	3.9	6	12	3.8	7	12	2.7	5	46	3.6	5
Human diseases	31	2.5	3	26	3.0	3	14	2.0	2	71	2.6	3
Theft problem	28	2.1	2	37	1.7	2	15	2.5	4	80	2.0	2
Conflict with lowlanders	37	1.5	1	34	1.5	1	10	1.2	1	81	1.5	1
Market problem	9	4.2	7	3	3.3	5	1	3.0	6	13	3.9	7
Flies infestation	24	3.8	5	18	3.6	6	15	3.4	7	58	3.7	6

WM = Weighted.

As discussed earlier, conflict with the lowlanders was one of the most important problems. Although conflict has always been there, most of the respondents (73%) indicated that it became a serious problem between 1998 and 2008 (Table 35). About 70.4% of the highlanders think that this is due to mere hate, while some (7%) admitted that this was due to destruction of crops and arable land by the highland cattle. The complaints of the lowlanders noted by the highlanders were competition for feed (5.6%) and fear of transmittable livestock diseases (4.2%). Cattle rustling or theft by lowlanders was reported as a cause for conflict by 11.3% of the respondents. Moreover, some key informants also indicated that socially unaccepted behaviour of cattle herders is not tolerated by the lowlanders.

About 50.5% of the highlanders indicated that they depend on government support for conflict resolution. Other options to minimize conflict is delineation of grazing area in the lowlands reserved for the highlanders (21.9%), minimize the number of cattle going to the lowlands (18.1%) and create different kinds of family relationships with the lowlanders (9.5%).

As discussed earlier, cattle theft was also one of the most important constraints identified and ranked second by the highlanders. Looting of cattle by the lowlanders is a major causes for conflict. This problem should be solved through discussion with community leaders of both highland and lowland areas and the local government.

Livestock disease is a major problem to cattle production in the lowlands and is also another cause for conflict. The lowlanders fear that the highland cattle bring with them various types of diseases and are concerned that they may transmit these diseases to their animals. As a result, the lowlanders tend to keep their animals as far away from the herds of the transhumant. As presented in Table 36, the major common diseases of cattle

identified by the highlanders include babesiosis (79.9), lumpy skin disease (LSD) (72.5%), Foot-and-Mouth-Disease (55.0%), tick infestation (54.1%), swelling (body oedema) (49.5%), blackleg (*Mich*) (44.0%) and anthrax (43.1%).

Table 35. *Conflicts and resolution mechanisms between the highlanders and lowlanders*

Variables	Household count	Percent
Did you experience conflict with lowlanders?	N = 119	
Yes	67	56.3
No	52	43.7
When did the conflict start? (E.C.)	N = 67	
1960–1970	1	1.5
1971–1980	4	6.0
1981–1990	13	19.5
1991–2000	49	73.0
Reason given by highlanders for conflict	N = 71	
Simply they hated us	50	70.4
Destruction of crops by cattle	4	5.6
Need labour for agricultural activities	1	1.4
Lowlanders theft cattle	8	11.3
Competition for livestock feeds	4	5.6
Fear of livestock diseases	3	4.2
Destruct arable land by cattle	1	1.4
Possible solution suggested by highlander	N = 105	
Minimize cattle population sent to lowlands	19	18.1
Make relatives with the lowlands	10	9.5
Delineated grazing area in the lowlands	23	21.9
Government make solution	53	50.5

Table 36. *Major livestock diseases in the lowlands as identified by highlanders*

Major diseases	Chilga		Dembia		Gondar Zuria		Overall	
	HHC	%	HHC	%	HHC	%	HHC	%
	N = 50		N = 34		N = 25		N = 109	
Babesiosis	43	86.0	28	82.4	16	64.0	87	79.8
Lumpy skin Disease	33	66.0	30	88.2	16	64.0	79	72.5
Foot-and-Mouth disease	31	62.0	16	47.1	13	52.0	60	55.0
Tick infestation	35	70.0	12	35.3	12	48.0	59	54.1
Oedema	25	50.0	16	47.1	13	52.0	54	49.5
Blackleg	17	34.0	19	55.9	12	48.0	48	44.0
Anthrax	10	20.0	23	67.6	14	56.0	47	43.1
Parasites	22	44.0	18	52.9	7	28.0	47	43.1
Liver fluke	8	16.0	14	41.2	7	28.0	29	26.6

HHC = Household count.

Fly infestation was identified as a problem to livestock in the lowlands. Biting flies are quite common in the lowlands and their attack intensifies towards the end of the rainy

season and picks between September and October. This infestation of flies was one of the reasons that forces the highlanders to return home around October. The effects of these biting flies as identified by the transhumant are irritation of the skin, fly worry and restlessness of animals, reduced feed intake, body weight loss and decline in milk production.

