



# An assessment of the livestock economy in mixed crop-livestock production systems in Ethiopia

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## ABSTRACT

The livestock subsector has contributed little to the remarkable economic growth recorded in Ethiopia in the last decade. In an effort to stimulate livestock production, the Ethiopian government has recently recognized livestock as an important strategic subsector in which to invest. Unlike most studies that focus purely on aspects of livestock production, this study provides a detailed descriptive assessment of the livestock production and marketing behavior of smallholder mixed crop-livestock farmers.

The study uses a dataset collected in the Agricultural Growth Program baseline survey from farm households in districts of Ethiopia with high potential in grain crops production, areas which have a significant share of the livestock in the country. Smallholder livestock production is characterized by lower levels of livestock ownership, limited market orientation, and lower productivity. These characteristics restrict the capacity of these livestock systems from taking advantage of the emerging opportunities in both domestic and export livestock markets. We find a high degree of heterogeneity in access to livestock assets, production practices, marketing, and livelihood strategies among farm households. Hence, a single policy recommendation might not work for all farmers.

Our assessment appraises the current status of livestock production systems in Ethiopia and highlights potential income sources from livestock, including positive synergies between these income sources to help reduce poverty and to promote economic growth in rural communities.

## I. INTRODUCTION

Globally, Ethiopia has been one of the fastest growing economies in the last decade. Growth in agriculture has been an important contributor to this growth during the 2004-2014 period over which growth in real per capita GDP averaged 7.9 percent per annum. Growth in agriculture on average contributed 34 percent to the growth in real GDP, which averaged 10.7 over the same period (National Bank of Ethiopia (NBE) 2014). Agriculture appears to have benefited from the focus it was given in Ethiopian government's development policies since the launch of the Agricultural Development Led Industrialization (ADLI) policy framework in mid-1990s (Bachewe et al. 2015). Policies in the last two decades have focused on agricultural growth and poverty reduction (MoFED 2010). The government, in collaboration with donors, has launched a number of programs aimed at reducing rural poverty and increasing smallholder farmers' productivity, resulting in significant progress, particularly in the last decade. Furthermore, Ethiopia invested considerably in rural infrastructure, education, and other social services (Bachewe et al. 2015).

Agriculture grew at average annual rate of 7.6 percent between 2004/5 and 2013/14, during which time it accounted for 47 percent of the real GDP (NBE 2014). The rural poverty headcount ratio decreased by 36 percent from 0.475 in 1995/96 to 0.304 in 2010/11, an average annual rate of decline of 2.3 percent. Furthermore, the poverty gap and severity indices declined at average annual rates of 3.0 and 2.8 percent, respectively, during the same period (MoFED 2013).

Within agriculture, the livestock subsector is the least developed. Most of the growth in agriculture is attributed to growth in crop production. Relative to growth in real crop output, which averaged 8.8 percent during 2004/05-2013/14 period, the growth in livestock output was slower at 5.9 percent (NBE 2014), even if it started from a lower base. Furthermore, crop and livestock output on average accounted for 68 and 22 percent of real agricultural output during the same period, with crop output increasing in importance in all years, while livestock outputs declined in importance in almost all years.

Despite the relatively poor performance of the subsector, Ethiopia has considerable potential in livestock production. The cattle population in Ethiopia is the largest in Africa and fifth largest in the world. Ethiopia has some of the largest numbers of other livestock species, and the population of livestock in general has grown rapidly during the last decade (FAOSTAT 2015).

Following the rapid real per capita income growth in the last decade, the share of animal products in total food spending increased annually at 2.9 percent during the period from 2000 to 2005 and at 4 percent between 2005 and 2011, while real expenditure on animal products increased at 4.9 and 7.4 percent during the respective periods (Worku et al. 2015). Furthermore, growth in live animal and meat exports was rapid during the 2004/05 to 2013/14 period. Agricultural exports on average accounted for about 85 percent of the real value of total exports from Ethiopia, while the share of live animal and meat exports averaged 4.1 and 1.9 percent, respectively, during the same period. Unlike the decline in agriculture's share in total exports, live animal and meat exports increased in importance (NBE 2014). Despite

the growing market opportunities for animal products and the largely untapped resource potential of the subsector, production and marketed supply of livestock remain stagnant.

The purpose of this study is to document livestock production and productivity in Ethiopia. This paper uses data from the Agricultural Growth Program baseline survey, a detailed large-scale household dataset, to explore smallholder households' access to livestock assets and their livestock production practices and marketing behavior, income diversification strategies, and the impacts of different income sources on poverty and income inequality.

A number of studies have investigated different aspects of the livestock subsector in Ethiopia, covering a range of topics including: livestock production and marketing (Negassa and Jabbar 2008; Negassa et al. 2011; Solomon et al. 2003), milk and meat production and marketing (Anteneh et al. 2010), live animal and meat export chains (Legesse et al. 2008); determinants of herd stocking decisions (Tamirat 2013) and livestock holding size and off-take rates (Negassa and Jabbar 2008); characteristics of pastoralist livestock production and marketing (Barrett et al. 2004); and the impacts of risk and wealth on cattle herd size and marketing behavior (Lybbert et al. 2010). A common thread in these studies, many of which explore mixed crop-livestock systems, is their focus on aspects of livestock production. This study is unique in investigating the synergies between crop and livestock production. That a large proportion of the livestock in Ethiopia are produced by households engaged in mixed crop-livestock practices underlines the importance of this study. Few studies provide detailed micro-level analyses of the potentials and constraints in the subsector. This study is aimed to fill this knowledge gap and thereby inform the design of effective rural development interventions.

The remaining sections of this paper are organized as follows. The next section describes the AGP dataset used in this study. Section 3 outlines the methods of analyses. Section 4 presents and discusses the results. The final section indicates the policy implications and concludes.

