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# Executive summary

A Participatory Rural Appraisal (PRA) study was conducted across eight systematically selected villages in East Wollega zone of the Oromia region, Ethiopia. The objectives of the study were mainly to assess the overall trends and prospects for crop–livestock production; utilization/allocation of main and by-products; characterization of crop residue transactions; and identification of the major determinants in crop residue use.

According to the current study, the size of farm land allocated for crop production has increased by 35% per village during the last decade presumably related to an increase in population leading to deforestation and replacement of grazing land by crop land. In contrast, the number of cattle, sheep, goats and donkeys decreased in most of the study villages during the last decade mainly due to critical feed shortage, an increase in internal and external parasites, disease and insect prevalence, limited veterinary services, lack of training for new animal production technology, lack of capital and poor genetic performance of local cattle for meat and milk yield. The increase in human population together with the decrease in productivity per unit area is putting additional pressure on grazing land. This in turn has forced farmers to use crop residues as a supplementary animal feed during some months of the year and for emergency feeding when the dry season is prolonged. Some of the major factors influencing crop residue use were distance from market centre, the size and intensity of grazing land, coverage of forest lands, farmers' knowledge level, agro-ecology, wealth status of farmers, climatic and edaphic factors.

Across all villages, teff straw is the major crop residue used for different purposes. On average, 38% of teff straw is used for stall feeding and 28% sold at market. Finger millet straw, maize and sorghum stover are also important crop residues mainly used for stubble grazing and household fuel sources. In general, intensification of the current crop residue use system with wise management and proper allocation has had a positive impact on the livelihood of farmers since crop residue is used to fill the gap of prevailing feed shortage, used as a source of income, and used as fuel wood to minimize the problem of deforestation and climate change. Though not deliberately practised, the residue left on crop fields has also an important role in restoring soil fertility.

# 1 Introduction

Mixed crop–livestock farming systems comprise a large proportion of farming systems in the tropics and about 60% of livestock production in Africa is associated with mixed crop–livestock farming systems (World Bank 1987). Farming systems that successfully integrate crop and livestock enterprises stand to gain many benefits that can have a direct impact on whole farm production. Ruminant animals are especially desirable due to their ability to convert forages, browse and crop residues that have high cellulose into useful food and fibre products. Such animals provide system diversification, recycling of nutrients, enhanced soil fertility, power and transportation and act as biological 'savings accounts' for farmers during stress periods. Nevertheless, even with the potential for synergies, if the system is managed to excessively favour either crops or livestock, synergies are lost and detrimental effects may result (de Leeuw 1997).

The intensification of this system is mainly due to demographic pressure leading to an increase in demand for crop and livestock products. In such a system, crop residues are becoming an important production component and play an important role mainly as food, feed, fuel, and soil nutrient balancing. Kossila (1988) indicated that the potential for use of crop residues as livestock feed is greatest in integrated crop–livestock farming systems.

Emphasizing crop–livestock relations, McDowell (1988) identified prevailing systems on small, mixed farms in Africa, Asia and Latin America. About 10 major systems with 22 subsystems were identified in Africa. In all the 22 subsystems, dependence of livestock on crop residue was high. Owen and Aboud (1987) predicted that with the world population expected to be double by 2025 (even treble in the developing tropics), cereal production, and hence straw production will have to increase. With the increased pressure on land for food production, less land will be available to produce animal feed, either from pasture or fodder crops, and crop residue will assume even greater importance as animal feed. This will lead to greater integration of crop and animal production.

Besides serving as animal feed, crop residues have several other uses. In South Asia, crop residues are used as compost and mulch for crop production, bedding for livestock, a substrate for growing mushroom, fibre for paper manufacture and as fuel (Underwood et al. 2000). In semi-arid sub-Saharan Africa (SSA), they are used to control wind erosion and in the construction of roofs, fences, granaries, beds and doormats (de Leeuw 1997). Research has also shown that annual incorporation of millet stover into the sandy soils of semi-arid SSA0 increases soil pH, organic matter content and exchangeable cations and crop yield. In Ethiopia in general, and in western Oromia in particular, crop residues have several roles. However, the quantity used for the different purpose and the relative returns to different uses have not been well described. Therefore, this study aims at studying the decision making processes at the farm/household level to capture the diversity/contrasts and recent changes in crop residue use at various levels around Nekemte *woreda* of western Oromia, Ethiopia in order to better target technical, institutional and policy options to improve the livelihoods of the poor.

# 2 Objectives

1. To identify the major determinants in the decision making process on crop residue use at farm level
2. To assess the implications of crop residue use decisions on livelihoods and the environment
3. To assess overall crop and livestock production, productivity, utilization and allocation of main products and by-products to different uses
4. To determine trends and future prospects for crop–livestock mixed farming in relation to crop residue use
5. Characterization of feeding strategies and crop residue transactions in different seasons.

# 3 Methods

## 3.1 Market centre identification

The market centre, Nekemte town, was selected based on availability of agricultural inputs and market access to agricultural main and by-products. It is located at 331 km west of Addis Ababa at an altitude ranging from 1950–2085 masl. It is the capital city of East Wollega Zone.