As discussed with key informants, the transhumant herders use both traditional treatment and also various types of medicaments to treat their sick animals while in the lowlands. Accordingly, the transhumant arrange for various types of drugs before they travel to the lowlands. The herders also get informal training on disease diagnosis and drug administration from their fellow farmers. The major drugs used are various types of antibiotics and antihelminthics. Health posts vaccination and treatment of animals before the herders move to the lowlands and also when they come back to the highlands at the end of the rainy season are essential. As the transhumant are mobile during their stay in the lowlands, some formal training of the transhumant herders as paravets before they move their animals to the lowlands may be useful.

Lack of adequate market for milk and milk products was also considered as one of the problems that the highlanders face during their stay in the lowlands. The transhumant produce raw milk, fermented milk, butter and buttermilk as important dairy products. Some of these products are sold to the lowlanders in villages and urban centres. However, the local market is so limited, it cannot absorb all the produce. The strategy used by the transhumant is to convert the milk into butter and transport and market it the highland areas. In addition, the transhumant also regulate the milk production from their cows by partial milking.

5 Summary and conclusion

This study was undertaken in 2007 in three highland districts and one lowland district of North Gondar Zone, northwestern Ethiopia. The objectives of the study were to understand the transhumance cattle production system, identify the major constraints and provide possible solutions. The highland *woredas* are Chilga, Dembia and Gondar Zuria. Informal and formal surveys were employed to collect qualitative and quantitative data. Three districts and nine rural *kebeles* were selected purposively with the criteria of experience of transhumance and accessibility of the areas, respectively. A total of 180 representative households were selected using systematic random sampling methods. Semi-structured questionnaires and topical guidelines (checklists) were prepared and used to collect the necessary data.

The farming system in highland districts is characterized as intensive crop–livestock production system. The average land holdings of the highland areas were 2.2 ± 0.18 ha per household. The overall land allocation was 2.1 ± 0.18 ha for crops, 0.04 ± 0.01 ha for trees/fruits and 0.1 ± 0.01 ha for grazing lands. On the other hand, the average number of cattle holding per household was 8.7 ± 0.48 heads. The average herd structure per household showed was 2.4 ± 0.17 cows, 2.0 ± 0.16 calves, 2.0 ± 0.08 oxen, 1.4 ± 0.12 heifers and 0.3 ± 0.07 breeding bulls.

Livestock production system by the highlanders is characterized by mixed crop–livestock production and transhumance production system. Mixed crop–livestock production system was practised fully in the highland areas, whereas transhumance production system was practised to some extent in the highland and dominantly in the lowland areas by the highlanders. Transhumance production system is categorized into two, namely, dry and rainy season transhumance. Even though most of the highlanders did not practice transhumance production system during the dry season, only 15% of the highlanders take their animals to the wet lands around Lake Tana shore for grazing to overcome feed shortage. Because of its location in the same district, most of the time, dry season transhumance was mainly limited to Dembia district. On the other hand, most of the highlanders (75.0%) used to trek their cattle to the lowlands during the rainy season. Among the reasons forwarded by the highlanders why cattle trekked to the lowland areas, abundant livestock feeds (99.2%), availability of free land areas for stocking (92.4%), disease free areas (25.0%) and mud free areas (0.8%) were the major ones.

Preferred districts by the highland farmers to practice transhumant cattle production during the rainy season were Metema (84.0%), Armachiho (9.6%), Quara (4.0%) and Alefa and Chilga (0.8% each). The selection of lowland areas depended on availability of

good quality and adequate quantity of feed resources (91.0%), presence of relatives in the lowlands (5.7%) and proximity to their home district (1.6%).

Selection of specific time for trekking of their cattle to the lowland depended on the severity of feed shortage and land for stoking, the start of rain in the lowlands, and availability of labour. In most instances, farmers commence trekking their animals to the lowlands in May (69.5%), June (29.6%) and April (0.8%). Farmers return to the highlands in October (45.8%) and September (35.9%). The timing of return to the highlands depended on ambient temperature, availability of crop aftermath in the highlands, biting flies, and demand for labour in the highlands.

There are three major routes for transhumance to the lowlands. These routes were commonly well known by the transhumant. Along the routes, there are places commonly named by the transhumant and these places were used for resting cattle after long hours trekking. The selection of routes depended on distance to reach, availability of enough forage, and availability of non-crop covered areas. Whatever the routes are chosen, the most important destination for the transhumant is Agamwuha *kebele* (Lemlem Terara) in Metema district.