## 2. THE DATA

This study uses data collected in the Agricultural Growth Program (AGP) baseline survey that was fielded in May 2011. The AGP operates in woredas (districts) with high potential in the production of grain crops. At the time of the survey, the AGP was active in four of the 11 regions in Ethiopia<sup>1</sup>: Tigray, Amhara, Oromia, and Southern Nations, Nationalities, and Peoples (SNNP).<sup>2</sup> The AGP baseline survey included a sample of 7,928 households, representing 9.4 million households.<sup>3</sup>

The four regions included in the AGP baseline survey are where a large majority of the country's sedentary agriculture is located. In 2010/11, these regions together accounted for 96 percent of the rural households in the country (CSA 2011b).<sup>4</sup> In the same year, the regions accounted for 97.3 percent of the nationwide cultivated area. The CSA and AGP datasets together imply that the households covered in the AGP baseline survey represented 65.3 percent of all households nationwide in 2010/11. Moreover, the four regions accounted for a large majority of the livestock population in the country. The cattle in the four regions account for 96 percent of the total cattle population in the country in 2010/11 (CSA 2011a). Similarly, the number of sheep, goats, and equines in the four regions accounted for 91, 83, and 97 percent, respectively, of nationwide totals in the same year (CSA 2011b). Furthermore, the woredas covered in the AGP baseline survey alone accounted for 65 percent of the total number of cattle in the country. The number of sheep, goats, and equines owned by households in the woredas surveyed accounted for 65, 27, and 71 percent, respectively, of the nationwide totals in 2010/11.

In Table 2.1 we summarize the demographic characteristics and the ownership of farming assets of households covered in the AGP baseline survey and characterize their communities/villages. The variables describe those aspects that impact households' crop and livestock production practices and participation and earning capacity in income generating activities.

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<sup>1</sup> The 11 regions are divided into 94 administrative zones and 743 woredas (districts).

<sup>2</sup> The second phase of the AGP (AGP-II), which commenced in 2016, includes four other regions of the country.

<sup>3</sup> Details of the sampling design and data collection methods used are provided in the AGP baseline report (Berhane et al., 2013)

<sup>4</sup> Note, however, that CSA data do not include the non-sedentary population of three and six zones in Afar and Somali regions out of the six and nine zones in the respective regions (CSA, 2011b). As a result, this share as well as those that follow are overestimates of the actual shares of the sedentary rural population in Ethiopia.

**Table 2.1—Summary of household and community level variables**

Variables	All households	Female-headed households	Male-headed households
<b>Characteristics of household head</b>			
Age (years)	43.0	47.5	41.1
Formally educated (%)	34.4	10.0	44.8
Years of formal education	1.6	0.4	2.2
Spouse formally educated (%)	26.9	40.3	26.7
Spouse's years of formal education	1.1	2.6	1.0
Head engaged in farming (%)	88.9	71.1	96.6
<b>Characteristics of farm households</b>			
Household size (number of members)	4.8	3.7	5.3
Adult equivalent household size (number)	3.9	3.0	4.3
Female aged 15-60 years (number)	1.3	1.2	1.3
Male aged 15-60 years (number)	1.1	0.6	1.3
All members aged 15-60 years (number)	2.4	1.9	2.6
Dependence ratio (%)	47.6	48.3	47.3
<b>Farm characteristics</b>			
Cultivated land per household (ha)	1.3	1.1	1.4
Cultivated land per adult equivalent (ha)	0.4	0.4	0.4
Livestock ownership (% of households)	91.7	84.9	94.6
Cattle ownership (% of households)	81.7	70.3	86.6
Livestock owned per household (TLU)	3.3	2.5	3.7
Livestock owned per adult equivalent (TLU)	0.9	0.8	0.9
Cattle owned per household (TLU)	2.7	2.0	2.9
Cattle owned per adult equivalent (TLU)	0.7	0.7	0.7
<b>Access to informal/ formal institutions</b>			
Member in Mahiber (%)	31.9	27.8	33.7
Access to credit for fertilizer (%)	10.4	7.8	11.5
Access to extension advice (%)	35.0	26.4	38.7
<b>Community/village characteristics</b>			
Distance to town near Kebele (km)	13.0	13.0	13.0
Distance to daily market out of Kebele (km)	23.4	23.1	23.6
Distance to periodic market out of Kebele (km)	11.6	11.7	11.6
Veterinary clinics in the village (number)	0.3	0.3	0.3
Distance to veterinary clinics (km)	14.0	14.1	14.0

Source: Authors' computation using the AGP baseline dataset (2011).

We observe that an average household head in the AGP baseline survey was 43 years of age in May 2011. Male heads are on average 6 years younger than females. Female heads are on average older than male heads, primarily because in rural Ethiopia females become household heads mostly after separating from male spouses either through death or divorce. Out of all the female heads in this dataset, 48 percent were widowed and about 19 percent were divorced/separated while the number of male heads widowed, divorced, and separated together accounted for only 3 percent of all male heads. About 34 percent of household heads have formal education, on average 1.6 years of education. A considerably lower proportion (10 percent) of female heads are formally educated and have fewer years of education. About 10 percent of female heads and 12 percent male heads have informal education. While 71 percent of female household heads are primarily engaged in agriculture, over 96 percent of male heads are.

An average household in the AGP baseline survey had 4.7 members, which is 3.8 adult-equivalents. Dependency ratios averaged 47.6 percent, with an average of 2.4 household members aged between 15 and 60 years, the working age. Male-headed households were larger in size in both counts, have a lower dependency ratio (47.3 percent), and have a higher number of working age members (2.6), equally divided between females (1.3) and males (1.3). In contrast, female-headed households are smaller; have a slightly higher dependency ratio (48.3 percent); and fewer working age members (1.9), out of which 1.2 were female and 0.6 were male. Using the AGP baseline survey data, Bachewe et al. (2016) showed that family labor accounted for 93 percent of the total labor used in crop production in Ethiopia and that over three-quarters of households rely only on family labor. Consequently, an average female-headed household is more likely than are male-headed households to face labor shortages in crop production due to having fewer working-age members.