## 3.2 Study village selection and verification

As this research exercise was part of a larger globally implemented project, similar and systematic village selection strategies were used across a number of global study sites. Accordingly, villages near to the market centre and main road, villages near to market centre but far from main road, villages far from market centre but near to main road and, villages far from both market centre and main road were selected based on coordinate readings from Google Earth. For each category, two villages were selected by scrutinizing aerial images from Google Earth. The household density was also considered. The nearest site or village on the highway selected in Google Earth was located as departing point to the selected village guided by GPS reading for village verification while navigating along the highway.

The centres of the study village were identified using GPS readings to specify the altitude, latitude and longitude of the selected area. Accordingly, eight villages around Nekemte town namely, Beqo, Gombo Boneya, Mandara Bake, Kibi, Boneya, Bata, Lugo and Gajo were selected and delineated. Detailed information regarding each village is given in Annex 1.

## 3.3 Household selection

Social factors such as wealth status and gender were considered during household sampling. From the total number of households in the village, at least 10 households representing different social groups were selected for village level survey. Wealth categories were identified before sampling depending on the number of cattle/livestock owned, land holding size and other capital assets. Accordingly, poor, medium and rich class household classes were included in the study.

## 3.4 Survey (data collection and analysis)

A village survey instrument was prepared, and pre-tested in some villages to ensure a thorough understanding of the questions by the researchers (Figure 1). Village land area, use of cropping technologies, use of crop residues, trends of crop residue use, main constraints of crop production and composition of feed intake for ruminants with villagers are some of the guiding points included in the questionnaire. Representative social groups of 10–20 farmers were identified in each village and they responded as a group during the final village survey (Figure 2). The survey took place in August 2010. Resource mapping was also carried out for four selected villages. Descriptive data analysis was made using Statistical Packages for Social Sciences (SPSS).

**Figure 1.** *Pre-testing the village survey instruments.*

**Figure 2.** *Actual village survey with representative farmers.*

# 4 Results and discussion

## 4.1 Population size and assets category of the villages

The population of the villages ranged from 391 (Bata village of North Bandira) to 196 (Kibbi village). The average population per village was 259 and the average number of households was 51. Eight per cent of the households in the study area were landless, 20% had no livestock, 16% were female headed and 10% were below poverty line (Table 1).

**Table 1.** *Average population size, household number, land holding size and herds owned by eight villages sampled around Nekemte*

| Population size and assets | Mean | Std. deviation |
|---|---|---|
| Total village population | 259 | 61 |
| Total village households | 51 | 13 |
| Large farm hh | 22 | 10 |
| Small farm hh | 25 | 11 |
| Landless/non-cultivating hh | 4 | 6 |
| Large herd hh | 17 | 8 |
| Small herd hh | 25 | 7 |
| HH no livestock (ruminants/pigs) | 10 | 8 |
| HH no dairy animals | 16 | 13 |
| HH no poultry | 13 | 10 |
| HH providing agricultural labour | 5 | 6 |
| HH with member working out of village | 3 | 4 |
| Female headed hh | 8 | 4 |
| HH below poverty line (BPL) | 5 | 4 |

Note: Poverty line refers for those hhs who do not access food at least twice a day.

## 4.2 Assets and trends related to farm land, grazing land and irrigation

The mean land size owned per single village was 113 ha, out of which 79% (89 ha) was farm land. In 2000, only 66 ha were ploughed out of 113 ha. This suggests that an increase in human population has led to deforestation and replacement of grazing land with crop land. Consequently, utilization of crop residue for animal feeds has become more prevalent in recent years. Only 1 ha per village was openly grazed, an average of 13 ha was grazing land with restricted access and about 87% of the total households per village reported using grazing land with restricted access. Currently, an average of 2 ha per village was under irrigation and about 27% of households share this limited irrigated land (Table 2).

**Table 2.** *Land and irrigation ownership/distribution across eight villages around Nekemte*

| | Mean | Std. deviation |
|---|---|---|
| Village land, total (ha) | 113 | – |
| Cultivated total (ha) | 89 | – |
| Rainfed, current (ha) | 87 | 28 |
| Rainfed, 10 years ago (ha) | 66 | 15 |
| Irrigated, current (ha) | 2 | 3 |
| Irrigated, 10 years ago (ha) | 0 | – |
| Grazing land open access, area (ha) | 1 | 2 |
| Grazing land restricted access, area (ha) | 13 | 9 |
| Grazing land restricted access, usage (% hh) | 87 | 29 |
| Irrigation use (% hh) | 27 | 36 |
| Irrigation by canal (%) | 0 | 0 |
| Irrigation by electric tube well (%) | 0 | 0 |
| Irrigation by diesel tube well (%) | 0 | 0 |
| Irrigation by river pump (%) | 0 | – |

## 4.3 Season classification

The months of the year were classified into three main seasons across all villages (Table 3). The first season covers from May/June to August/September. This season is also called the main crop growing season under rainfed conditions. The second season extends from September/October to December/January. This season is the period when most crops attain maturity and are harvested. In areas where there is irrigation and residual moisture, a few crops such as maize, barley and other horticultural crops are planted in this season. The third season is from January/February to April/May. This season is known by its dry spell and the start of land preparation for crops grown during the first season.