Indigenous breeds of cattle are the only livestock species taken to the lowlands. Donkeys accompany the transhumants and are used to transport their luggage. Crossbred cattle are not included in the herd because the transhumants believe that crossbreeds could not tolerate the high ambient temperature, disease load and the long trekking distance. Among the different cattle age and sex groups, heifers (97.6%), young bullocks (84.4%), dry cows (82.1%), calves (70.9%) and milking cows (62.3%), breeding bulls (21.7%) and oxen (6.7%) were taken to the lowlands according to their priority. In terms of cattle population, it is estimated that 60.3% of cattle population is trekked to the lowlands during the rainy season.

The transhumant used different size of labour for trekking and herding their animals in the lowlands. The number of individuals per group was higher form trekking (2.8 ± 0.156) than herding (2.2 ± 0.102) due to the need for extra care and management of animals while being moved. Grouping is considered as an important mechanism to optimize labour use and to protect their cattle from theft. Groups are commonly formed among relatives and to some extent with neighbours. The average number of cattle owners and the size of the cattle herd involved in one group were 4.3 ± 0.175 and 58.8 ± 3.884, respectively.

Most of the transhumants have established different types of relationships with the lowlanders to ensure their safety and not to be driven out from the lowlands. These

different types of relationships were also strengthened by provision of gifts in the forms of cash and/or in kind. These relationships and provision of gifts serve as one of the conflict management mechanisms between the highlanders and lowlanders.

Regarding productive performance of animals, the average daily milk off-take and the average lactation yield of the indigenous cows was about 2.0 ± 0.070 litres/cow/day and 540 ± 21.053 litres, respectively. The average lactation length of indigenous cows was estimated at 8.9 ± 0.162 months. The mean weaning age of calves was 11.6 ± 0.257 months. The mean age at first calving of heifers and calving interval of cows was 5.2 ± 0.299 years and 19.0 ± 0.380 months, respectively. The mean lifetime calf crop production was estimated 7.4 ± 0.474 heads.

About 86.4% of the respondents who practice transhumance have experience of selling different dairy products to consumers, traders, and catering agents in the highlands. These farmers indicated that the major diary products they sell were butter (95.6%) followed by raw milk (18.4%) and fermented milk (*Ergo*) and buttermilk (6.1%). Similarly, milk is a major product for the transhumance during their stay in the lowlands. Marketing of milk to the lowlanders depends on the location of highlanders. However, during the transhumance period, most of the transhumant (92.2%) have experienced marketing milk and milk products. Butter (95.3%) was the major marketable commodity followed by raw milk (61.3%), buttermilk (18.9%) and fermented milk (14.2%).

The transhumants ferment the fresh whole milk into sour milk prior to churning after 24 hours (69.6%), or three days (17.4%) or two days (8.7%) interval depending on the volume of milk produced. They keep the fermented milk (Ergo) inside their temporary accommodation (hut) (72.7%), underground by digging a hole (14.5%), simply by covering the milk utensils with grass (8.2%) around their temporary places, hanging on a tree branch (3.6%) and inside a cave (0.9%) during daytime. These storage systems are used to protect from theft by the lowlanders and to some extent from wild animals. Butter is also kept inside their temporary accommodation (hut) (44.4%), underground by digging a hole (29.6%), in relative's house (22.2%), hanging on a tree (2.8%) and simply kept around temporary places by covering with grass (0.9%). Milking, churning of fermented milk, butter processing and selling of dairy products are performed by the herders themselves. The experience of marketing different dairy products by the transhumants has given lesson to the lowlanders to market their dairy products. There is a large quantity of milk produced by the transhumant and lowlanders in Metema district during the rainy season, and this needs to be further developed into a more organized marketable commodity. The sector can create job opportunities of the people in the district by collecting, processing and marketing dairy products.

About a quarter of inhabitants found in the highland areas of North Gondar Zone had experience of selling different age groups of cattle during the transhumance period in the lowland area. In most cases, transhumants sell dry cows and oxen, while heifers and young bullocks were marketed as secondary options. The major cattle buyers are traders (66.7%), farmers (48.1%), urban customers (14.8%) and butchers (7.4%).

The highlanders face various constraints in their livestock production both in the highlands and the lowland areas. The major constraints in the highlands are shortage of land, theft, livestock diseases, human diseases, tick infestation, bloating and fly infestation. In the lowlands, the major challenges for the transhumant are conflict with lowlanders, cattle theft, different human and livestock diseases, tick infestation, flies infestation and milk and milk products marketing. These issues need attention and should be addressed. Proper animal health care, good management of grazing land and other feed resources, community-based conflict management, provision of improved technology and ideas through awareness and appropriate training to the community are critical to this production system. In recent years, the human population has been increasing in the lowlands, and the current infrastructure development in the lowlands (tarmac road, electricity, phone etc.) will further encourage more migration to the lowlands. The conflict over resources will intensify, probably leading to the demise of this production system unless alterative development strategies, such as intensification of the production system in the highlands and development of feed conservation and marketing in the lowlands are devised.

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