Land and livestock constitute the major productive assets of farm households in rural Ethiopia. The degree of heterogeneity of households' access to these assets is expected to partly explain their production practices and marketing behavior. Cultivated land averaged 1.3 hectares per household and 0.4 hectares per adult equivalent. Female-headed households cultivated less land relative to male-headed households. Farm households not only have limited land assets, but also the distribution of land is highly unequal. The Gini coefficient<sup>5</sup> of household cultivated area is 0.48. Small and shrinking farm size is one of the major challenges facing agriculture in Ethiopia (Headey and Jayne 2014).

Most households (92 percent) own at least one livestock species. Ownership of livestock averaged 85 and 95 percent in female- and male-headed households, respectively. Eighty-two percent of the households in the aggregate sample owned cattle. Livestock and cattle ownership averaged 3.3 and 2.7 tropical livestock units (TLU) per household and 0.9 and 0.7 TLU per adult equivalent, respectively.<sup>6</sup> Livestock and cattle ownership was highly unequally distributed with Gini coefficients of 0.48 and 0.42, respectively. Female-headed households owned less livestock and cattle, while their per capita ownership was similar to male-headed households.

About 32 percent of farm households in the AGP dataset are members in local *Mahiber* or informal associations.<sup>7</sup> On average, 77 percent of the farm households have access to credits and 33 percent made use of available extension services. Membership of informal associations, access to extension and credits services was higher in male- than in female-headed households. While three out of 10 villages had veterinary clinics, the average distances to the nearest town, market, and veterinary clinic varied from 12 to 23 kilometers.

### 3. METHOD OF ANALYSES

This section describes the analytical tools we use to characterize livestock and crop production, agricultural marketing, and income generation practices of the survey households. We first outline the indices used to gauge the level of commercialization and intensification in crop and livestock production by the survey households. This is followed by a discussion of the tools used to measure income diversification and inequality.

#### 3.1. Measurement of Crop and Livestock Commercialization

##### COMMERCIALIZATION AND INTENSIFICATION IN CROP PRODUCTION

The approaches used to assess the degree of commercialization in crop production by the farm households differ from those used to assess commercialization in livestock production due to differences in the lengths of production cycles involved. Livestock and perennial crops have longer production cycles than annual crops. Mutabazi et al. (2013), Govere and Jayne (1999), and Strasberg et al. (1999) measure the level of crop commercialization for farm households as follows:

$$HCI_i = \frac{GVS_i}{GVP_i} \quad (1)$$

where  $HCI_i$  is household  $i$ 's crop output commercialization index;  $GVS_i$  is the value of crop sales and  $GVP_i$  is the total value of crops that household  $i$  produced. For a given total value of crop output, the  $HCI$  increases with the value of crop sales. A value of zero indicates a household engaging totally in subsistence crop production, while a  $HCI$  value of 1 indicates complete commercialization of crop production by the household.

The level of input intensification in crop production for a farm household is measured using the index:

$$HCII_i = \frac{GVI_i}{GVP_i} \quad (2)$$

where  $HCII_i$  is household  $i$ 's crop input commercialization index; and  $GVI_i$  is the value of purchased inputs used in crop production. The  $HCII$  increases with the level of use of purchased inputs in crop production by a farm household.

##### COMMERCIALIZATION AND INTENSIFICATION IN LIVESTOCK PRODUCTION

In smallholder mixed crop-livestock farming systems and in pastoral systems, animals are kept for multiple functions in addition to sales. Sales of livestock are not regular phenomena and occur sporadically based mostly on immediate cash needs. In this regard, one of the key indicators of commercialization in livestock production is the proportion of live

<sup>5</sup> The Gini coefficient (of X) measures the extent of inequality (in X) among the sampled households or individuals being studied.

<sup>6</sup> TLU normalizes households' livestock holdings. Accordingly, the TLU of a given household is computed as: TLU = camels + (0.7\*Cattle) + (0.8\*horses) + (0.5\*donkey) + (0.5\*mules) + (0.1\*Sheep) + (0.1\*goats) + (0.01\*chicken).

<sup>7</sup> Mahibers are often organized by a similar group of people or peers, such as elders, women, and students. Mahibers often, but not always, are organized for a given purpose. This includes for observing a certain holiday or for helping those in need (of something specific or of multiple needs).

animals that leave the farm for off-farm slaughter, exports, or other uses. In the literature, different methods are used to compute livestock off-take rates (e.g. Sutter 1987; Negassa and Jabbar 2008).

In this study, two types of off-take rates are estimated for cattle and small ruminants, namely annual gross and net commercial off-take (intake) rates. Annual gross commercial off-take (intake) rates are computed as:

$$\text{Gross commercial sales (off-take) rate} = \frac{\text{Sales}_i}{\bar{n}} \quad (3)$$

$$\text{Gross commercial purchase (intake) rate} = \frac{\text{Purchases}_i}{\bar{n}} \quad (4)$$

$$\text{Gross slaughter off-take rate} = \frac{\text{Slaughters}_i}{\bar{n}} \quad (5)$$

where  $\bar{n}$  stands for the average stock over a one-year period, and is given as the average of the number of livestock at the beginning and at the end of the year. On-farm slaughters could be either for own consumption or on-farm sale. However, data on the purpose for which livestock were slaughtered were not collected in the AGP baseline survey. Thus, we assume that all of the on-farm slaughter of livestock recorded was for commercial purposes.

Gross commercial off-take or intake rates are crude measures, as they do not show the net market position of farm households. As a result, we also compute the annual net commercial off-take, which is given as:

$$\text{Net commercial off-take rate}_i = \frac{\text{Sales}_i - \text{Purchases}_i + \text{Slaughters}_i}{\bar{n}} \quad (6)$$

On the other hand, the livestock input commercialization index,  $HLCII_i$ , is given as the ratio of total livestock input costs to the value of livestock revenue:

$$HLCII_i = \frac{GVL I_i}{GVL P_i} \quad (7)$$

where  $GVL I_i$  is the value of inputs used in livestock production and  $GVL P_i$  is revenue generated from the sale of livestock and livestock products.  $HLCII_i$  increases with level of livestock inputs use or intensification.