**Table 3.** *Seasonal definition and crop list across eight villages around Nekemte*

| | First season | Second season | Third season |
|---|---|---|---|
| Local name | Ganna/rainy season | Harvest season | Bona/dry season |
| First to last month | May/June–August/September | September/October–December/January | January/February–April/May |
| List of crops grown | Finger millet, teff, noug, sorghum, maize, barley, faba bean, horticultural crops, hot pepper, wheat, oat, potato | Maize, barley, potato, vegetables, anchote | – |

## 4.4 Types of crops produced and land allocated for each crop

Teff, maize, finger millet, bread wheat, barley, sorghum and potato are some of the major crops produced and occupy a substantial percentage of farm land. All farmers grow maize, potato and other horticultural crops such as onion and sweetpotato around homesteads although the area allocated to these crops is minor (Table 4). This diversification of crops per household helps to minimize risk of unexpected failures/disasters, efficient utilization of land, soil fertility management through the rotation system and also to minimize pest and disease problems. Soil type and fertility are the major determinants for the type of crops produced. Farmers in some of the study villages reported that the decline in soil fertility, along with limited access and the high price of inputs have led to yield problems for agricultural crops.

**Table 4.** *Average land allocated per crops and household growing crops in eight villages around Nekemte*

| Crop type | Average area allocated for the crop (ha) | Percentage area allocated for the crop | HH growing the crop (%) |
|---|---|---|---|
| Teff | 19 | 21 | 97 |
| Maize | 12 | 13 | 100 |
| Finger millet | 11 | 12 | 60 |
| Bread wheat | 8 | 9 | 45 |
| Barley | 7 | 8 | 58 |
| Noug | 7 | 8 | 59 |
| Sorghum | 7 | 8 | 96 |
| Potato | 6 | 7 | 100 |
| Hot pepper | 3 | 3 | 80 |
| Other horticultural crops | 3 | 3 | 100 |
| Faba bean | 2 | 2 | 40 |
| Field pea | 2 | 2 | 24 |
| Sweetpotato | 2 | 2 | 60 |

## 4.5 Intensification of crop technologies

Crop technologies have started to be used in the last decade in most of the study villages. For instance, application of commercial fertilizer, use of improved varieties, herbicide and manure application have increased over the last ten years. However, mechanized crop technologies such as tillage by tractor, seeding by drill, use of combine harvester and thresher are still not found. This is due to the subsistence nature of the farming system and lack of cash, and lack of the services to support technologies. Only 29% of households used improved seed during the 2009 cropping season (Table 5). This is mainly due to unavailability and high cost of inputs, particularly fertilizer and improved seed, the poor extension system (lack of awareness) and lack of capital.

**Table 5.** *Use of cropping technologies in eight villages around Nekemte*

| Cropping technologies | % area | % hh using | ↓ trend 10 yrs | ↑ trend 10 yrs |
|---|---|---|---|---|
| Tillage by tractor | 0 | 0 | 0 | 0 |
| Tillage by animal | 100 | 100 | 0 | 0 |
| Seeding by drill | 0 | 0 | 0 | 0 |
| New seed 2009 | 19 | 29 | 0 | 6 |
| Chemical fertilizer | 73 | 95 | 0 | 8 |
| Manure application | 22 | 93 | 0 | 6 |
| Hand weeding | 98 | 97 | 3 | 4 |
| Herbicide application | 51 | 91 | 0 | 8 |
| Pesticide application | 16 | 46 | 0 | 4 |
| Thresher use | 0 | 0 | 0 | 1 |
| Combine use | 0 | 0 | 0 | 0 |
| Chaff cutter/chopper | 0 | 0 | 0 | 0 |

NB: Figures under ↓ and ↑ trends are number of villages, total villages considered = 8.

## 4.6 Allocation of main product of major crops

Teff, maize, barley, bread wheat, finger millet and noug were major crops grown in the study area. Grain products of these crops are mainly used for household consumption, later sale and sources of seed. An increase in population size, cultivated land and productivity of these crops have raised the amount of grain consumed, sold and planted during the last decades. Feeding of grain products for livestock is not common across most of the study villages. But, some farmers practice feeding of boiled teff in one village (Mandara Bake) and finger millet cake, boiled barley and oats in two villages (Beko and Kawisa) for lactating cows and oxen. The allocation of teff grain for household consumption has decreased in two villages mainly due to the decrease in land size allocated for teff production. The increase in the price of teff has encouraged farmers to sell teff and use other grains for home consumption (Table 6).

**Table 6.** *Allocation of main crop product of major crops produced in the study area*

| Allocation of crop main product | Teff | | | Maize | | | Other crops | | |
|---|---|---|---|---|---|---|---|---|---|
| | Share (%) | ↓ trend 10 yrs | ↑ trend 10 yrs | Share (%) | ↓ trend 10 yrs | ↑ trend 10 yrs | Share (%) | ↓ trend 10 yrs | ↑ trend 10 yrs |
| Sold from field | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Payment in kind | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| HH consumption | 53 | 2 | 6 | 51 | 2 | 6 | 35 | 1 | 6 |
| Livestock feeding | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 2 | 1 |
| Later sale | 29 | 2 | 6 | 34 | 1 | 5 | 49 | 1 | 6 |
| For use as seed | 16 | 1 | 6 | 12 | 1 | 6 | 14 | 1 | 6 |
| For other uses | 2 | – | – | 3 | – | – | 2 | – | – |

Key: Figures under ↓ and ↑ trends are number of villages from eight villages considered in the study.
Other crops refer to barley, wheat, noug, and finger millet.
Other use refers to provision of grains for relatives, neighbouring and others free of charge.