## 3.2. Income Diversification and Inequality Measures

### MEASURES OF INCOME DIVERSIFICATION

Studies on household income diversification strategies employ two methods common in the literature (Carter and Barrett 2006; Brown et al. 2006). The first examines households' participation in different income earning activities. The second is based on households' assets and analyzes diversification behavior by examining asset endowments. In this study we use the income based approach, focusing on three measures of income diversification: (1) number of income sources, (2) the share or relative importance of different income sources in total income, and (3) the Herfindahl diversification index ( $HDI$ ), which measures income diversification at the household level. Among the three listed, the  $HDI$  is considered as the most comprehensive measure of income diversification because it takes into account both the number of income sources and the relative importance each income source in total income.

The first measure used, the number of income sources, is a simple count of income generating activities. The second measure, the share of a given income source  $j$  out of total income of household  $i$  is computed as:

$$S_{ij} = \frac{Y_{ij}}{\sum_{j=1}^J Y_{ij}} \text{ for all } j = 1, 2, 3, \dots, J \quad (8)$$

where  $S_{ij}$  is the share of  $j^{\text{th}}$  income source for  $i^{\text{th}}$  household;  $Y_{ij}$  is magnitude of income from  $j^{\text{th}}$  source;  $J$  is the total number of income sources; and  $\sum_{j=1}^J Y_{ij}$  is the total income of household  $i$  from all sources.

The  $HDI$ , the third measure, is computed from the Herfindahl index ( $HI$ ), often used in industrial organization to measure the extent to which markets are dominated by a few large firms that might be exercising monopolistic power. In our case the  $HI_i$  measures income share and is computed as:

$$HI_i = \sum_{j=1}^J S_{ij}^2 \quad (9)$$

where  $HI_i \in (0, 1]$  with  $HI_i$  approaching 0 when there are a large number of income sources with small and equal shares.  $HI_i$  increases with concentration of income into fewer sources and  $HI_i = 1$  when household  $i$  has only one income source. Since  $HDI_i$  measures diversification, as opposed to concentration, it is given as one minus  $HI_i$  or:

$$HDI_i = 1 - HI_i = 1 - \sum_{j=1}^J S_{ij}^2 \quad (10)$$

*HDI* increases with diversification. Households generating income from diverse sources have high *HDI*. Together with the simple income share, the *HDI* is widely used to analyze households' income diversification patterns. Although *HDI* serves as a comprehensive tool to measure households' income diversification, studies that investigate changes in income sources typically use income share rather than diversification, as this shows the change in the relative importance of individual income source in total income.

In this study, four major income sources are identified and analyzed—crop income, livestock income, off-farm income, and non-farm income. All incomes are in the form of cash generated over a period of one year. The information on non-cash benefits are scant and are not considered here. Crop income is computed as the sum of the value of output of all crop types that are produced by households minus all variable costs of production. The value of crop output includes the output actually sold in markets as well as that part consumed at home or used for other purposes, such as in-kind payment for hired labor or rented land. Similarly, livestock income is computed as the sum of revenue generated from livestock and livestock product sales minus all variable costs of livestock production, e.g., costs of herding, veterinary services, and feeds. Relative to the standard rural income generating activities (RIGA) methodology used in Davis et al. (2010), the income grouping used in this work is less disaggregated as it involves fewer income groups and activities. However, given our main objective of investigating the role of livestock production in total income, the level of disaggregation used is sufficient. All income values are given in real per adult-equivalent or real per capita terms and are computed by dividing total household real income by adult-equivalent household size. Real household incomes are computed by deflating nominal incomes using regional average consumer price index (December 2006 prices) (CSA 2012).

## MEASURES OF INCOME INEQUALITY

Addressing income inequality is generally one of the objectives of most rural development strategies. A given income source could be income inequality decreasing, inequality neutral, or inequality increasing. Among several measures of income inequality, the decomposition of the *Gini* coefficient index for total income is the most widely used measure, due to several of its desirable properties (Birthala et al. 2014). Suppose there are  $J$  income sources, where  $j = 1, 2, 3, \dots, J$ . Then, following Lerman and Yitzaki (1985) as discussed in the study by Birthala et al. (2014), the Gini coefficient index for total income ( $G_0$ ) is decomposed as:

$$G_0 = \sum_{j=1}^J R_j G_j S_j \quad (11)$$

where  $S_j$  stands for the share of the  $j^{\text{th}}$  source in the total income,  $G_j$  is the Gini coefficient index for the  $j^{\text{th}}$  income source; and  $R_j$  is the correlation between the Gini coefficient index of the  $j^{\text{th}}$  income source and total income. Based on the *Gini* coefficient index decomposition given in equation (11), two measures of income inequality are derived: (i) the Gini income elasticity and (ii) the percent change in overall Gini coefficient. The Gini income elasticity is given as:

$$g_k = \frac{R_j G_j}{G_0} \quad (12)$$

Then, the impact of a given income source on the inequality of total income is given as follows: if  $g_k > 1$  income source  $j$  increases inequality. On the other hand, if  $g_k < 1$  it reduces income inequality. Furthermore, the percentage change in overall Gini coefficient due to a one percent change of income from a given source, is given as:

$$\left( \frac{\partial G_0}{\partial e_j} \right) / G_0 = \frac{R_j G_j S_j}{G_0} - S_j \quad (13)$$

In order to facilitate the descriptive analysis, farm households in the AGP baseline dataset are classified into different groups. The groups are formed across regions, by sex of household head, and by quintiles of per capita income, cultivated land, and livestock assets. For brevity purposes, most of the descriptions are provided using mean values of the relevant measures.

## 4. RESULTS AND DISCUSSIONS

We discuss results of our analyses in the following six subsections. In the first subsection we characterize the livestock production system of smallholder farmers in terms of access to livestock and size and composition of holdings. The second subsection discusses the technical performance of livestock. In the third subsection we characterize the livestock marketing system, which is followed by a discussion in the fourth subsection of farm households' participation in different income generating activities. In the fifth subsection we discuss the market orientation of smallholder crop and livestock

producers. Finally, we discuss the results of analyses that gauge the role of different income sources at reducing income risk and inequality.

## 4.1. Characterization of smallholder livestock production system

This section characterizes the structure and composition of the livestock endowments of farm households, which impact their production objectives, management practices, and market orientation. Variables used are summarized in Table 4.1 for the entire sample and by sex of household head. Table A.1 in the Appendix summarizes the variables across regions and by income and land quintiles.

### 4.1.1 ACCESS TO LIVESTOCK ASSETS

On average, 92 percent of farm households own at least one livestock species (Table 4.1). Livestock ownership averaged 89 percent in SNNP, 92 percent in Amhara, and 93 percent in both Tigray and Oromia (Table A.1). However, patterns of livestock ownership varied across species and regions. For instance, the proportion that own cattle and sheep is lower in Tigray and Amhara, while it is higher in Oromia and SNNP. The reverse applies to chicken. Less than half of households in all categories (sex of household head, regions, and income and land quintiles) own each type of livestock, except for cattle and chicken. This indicates that smallholder farmers have limited access to most livestock assets, except to cattle and chicken. However, less than half of households with female-heads and less than half of all households in SNNP own chickens.

**Table 4.1—Structure and composition of livestock ownership, by sex of household head**

Livestock type	Households that own livestock (%)			Number of livestock owned (head count)			Number of livestock owned (TLU)			Livestock composition (% livestock TLU)		
	All	Female	Male	All	Female	Male	All	Female	Male	All	Female	Male
All	92	85	95	–	–	–	3.3	2.5	3.7	–	–	–
Cattle	82	70	87	3.8	2.8	4.2	2.7	2.0	2.9	73.7	70.2	75.1
Sheep	40	36	41	1.8	1.4	1.9	0.2	0.1	0.2	8.0	9.6	7.4
Goats	17	15	19	0.7	0.5	0.7	0.1	0.1	0.1	2.6	3.1	2.4
Chicken	54	48	57	2.8	2.2	3.0	0.03	0.02	0.03	6.2	10.6	4.5
Horses	14	10	16	0.3	0.2	0.3	0.2	0.1	0.2	3.8	3.0	4.1
Mules	2	1	2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.3
Donkeys	26	16	31	0.4	0.2	0.4	0.2	0.1	0.2	5.3	3.4	6.1
Camels	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.0	0.0

Source: Authors' computation using the AGP baseline dataset (2011).

Relative to male-headed households, a lower proportion of female-headed households own each type of livestock. The likelihood of livestock ownership is negatively associated with household income distribution. The proportion that own each type of livestock except mules, increases with per capita income until the fourth quintile, but then decreases in the fifth income quintile. The proportion that own all types of livestock generally increases with land size in all livestock types, except cattle, sheep, and horses. What is unique to households in the high potential areas of Ethiopia is that they are more likely to own large ruminants rather than small ruminants.

### 4.1.2 SIZE AND COMPOSITION OF LIVESTOCK HOLDINGS

Cattle ownership averaged nearly 4 head per household in the aggregate sample. Sheep and goat ownership averaged 1.8 and 0.7 head per household, respectively, while chicken averaged 2.8. An average household owned less than one equine (horse, mule, or donkey) and camel together. Average cattle holdings are the highest in Oromia followed by Tigray.

The composition of livestock species, shown in the last three columns of Table 4.1, provides information on the importance of each type of livestock in terms of tropical livestock units. On average, cattle accounted for 74 percent of the livestock owned by households. The proportion in Amhara, Tigray, and Oromia stood at 70, 71, and 72 percent, respectively, while it was higher in SNNP at 81 percent. Small ruminants (sheep and goat together) on average accounted for 10.6 percent of total TLUs owned, while chicken accounted for about 6 percent. The number of livestock owned increases both in count and in terms of TLU with land size. The same holds across different income quintiles, with few exceptions. Relative to male-headed households, the contribution of chicken in female-headed households to their total livestock holdings in terms of TLU is more than twice as high. The contribution of cattle is relatively higher in male-headed households.

A lower proportion of female-headed households own all types of livestock and the number of livestock they own is lower relative to male-headed households, which generally indicates the limited access of female-headed households to livestock assets.

### 4.1.3 ACCESS TO CATTLE

Table 4.2 summarizes the structure and composition of cattle ownership across sex of household head. Table A.2 in the appendix provides a summary across regions and income and land quintiles.

**Table 4.2—Structure and composition of cattle ownership, by sex of household head**

Cattle type	Percent that own cattle (%)			Number owned (head count)			Number owned (TLU)			Composition (% of TLU)		
	All	Female	Male	All	Female	Male	All	Female	Male	All	Female	Male
Calves	49	42	52	0.8	0.6	0.9	0.6	0.5	0.6	20	22	19
Bulls	24	16	27	0.4	0.2	0.5	0.3	0.2	0.3	9	7	9
Heifers	37	31	40	0.6	0.5	0.7	0.4	0.3	0.5	16	18	16
Cows	58	52	60	1.0	0.8	1.1	0.7	0.6	0.8	26	30	24
Oxen	53	36	60	1.0	0.6	1.1	0.7	0.5	0.8	29	23	32
<b>Breed composition (%)</b>												
<b>Breed</b>	<b>All</b>	<b>Female</b>	<b>Male</b>									
Local	99.0	98.9	99.0									
Cross-bred	0.9	0.8	0.9									
Exotic	0.1	0.3	0.1									

Source: Authors' computation using the AGP baseline dataset (2011).

Forty-nine percent of households reported owning calves, while 24, 37, 58, and 53 percent reported owning bulls, heifers, cows, and oxen, respectively. The fact that the highest proportion of households owns cows has important nutritional implication, particularly for children. Using the AGP baseline survey data, Hoddinott et al. (2014) show that cow ownership improves the nutritional status of children in the household. Out of all households in the dataset, 98.6 percent are engaged in crop production or in crop production and one or more other activities. The latter, together with the proportion that own oxen, imply that over 40 percent of households lack draft oxen, which are mostly used in crop production. The fact that less than 30 percent own bulls also indicates that the households will in the future face problems to replace their oxen. Similarly, many households will face problems replacing cows given that less than 40 percent own heifers. In general, a significant proportion of households neither own sufficient cattle stock nor the reproductive capacity for replenishing their livestock.