## 4.7 Use of crop residues for most important crops and its trends

The use of crop residue depends on the type of the crops (Table 7). On average, 50% of teff straw is allocated for stall feeding, 22% for sale and 12% for construction. However, 41% of maize stover is used for stubble grazing by other farmers' animals, 34% by own animals and 24% for household fuel. For other crops such as barley, wheat, sorghum and finger millet, about 51% was used for stubble grazing by other farmers' animals, 19% for stubble grazing by own animals, 9% for stall feeding and 8% was burnt. None of the respondents across any of the villages reported deliberately using crop residues for mulching. However, small quantities of crop residues left on the field contributed to restoring soil fertility. Similarly, Unger and Baumhardt (2001) reported that crop residue retention through use of zero-tillage practices increased soil water content at planting and was primarily responsible for yield increases. The authors also indicated that the greater stover (residue) production, which, when properly managed, provided greater protection against erosion. Similarly, leaving crop residue on the soil surface year round, before and after planting provides soil surface protection at critical times to protect the soil against wind and water erosion (Lemunyon and Gross, undated). There is no or very limited effort observed to make crop residue palatable and supplement with concentrate or other nutritionally rich feeds. This is mainly due to lack of information and might also be due to unavailability of concentrate or cash constraints to purchase supplements.

During the last decade, allocation of crop residues for different purposes has changed (Table 7). Collecting, fencing and protecting of crop residue, particularly teff straw is practised mainly to preserve biomass for stall feeding, construction and marketing purposes. The decrease in area and productivity of grazing land due to land shortage or due to increase in population has forced farmers of all villages to conserve crop residues, especially teff straw and to practice stall feeding (Figure 3). Burning of crop residue and leaving it on the field deliberately to boost soil fertility or to maintain soil moisture is rarely practised. The gradual decline in forest coverage and hence shortage of fuel wood has led villagers in the study area to shift towards use of crop residues for this purpose. Maize and sorghum stover were commonly used for fuel wood and construction. An increase in population was another factor that has necessitated house construction and hence placed more pressure to use teff straw for this purpose.

**Figure 3.** *Stall feeding of teff straw.*

**Table 7.** *Use of crop residues of the most important crops at villages in Nekemte*

| Crop residue allocation | Teff residue (share in %) | Maize residue (share in %) | Residue from other crops (share in %) | Overall CR use ↓ trend 10 yrs | Overall CR use ↑ trend 10 yrs |
|---|---|---|---|---|---|
| In field: | | | | | |
| Left as mulch | 0 | 0 | 0 | 7 | 0 |
| Stubble grazing, own animals | 5 | 34 | 19 | 0 | 7 |
| Stubble grazing, by others | 6 | 41 | 51 | 5 | 0 |
| Burnt | 0 | 0 | 8 | 5 | 2 |
| Taken away from field: | | | | | |
| Sold | 1 | 0 | 0 | 0 | 2 |
| Given as payment in kind | 0 | 0 | 0 | 0 | 0 |
| Collected by others for free | 1 | 1 | 4 | 5 | 0 |
| Taken home for: | | | | | |
| Stall feeding | 50 | 0 | 11 | 0 | 8 |
| Household fuel | 0 | 24 | 2 | 0 | 8 |
| Roofing/construction | 10 | 0 | 0 | 0 | 7 |
| Sale | 20 | 0 | 0 | 0 | 4 |
| Other uses (plastering, thrashing floor, fencing material) | 7 | 0 | 5 | 0 | 8 |

Key: Figures under ↓ and ↑ trends are number of villages from the eight villages considered in the study.
Residue from other crops includes barley, wheat, sorghum and finger millet.
Total villages considered for the study were eight.

### 4.7.1 Some of the major determinants of crop residue use

#### 4.7.1.1 Distance from market centre

Selling of crop residue, particularly teff straw is largely dependent on the distance and accessibility to market centre. Therefore, villages nearby to Nekemte town such as Gombo Boneya, Lugo, Gajo and Boneya commonly market teff straw in Nekemte market, mainly for construction purpose and some for stall feeding (Table 8 and Figure 4).

**Table 8.** *Percentage of teff straw allocated for different purpose*

| Village | Distance from Nekemte | % of straw used for different purpose | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | MK | SF | SGO | SGOT | CON | TBO | BR |
| Beko | 27 | 0 | 80 | 8 | 2 | 5 | 0 | 5 |
| Gombo Boneya | 5 | 40 | 20 | 20 | 10 | 10 | 0 | 0 |
| Mandara Bake | 32 | 0 | 60 | 0 | 0 | 15 | 0 | 25 |
| Kibbi | 22 | 10 | 60 | 10 | 5 | 15 | 0 | 0 |
| Boneya | 16 | 45 | 30 | 3 | 3 | 15 | 4 | 0 |
| Bata | 41 | 0 | 20 | 0 | 30 | 5 | 30 | 15 |
| Lugo | 10 | 70 | 10 | 10 | 5 | 5 | 0 | 0 |
| Gajo | 5 | 60 | 25 | 2.5 | 2.5 | 5 | 5 | 0 |

Key: MK = market, SF = stall feeding, SGO = stubble grazing by own animal, SGOT = stubble grazing by others, CON = construction, TBO = taken by others, BR = burnt.