A lower proportion of households in Tigray and Amhara regions own all classes of cattle, except oxen, relative to those in Oromia and SNNP. Relative to male-headed households, a lower proportion of female-headed households own all types of cattle. The difference is notably high for oxen ownership, which may have repercussions on the crop productivity of female-headed households.

Although the relationship between ownership of different classes of cattle and income distribution is non-linear, the general pattern is that ownership generally increases with income. There is a clear and positive relationship between ownership of different classes of cattle and cultivated area, indicating the importance of cattle in crop production. For example, the likelihood of owning oxen increases from 27 percent in the first land quintile to 71 percent in fifth land quintile.

### 4.1.4 SIZE AND COMPOSITION OF CATTLE HOLDINGS

An average household owns less than one head of calf, bull, or heifer, and average holding of cows and oxen is one head per species per household (Table 4.2). In terms of TLU, average holdings are less than 1.0 in all cattle classes. The size of cattle holdings of female-headed households is consistently lower than that for male-headed farm households. Despite the non-linear relationship, both the proportion of households that own different classes of cattle and the number of heads of cattle owned generally increase across income quintiles.

The number of different classes of cattle owned increases with land size. Furthermore, the number owned by households in the fifth land quintile is more than twice that owned by households in the first quintile in all cattle species. In particular, relative to households in the first land quintile, those in the fifth quintile own over four times as many oxen, the latter of which are critical inputs among households that use larger areas in crop production. Farmers that do not own a pair of oxen lack draft power, and similarly those with no bulls have to rely on the bulls of other farmers for breeding purposes, which may delay or decrease the efficiency of breeding.

The number of cows owned by households in different income quintiles is similar, and ranges only between 0.8 and 1.1. That is, 80 percent of the households in the poorest income quintile own one cow. Similarly, the number of cows that households in the lowest land quintile own averaged 0.7. The number of cows that households own has direct implications on households' milk production and consumption, as we shall see below.

In general, the size of holdings of different cattle species observed among the households surveyed is too low for sustainable breeding and to provide an adequate supply of draft oxen. This in turn prevents households from generating marketed surpluses of different classes of cattle and, thereby, take advantage of emerging opportunities in livestock markets. The introduction of small scale mechanization wherever technically and socially feasible, will help release cattle from draft power, one of the primary purposes they currently serve. During 2013/14, nearly 40 percent of cattle aged 3 to 10 years were used for draft power (CSA 2014).

In TLU terms, oxen account for the highest proportion of the cattle herd, about 29.4 percent, while cows account for 26 percent. Young cattle (calves, bulls and heifers) together account for about 45 percent of total cattle TLU. There are regional variations in cattle herd composition, which may reflect some differences in the purpose of rearing cattle across regions. The contribution of oxen to total cattle TLU varies from 13 percent in SNNP region to 32 percent in Oromia, 38 percent in Tigray, and 41 percent in Amhara. This may reflect the dominance of cereal crops in Amhara and Tigray. In SNNP, cows account for the highest percentage of cattle TLU.

The contribution to TLU of cows, heifers, and calves is higher for female-headed households relative to male-headed households and the opposite is true for the remaining classes of cattle. This may indicate that female-headed households focus more on the use of cattle in milk production, while male-headed households focus on their use in draft power.

There is no clear relationship between cattle herd composition and household income and land distribution, except for in the case of oxen and cows. The proportion of oxen increases with household income and land, while the opposite holds with cows.

#### 4.1.5 CATTLE HERD BREED STRUCTURE

The smallholder cattle production system is almost entirely dependent on local indigenous local breeds, and as such, there is no variation across cattle class, regions, sex of household head, and income and land size quintiles (the last four rows of Table 4.2 and Table A.2). The percentage of cattle made up of local cattle breeds is about 99 percent, with cross-breeds and exotic cattle breeds accounting for only about one percent (shown in the last three rows of Table 4.2 and Table A.2). This suggests that there may be considerable potential to increase the smallholder cattle productivity by introducing cross- and exotic breeds.

## 4.2. Livestock technical performance parameters

The AGP baseline survey data does not include some of the variables required to fully assess the technical performance of livestock production systems. Therefore, this section is limited to a discussion of three important technical parameters: annual calving rate, annual death rate, and annual herd or flock growth rate. Following Lesnoff (2008), the parameters are computed using retrospective data that covers a 12-month period, June 2010 to May 2011. Table 4.3 summarizes the results of these computations by sex of household head, while Table A.3 summarizes the results across regions and income, land, and livestock quintiles.

### 4.2.1 ANNUAL CALVING RATE

The annual calving rate is computed as the ratio of total number of calf births during the year to the average stock of cows that were present during that year. The birth rate for other livestock species is not computed due to lack of information on the number of breeding female animals. The average annual calving rate of cattle is 46.5 percent for the whole sample. That is, less than half of the cows gave birth to a calf. Calving rates are slightly lower among female-headed households. The lowest calving rate is observed in Tigray, while calving rates in other regions differ only slightly. Although there exist slight differences across different income and land quintiles, the differences appear unrelated to income and land size. However, calving rates increase with livestock quintile. This is consistent with the increase in breeding potential with increase in the number of livestock. In general, these annual calving rates are considered to be very low relative to rates seen elsewhere in Africa and indicates one of the potential areas for improving cattle productivity in Ethiopia.

**Table 4.3—Livestock technical performance parameters, by sex of household head**

Livestock	Annual death rate (%)			Annual growth rate (%)		
	All	Female	Male	All	Female	Male
Calves	19.4	19.6	19.4	5.8	-2.6	8.4
Bulls	9.8	13.5	8.7	-14.1	-19.1	-12.7
Heifers	7.9	8.1	7.8	-8.9	-8.0	-9.2
Cows	11.0	15.9	9.1	-10.1	-13.4	-8.9
Oxen	6.1	6.4	6.0	-7.3	-8.2	-7.1
Sheep	23.1	21.9	23.5	-4.7	-2.4	-5.5
Goats	20.2	22.9	19.4	-1.2	9.6	-4.9
Annual calving rate of cattle, %	46.5	45.4	46.9			

Source: Authors' computation using the AGP baseline dataset (2011).