**Figure 4.** *Women transporting teff straw for various competing uses.*

#### 4.7.1.2 The coverage and intensity of grazing land

An increase in population together with the decrease in productivity per unit area is a driving force for the degradation of grazing land. This in turn, has forced farmers to use crop residues as a supplementary animal feed during some months of the year. In villages having sufficient grazing land (be it communal or private), for instance Gombo Boneya, did not feed crop residues as livestock feed to the same extent as those with limited grazing land.

#### 4.7.1.3 Farmers economic background

Wealthier (rich) farmers, particularly from Lugo and Gombo Boneya villages, do not practice selling of crop residue.

#### 4.7.1.4 The coverage/presence of forest resource

Farmers indicated that nobody collected maize and sorghum stover for fuel wood purpose 10 years ago but now due to deforestation of natural forests and shortage of fuel wood they are forced to collect and even store maize and sorghum stover for later use during the rainy season. Furthermore, sorghum and maize stover are also used to construct fences and storage containers for maize cobs. This practice is common in Bata, Gombo Boneya, Gajo, Mandara Bake, Beko and Boneya villages.

#### 4.7.1.5 Level of knowledge

There is considerable variation in the use of crop residues among farmers in the study areas. In some villages, farmers do not intensively use crop residues as feed for livestock, soil fertility restoration and soil moisture conservation. For instance, from the current study, farmers of Bata village (North Bandira) collect only limited amounts of teff straw for stall feeding, and a larger proportion was left on the field and set on fire. Their perception is that this increases productivity of sweetpotato and 'Anchote'—an indigenous root crop used for food by local people in western Ethiopia.

#### 4.7.1.6 Agro-ecology

Villages at higher altitude have grasses, green fodders and shrubs that stay green for most of the year. In such areas, crop residues are used as feed for only a limited period of time (e.g. Mandara Bake, Gajo and Lugo villages). The performance of crops is different under different agro-ecologies. There is variation in performance of crops even within micro climate. Hence, allocation of crop residues for different use is affected by its quantity (total production) and quality.

## 4.8 Livestock production and coping with feed shortage

Livestock including indigenous cattle, sheep, goats, donkeys and poultry are found across all the study villages (Table 9). The average number of indigenous cattle per village is 214, and 84% of households keep indigenous cattle. In the study villages no crossbred cattle, mules/horses, poultry or camels were reported. Cattle, sheep, goat and donkey numbers have decreased in most of study villages during the last decade. This is reportedly because of an increase in internal and external parasites, feed shortage, disease and insect prevalence, limited veterinary services and lack of training for new animal production technology. There are also very limited efforts to eradicate or prevent animal disease and insects through regular dipping, vaccination, de-worming and other animal health services. The absence of crossbred cattle was reported to be due to problems such as high and unaffordable price of crossbred heifers, inaccessibility of artificial insemination and little knowledge of farmers on crossbred cattle management.

**Table 9.** *Number of adult animals and households keeping them in the eight villages around Nekemte*

| Species/bred | No. in village (mean) | Std. deviation | HH keeping (%) | ↓ trend 10 yrs | ↑ trend 10 yrs |
|---|---|---|---|---|---|
| Cattle, indigenous | 214 | 81 | 84 | 7 | 1 |
| Cattle, crossbred | 0 | 0 | 0 | 0 | 0 |
| Sheep | 42 | 17 | 33 | 8 | 0 |
| Goat | 22 | 19 | 17 | 7 | 0 |
| Camel | 0 | 0 | 0 | 0 | 0 |
| Donkey | 15 | 17 | 19 | 4 | 2 |
| Horse/mule | 0 | 0 | 0 | 0 | 0 |
| Poultry local | 196 | 86 | 76 | 6 | 2 |
| Poultry farm | 0 | 0 | 0 | 0 | 0 |

Critical shortages of grazing and green fodder were reported in most of the study villages during April. Farmers overcome this shortage by using crop residues as animal feed. Similarly, extreme shortages of crop residues (dry fodder) are common in most of the study villages during June, July and August. During those months, use of green fodder is the best alternative followed by grazing of grasses (Table 10). In some villages, there is limited communal grazing land but these are grazed by large numbers of livestock beyond their carrying capacity (Figure 5). In villages where there is no communal grazing land, tethering of cattle on own grazing land is becoming popular because of shortage of labour for tending them and to conserve grazing land or increase utilization efficiency. Owing to un-affordability, inaccessibility and lack of knowledge, none of the farmers in the study villages reported use of concentrate feeds for their animals.

**Figure 5.** *Over concentration of livestock on grazing lands.*

Across all the study villages, the source of drinking water for ruminant is open access from natural water courses and the average distance from home is 1.1 km during the rainy and harvest seasons, but 1.3 km during the dry season.