#### 4.2.2 ANNUAL DEATH RATES

The annual death rate for a given livestock species is computed as the ratio of the total number of deaths to the average stock of that livestock species. High annual death rates of 20 percent are observed for small ruminants and calves, while death rates were 11 percent in cows, 10 percent in bulls, and 8 percent in heifers (Table 4.3). Death rates are the lowest in oxen (6 percent), which may be due to the extra care that farmers provide to oxen in terms of feed and veterinary services, given the critical importance of oxen in crop production. Death rates are somewhat higher in female-headed households in all species except sheep. SNNP region has the highest death rate in all species. Moreover, death rates have no unique pattern across income and land quintiles. Death rates generally decline with livestock ownership in all species, except calves. The high death rate observed among households used in our analyses is not unique. CSA reports that nationwide death rates averaged 8 percent in cattle and 22 percent in both sheep and goats during 2010/11 (CSA 2011a). Furthermore, CSA data indicate that, out of the cattle that died in 2010/11, 84 percent were afflicted by some disease, while this proportion was 98 and 82 percent in sheep and goats, respectively. This implies that the number and productivity of smallholders' livestock holdings could be increased by reducing livestock deaths through proper management and provision of veterinary services.

#### 4.2.3 ANNUAL GROWTH RATES

Annual growth rates of each livestock species is computed by subtracting one from the ratio of ending stock and beginning stocks ( $\text{Growth rate} = \text{Ending stock}/\text{Beginning stock} - 1$ ). Growth rates are negative in all livestock species except for calves, which is dominated by the positive growth rate of calves in male-headed households. The stock of calves shrank and a positive growth rate was observed for goats in female-headed households. All regions had negative growth rate in all species, except calves and goats, which had positive growth rates in SNNP and Oromia, respectively (Table 4.3 and Table A.3).

### 4.3. Characterization of livestock market participation by smallholders

The livestock marketing system of farm households can be characterized in terms of the frequency and intensity of their transactions in livestock markets. The transactions considered are livestock sales, livestock purchases, and livestock on-farm slaughter. We summarize the results on marketing frequency by sex of household head in Table 4.4, while the results on intensity of livestock marketing are provided in Table 4.5. The corresponding results are summarized across regions and income, land, and livestock quintiles in Tables A1.4 and A1.5. In addition, we describe patterns in milk production, consumption and marketing that were observed among the households surveyed. These results are summarized in Table 4.6 for all household categories.

#### 4.3.1 FREQUENCIES OF PARTICIPATION IN LIVESTOCK MARKETS

**Livestock sales.** The proportion of households that participated in livestock sales ranged from the 1.8 percent for calves to 13.7 percent for sheep. For bulls and heifers, the proportion was low; for cows and goats the percentage fell in the middle range; and for oxen this was higher at 10 percent (Table 4.5). A lower proportion of female-headed households sold all types of livestock. The proportion of households that sold livestock increases across livestock quintiles, which is expected. Similarly, the proportion that sold all types of livestock generally increases with land and income. This is consistent with our previous observation, which indicates that the proportion of households that own each livestock species increases with land and income.

**On-farm livestock slaughtering.** Farm households are more likely to slaughter goats and sheep than cattle. The proportion of households that slaughtered sheep (9.3 percent) and goats (3.4 percent) is considerably higher than that of the next closest livestock type, which was cows at 0.8 percent. The proportion of households that slaughtered other cattle types was 0.3 percent or lower (Table 4.4). Female-headed households were more likely to slaughter bulls and heifers than male-headed households, while the reverse held for the remaining livestock species. The proportion of households that slaughtered all livestock types generally increases with income, land, and livestock size. As such, there is little regional variation in on-farm slaughtering by farm households. The exceptions are the much higher proportion that slaughtered oxen and goats in Tigray, and those that slaughtered sheep in Amhara.

**Table 4.4—Proportion of households participating in livestock markets, by sex of household head**

Livestock	Livestock sales (%)			Livestock slaughtered (%)			Livestock purchased (%)		
	All	Female	Male	All	Female	Male	All	Female	Male
Calves	1.8	1.2	2.1	0.1	0.0	0.2	1.0	0.4	1.2
Bulls	2.3	1.7	2.5	0.3	0.4	0.3	1.3	0.4	1.8
Heifers	2.6	1.9	3.0	0.2	0.2	0.1	1.9	1.6	2.0
Cows	4.1	4.0	4.2	0.8	0.5	1.0	2.2	1.0	2.7
Oxen	10.2	6.5	11.7	0.3	0.2	0.4	8.2	5.2	9.4
Sheep	13.7	11.5	14.7	9.3	6.2	10.7	5.9	4.1	6.7
Goats	5.0	4.4	5.2	3.4	2.2	3.9	2.0	1.6	2.2

Source: Authors' computation using the AGP baseline dataset (2011).

**Livestock purchases.** Farm households purchase livestock for different purposes: breeding, draught use, or for consumption. A low proportion (1 percent) of farm households purchased calves. A high proportion of households (8 percent) purchased oxen, which are typically used to plow land. The proportion that bought sheep, cows, and goats followed oxen in that order (Table 4.4). This pattern is not unique to this data. CSA reported that out of a total number of 3 to 10-year-old cattle sold in 2010/11, three-quarters were bought by farm households, while the proportion was 67 percent in sheep and 42 percent in goats (CSA 2011a).

The pattern observed in the aggregate sample also held by sex of household head and for regions, with few exceptions. The exceptions, as observed in SNNP, include a higher proportion of households buying sheep than those that bought oxen, as oxen are not used in cultivating the dominant crop in SNNP, enset. Similar patterns are observed across income, land, and livestock quintiles, again with few exceptions (Table A.4).