**Table 10.** *Monthly availability and scarcity of different feed types*

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dry fodder | No shortage | 6 | 6 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Low shortage | 2 | 2 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 3 | 2 |
| | Medium shortage | 0 | 0 | 0 | 2 | 4 | 2 | 0 | 0 | 1 | 1 | 1 | 2 |
| | Considerable shortage | 0 | 0 | 0 | 1 | 2 | 4 | 3 | 2 | 1 | 1 | 1 | 2 |
| | Extreme shortage | 0 | 0 | 0 | 0 | 1 | 2 | 5 | 6 | 6 | 5 | 3 | 0 |
| Green fodder | No shortage | 1 | 1 | 0 | 0 | 0 | 1 | 7 | 7 | 8 | 5 | 3 | 3 |
| | Low shortage | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 4 | 2 |
| | Medium shortage | 4 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 3 |
| | Considerable shortage | 2 | 4 | 6 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Extreme shortage | 0 | 2 | 2 | 8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grazing | No shortage | 2 | 0 | 0 | 0 | 4 | 4 | 4 | 5 | 4 | 3 | 3 | 2 |
| | Low shortage | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 4 | 5 | 1 | 0 |
| | Medium shortage | 4 | 1 | 0 | 1 | 2 | 2 | 3 | 1 | 0 | 0 | 4 | 4 |
| | Considerable shortage | 1 | 4 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Extreme shortage | 1 | 3 | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note**:** Figures under the different months are number of villages. Total villages considered for the study were 8.

## 4.9 Feed composition and intake proportion for ruminants

In the rainy season, 67% of the intake for ruminants was reported as coming from grazing and the remaining was from forages including green fodder, collected grass and leaves.

Similarly, in the harvest season, 59% of the intake was reportedly from grazing, 21% from crop residues and 12% from forages including green fodder, collected grass and leaves. During the dry season (3rd season), crop residue and dry fodder accounted for 46% of the intake through stall feeding, 20% through grazing of crop residue and 20% from grazing of grasses (Table 11).

**Table 11.** *Estimated composition of feed intake for ruminants in eight villages around Nekemte*

| Feed by weight (%) | Rainy season | Harvest season | Dry season |
|---|---|---|---|
| Crop residue—dry fodder—stall fed | 0 | 0 | 46 |
| Crop residue—dry fodder—grazed | 0 | 21 | 20 |
| Forages—green fodder—fodder crops | 0 | 0 | 0 |
| Forages—green fodder—collected grass and leaves | 33 | 12 | 0 |
| Forages—green fodder—green residues | 0 | 9 | 0 |
| Concentrates | 0 | 0 | 0 |
| Rangelands, grazing | 67 | 59 | 34 |

## 4.10 Seasonal allocation of livestock dung

The current study reveals that livestock production and crop production are interdependent. Thus most of the crop by-products (crop residues) are utilized as animal feeds and in turn a major proportion of animal manure is used as organic fertilizer to boost crop productivity. In the study villages, cow dung is neither used as fuel nor for sale. During the harvest season, a high proportion of dung is used for plastering of threshing floors. Since livestock are allowed to free graze during the dry season (3rd season) a major proportion of dung excreted during the day is returned to the soil as nutrients. However, the extent of dung not used has increased over the last 10 years (Table 12).

**Table 12.** *Use of dung by season of production at the eight study villages around Nekemte*

| Allocation | 1st season (rainy) | 2nd season (harvest) | 3rd season (dry) | ↓ trend 10 yrs | ↑ trend 10 yrs |
|---|---|---|---|---|---|
| Used as fuel | 0 | 0 | 0 | 0 | 0 |
| Used as manure | 73 | 39 | 59 | 2 | 6 |
| Sold | 0 | 0 | 0 | 0 | 0 |
| Other use | 0 | 42 | 8 | 0 | 7 |
| Not used/wasted | 27 | 19 | 33 | 5 | 1 |

Note: other use includes plastering, decoration and smearing.
Figures indicated under ↓ and ↑ are number of villages.

## 4.11 Socio-economic characteristics and the status of social services in the study villages

### 4.11.1 Wealth status

Based on land holdings and numbers of livestock owned, farmers across all villages were categorized into three wealth classes (wealthy, middle and poor). Accordingly, most of the households per village are clustered under middle class (57%) and only 15% of the households are grouped as rich. The major income source for both rich and middle classes are from crops (63%) and livestock (37%). Income for poor farmers come from other farm activities, agricultural and non-agricultural labour and livestock and crop products (Table 13).

**Table 13.** *Share of income sources by wealth class at villages in Nekemte*

| Income share (%) | Wealthy | Middle | Poor |
|---|---|---|---|
| Wealth group, share of total village | 15 | 57 | 28 |
| Crops | 63 | 63 | 14 |
| Livestock | 37 | 37 | 16 |
| Other farm activities | 0 | 0 | 33 |
| Agricultural labour | 0 | 0 | 20 |
| Non-agricultural labour | 0 | 0 | 17 |

Note: Rich refers to those farmers that have > 6 cattle and > 3 ha of land; medium refers to those farmers that have 3–6 cattle and 1–3 ha of land; and poor refers to those farmers that have < 3 cattle and < 1 ha of land.

### 4.11.2 Distance of villages to different services

The distance of a village from the central market and all-weather roads greatly affects allocation and utilization of crop and livestock main and by-products. For instance, the households in highly productive villages such as Mandara Bake struggle to sell their main agricultural products and to buy agricultural inputs. Most villages have a primary school, a farmer training centre, cooperative offices, a health centre and a veterinary clinic comparatively nearby, but are far from colleges, banks, district headquarters and input/output markets (Table 14).

**Table 14.** *Average distance (km) of services and facilities for the eight villages around Nekemte*

| Services and facilities | Mean | Std. deviation |
|---|---|---|
| All-weather road | 6.3 | 6.8 |
| Local input market | 5.2 | 5.9 |
| Output market | 8.2 | 8.1 |
| Agricultural knowledge centre | 3.0 | 3.0 |
| Artifical insemination centre | 8.0 | 10.9 |
| Veterinary clinic | 4.6 | 2.5 |
| Cooperative offices | 3.3 | 3.8 |
| Micro-finance institutes | 8.0 | 9.4 |
| Commercial bank | 17.1 | 12.9 |
| Primary school | 2.3 | 2.9 |
| College | 17.1 | 12.9 |
| Health centre | 3.7 | 2.4 |
| Town | 6.6 | 4.5 |
| District headquarters | 11.3 | 9.7 |

### 4.11.3 Contact with extension and other livestock service providers

Even though the trend is increasing gradually, the frequency that crop or livestock extension officers, artifical insemination (AI) providers and veterinary service providers visited most of the study villages was infrequent. Besides, respondents across four villages of the study area reported that they could not remember the date when an AI provider visited their villages and gave technical support. As stated earlier, one of the major reasons for the decrease in numbers of livestock is due to disease problem. Poor veterinary services (in terms of visiting frequency and type of service provided) have exacerbated disease severity (Table 15).

**Table 15.** *Frequency of meeting of development agents and other expertise in the eight villages around Nekemte*

| DAs/expertise | Never | Daily | Weekly | Monthly | Quarterly | Yearly | ↓ trend 10 yrs | ↑ trend 10 yrs |
|---|---|---|---|---|---|---|---|---|
| Crop extension officer | 0 | 0 | 4 | 2 | 2 | 0 | 0 | 7 |
| Livestock extension officer | 1 | 0 | 2 | 4 | 1 | 0 | 0 | 5 |
| Veterinary service | 1 | 0 | 0 | 1 | 3 | 3 | 0 | 6 |
| AI provider | 4 | 0 | 0 | 0 | 2 | 2 | 0 | 3 |

Note: Figures indicated in the table are number of villages. Total villages considered for the study were 8.

### 4.11.4 Dietary situation and access to different social amenities

More than 83% of boys and girls in each village are in formal education. However, only 32% of adult women and 54% of adult men in each villages were literate. Most of these attained literacy through adult education. This implies that most of the villagers did not have an access to school when they were young (Table 16). Cereal and pulse crops are included in the everyday diet of almost all households in the study villages. Meat, milk and fruits, however, are consumed only on very few days of the year by very few households. No one reported receiving food aid during the last 10 years in any of the villages (Table 16).

**Table 16.** *Social indicators at villages in Nekemte*

| | Mean | Std. deviation |
|---|---|---|
| Primary school boys (%) | 85 | 26 |
| Primary school girls (%) | 83 | 30 |
| 10th grade boys (%) | 55 | 11 |
| 10th grade girls (%) | 31 | 25 |
| Literacy adult men (%) | 54 | 14 |
| Literacy adult women (%) | 32 | 19 |
| Consumption of fruit as much as they prefer all year (% hh) | 14 | 28 |
| Consumption of milk as much as they prefer all year (% hh) | 8 | 12 |
| Consumption of meat as much as they prefer all year (% hh) | 10 | 15 |
| Consumption of vegetables as much as they prefer all year (% hh) | 61 | 29 |
| Consumption of pulses as much as they prefer all year (% hh) | 94 | 18 |
| Consumption of cereals as much as they prefer all year (% hh) | 100 | 0 |
| HH receiving aid (% hh) | – | – |
| HH with 1 meal/day (% hh) | – | – |
| HH with pipe water (% hh) | 42 | 49 |
| HH with latrine (% hh) | 54 | 36 |
| HH with formal electricity (% hh) | – | – |
| HH with informal electricity informal (% hh) | 5 | 33 |
| HH with mobile phone (% hh) | 17 | 22 |
| HH with landline phone (% hh) | – | – |

## 4.12 Price of inputs and outputs in the study villages

Even though the price of inputs, particularly fertilizer, improved seed, labour, land rent and other livestock inputs continuously increases from year to year, the demand or perception of farmers to use these inputs to boost their agricultural productivity has also increased in the last decade. Similarly, there was a slight increase in price of outputs but the increase lacks consistency. During 2009, the average price of fertilizers was ETB[1] 8.65 and ETB 7.70 per kg of Diammonium Phosphate (DAP) and urea, respectively. There is a variation in price of agricultural inputs and outputs among the study villages. For instance, the average price of one local bullock at Beko village (N1) is about ETB 2500, whereas the price goes up to ETB 3000 in most of the villages near to Nekemte (Table 17, Annex 1).

**Table 17.** *Price of inputs and outputs in the study villages*

| Inputs and outputs | Mean | Std. deviation |
|---|---|---|
| Wage normal male (ETB/day, 8 hr) | 9.1 | 4.1 |
| Wage normal female (ETB/day, 8 hr) | 9.1 | 4.1 |
| Wage peak male (ETB/day, 8 hr) | 16 | 7.9 |
| Wage peak female (ETB/day, 8 hr) | 16 | 7.9 |
| Land rainfed rent (ETB/ha) | 560 | 343 |
| Land irrigated rent (ETB/ha) | 900 | 0.0 |
| Seed wheat (ETB/kg) | 6.1 | 5.2 |
| Seed maize (ETB/kg) | 16 | 9.0 |
| Fertilizer urea (ETB/kg) | 7.7 | 5.1 |
| Fertilizer DAP (ETB/kg) | 8.7 | 5.4 |
| Visit veterinary/clinic (ETB/visit) | 3.2 | 7.0 |
| Cow indigenous 1st calving (ETB/animal) | 823 | 559 |
| Bullock local (ETB/animal) | 2706 | 400 |
| Goat adult for slaughter (ETB/animal) | 270 | 92 |
| Sheep adult for slaughter (ETB/animal) | 375 | 140 |

1. ETB = Ethipian birr. On 17 February 2012, USD 1 = ETB 17.3114.

# 5 Conclusions and recommendations

Almost all farmers practised crop–livestock mixed farming in the eight villages included in the current study. Results indicated that crop residues are becoming an increasingly important production component and play an important role mainly as feed, fuel, sources of income and for soil nutrient management. However, soil fertility management and value addition to crop residues seemed to be the most important gaps observed in almost all the study villages. Hence, these gaps call for timely interventions. The current trend for increased feeding of crop residues to livestock has long term implications for soil fertility and hence local livelihoods.

According to the current PRA village level survey result, across all the study villages, the size of grazing land is decreasing from year to year. This is mainly due to an increase in population and subsequent conversion of forest areas and grazing lands to farmlands. In addition, the gradual increase in soil degradation and reduction in crop productivity per unit area has placed considerable pressure on forest and range lands to compensate for the decline in productivity per unit area. As a result, the number of livestock has decreased. Prevalence of diseases and other parasites were other reported factors for the decline in the number of livestock. To minimize this critical feed shortage, farmers across all villages utilize crop residues for livestock feed with long term soil fertility implications.

# 6 Acknowledgements

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# Annex 1 Description and summarized results of the village level survey

| Village code and name | Village code | Date of survey | Time | *Woreda* | Village distance from Nekemte | Coordinate reading of the centre of village | Participant: Farmers | Participant: Key informant | HH no. | T. pop | Major crops produced (with order of importance) | Major crop CR: Major crop type | Major crop CR: Major role |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beko (FN) | N1 | 13/08/2010 | 9:30 am–3:15 pm | Sibu-sire | 27 kms | N: 09º 02′15.8″<br>E: 036º 44′ 02.5″<br>Elv. 1748 masl | 12 | 2 | 65 | 254 | Maize, sorghum, teff, noug | Teff<br>Maize, sorghum | Stall feeding,<br>Fuel wood, stubble grazing |
| Gombo-bonaya (NN) | N2 | 18/08/2010 | | Wayu-Tuqa | 5 kms | N: 09º 03′ 59.6″<br>E: 036º 36′ 21.3″<br>Elv. 2098 masl | 10 | 1 | 56 | 289 | Teff, noug, millet, maize | Teff<br>Millet<br>Maize | Sold, stall feeding<br>Stubble grazing<br>Fuel, wood, stubble grazing |
| Mandara Bake (FF) | N3 | 19/08/2010 | 10:30 am–3:15 pm | Wayu-Tuqa | 32 kms | N: 09º 04′ 31″<br>E: 036º 43′ 06.4 ″<br>Elv. 2418 masl | 10 | 2 | 41 | 257 | Wheat, teff, maize, oat | Teff<br>Barley<br>Maize | Stall feeding<br>Stubble grazing, stall feeding<br>Stubble grazing |
| Kibbi (FN) | N4 | 20/08/2010 | 10:27 am–3:16 pm | Leka-Dulecha | 22 kms | N: 08º 56′ 12.3″<br>E: 036º 28′ 20.7″<br>Elv. 2208 masl | 12 | 3 | 48 | 196 | Teff, F. millet, barley, maize | Teff<br>Barley, F. millet<br>Maize | Sold*, stall feeding<br>Stubble grazing<br>Fuel, wood, stubble grazing |
| Bonaya (NF) | N5 | 20/08/2010 | 10:30–3:15 | Diga | 16 kms | N: 09º 02′ 59.4″<br>E: 036º 27′ 21.0″<br>Elv. 2184 masl | 10 | 1 | 35 | 215 | Millet, teff, noug, maize | Teff,<br>F. millet<br>Maize | Sold*, stall feeding<br>Stubble grazing<br>Fuel, wood, stubble grazing |
| Bata (FF) | N6 | 21/08/2010 | 10:17–2:40 | Leka-Dulecha | 41 kms | N: 08º 56′ 26.1″<br>E: 036º 35′ 4.9″<br>Elv. 1863 masl | 10 | 3 | 70 | 391 | Teff, maize, sorghum, millet | Teff<br>Maize sorghum | Stall feeding<br>Fuel wood, stubble grazing |
| Lugo (NF) | N7 | 22/08/2010 | 11:54 am–3:30 pm | Guto-Gidda | 10 kms | N: 09º 02′ 22″<br>E: 036º 34′ 05.1″<br>Elv. 2010 masl | 10 | 2 | 54 | 256 | Teff, maize, millet, noug | Teff,<br>F. millet, bread wheat<br>Maize | Sold*, stall feeding<br>Stubble grazing<br>Fuel, wood, stubble grazing |
| Gajo (NN) | N8 | 23/08/2010 | | Guto Gida | 5 kms | N: 09º 03′ 01.7″<br>E: 036º 30′ 52.2″<br>Elv. 2071 masl | 12 | 2 | 35 | 215 | Teff, millet, maize, noug | Teff<br>F. millet maize | Sold from field, stall feeding<br>Stubble grazing by own and others |