#### 4.3.2 INTENSITY OF PARTICIPATION IN LIVESTOCK MARKETS

This section describes smallholder farmers' livestock market participation intensity in terms of sales off-take, on-farm slaughter off-take, commercial intake (purchase), and net commercial off-take rates. The results of our analyses are summarized in Table 4.5 and shown by sex of household head, and in Table A.5 shown across regions and income, land, and livestock quintiles.

**Table 4.5—Intensity of livestock market commercialization, by sex of household head**

Livestock	Sales off-take rate (%)			Slaughter off-take rate (%)			Commercial intake (purchase) rate (%)			Net commercial off-take rate (%)		
	All	Female	Male	All	Female	Male	All	Female	Male	All	Female	Male
Calves	2.7	1.8	3.0	0.1	0.0	0.1	1.4	0.7	1.7	1.3	1.2	1.4
Bulls	6.0	6.3	6.0	1.0	1.8	0.7	3.7	1.6	4.3	2.8	4.7	2.2
Heifers	4.0	3.3	4.2	0.2	0.3	0.1	3.3	3.6	3.1	1.0	0.1	1.3
Cows	3.7	4.3	3.5	0.9	0.5	1.0	2.4	1.2	2.8	1.9	3.3	1.4
Oxen	10.9	9.7	11.2	0.3	0.2	0.3	9.5	9.1	9.7	1.2	0.5	1.4
Sheep	15.0	15.2	14.9	7.1	4.9	8.0	7.9	6.9	8.2	13.9	13.1	14.2
Goats	12.9	13.7	12.7	6.0	4.4	6.5	5.9	5.4	6.0	13.1	12.2	13.4

Source: Authors' computation using the AGP baseline dataset (2011).

**Livestock sales off-take rate.** The annual sales off-take rate is computed using equation (3) in Section 3.1. The highest sales off-take rate is observed in sheep at 15 percent, followed by goats at 13 percent, and 11 percent in oxen (Table 4.5). The sales off-take rate in the remaining cattle types ranged between 2.7 and 4 percent, except in bulls (6 percent). Relative to male-headed households, female-headed households have higher sales off-take rates for bulls, cows, and small ruminants. However, the order of importance of livestock types in off-take rates were mostly similar across sex of

household head, being highest for sheep and lowest for calves. Except for a few exceptions, the order of importance in off-take rates was similar across regions (Table A.5).

Off-take rates of all livestock types mostly increase with land size and per capita income, with some exceptions in each case (Table A.5). While there are differences in the order of importance of off-take rates across income, land, and livestock quintiles, there are more similarities than differences. Off-take rates mostly decline with sizes of livestock holdings for all livestock species, except calves and bulls. This indicates that, relative to their total livestock holdings, households with larger herds sell fewer livestock than households with smaller herds.

**Livestock on-farm slaughter off-take rate.** In general, on-farm slaughter is negligible in all cattle types where off-take rates are less than one percent for an average household in the sample and for male-headed households. For female-headed households, the only exception to this pattern is the off-take rate of bulls at 1.8 percent. On-farm slaughter rates are highest for sheep for both male and female-headed households, followed by goats. Slaughter off-take rates are higher in male-headed than in female-headed households in all livestock species, except for bulls and heifers (Table 4.5).

The patterns observed for an average household generally hold across households in different regions and income, land, and livestock quintiles with some exceptions. For example, slaughter off-take rates of cattle exhibit no specific pattern across income, land, and livestock quintiles, while sheep and goat slaughter off-take rates generally increase with income, land, and livestock size (Table A.5). Moreover, the sheep and goat slaughter off-take rate in Tigray (12.4 percent) is more than three times the rate in SNNP, while the average in Amhara (14.5 percent) is nearly three times the rate in Oromia. While goat slaughter off-take rates in Tigray and Amhara are also higher than those in Oromia and SNNP, the difference is not as large as that observed in sheep.

**Commercial livestock intake (purchase) rate.** Table 4.5 shows that the highest commercial intake rate is observed for oxen (9.5 percent), followed by sheep (8 percent) and goats (6 percent), while in the remaining species it ranged between 1.4 percent (calves) to 3.7 percent (bulls). The commercial intake rate for male-headed households is higher than that for female-headed households for all livestock types, except heifers.

The commercial intake rate for oxen is the highest in all regions and land, income, and livestock quintiles. Exceptions to the latter include the first land quintile and first and second income quintiles, in which the rate for oxen was second highest next to sheep purchases, while in the first livestock quintile it was fourth highest. Except in a few cases, the purchase rate of calves is the lowest in all regions and land, income, and livestock quintiles. Commercial intake rates of calves and oxen, which increase with income distribution, and, consistent with the importance of oxen in crop production, these purchase rates generally increase with land size. There are no clear relationships between the distribution of land, income, and livestock and commercial intake rates in the remaining livestock species.

**Net commercial livestock off-take rate.** Since farmers are engaged in purchases, on-farm slaughter, and sales of livestock, the best tool to characterize households' market orientation considers all of these aspects. The net market position of each household, which considers these aspects, is computed using equation (6) and is summarized in the last three columns of Table 4.5 and in Table A.5. In general, net commercial off-take rates are low for cattle, ranging from 1.0 percent in heifers and 1.2 percent in oxen, to about 2.0 percent in cows and 2.8 percent in bulls. Net commercial off-takes of sheep is considerably higher at about 14 percent and is 13 percent in goats (Table 4.5). Net commercial off-takes from female-headed households are considerably higher than for male-headed households for bulls and cows, while the reverse holds for heifers and oxen. Male-headed households have higher commercial off-take rates for the remaining species.

Net commercial off-take of most livestock types generally increases with income size. Rates for heifers, cows, sheep, and goats generally increase with landholding size, while the pattern is not unique across livestock holdings. Net commercial off-take rates of at least two cattle types are negative in the first income, land, and livestock quintiles. Moreover, net commercial off-take of at least one cattle type is negative in the second income, land, and livestock quintiles. Sheep and goat net commercial off-take rates exceed 10 percent in all land, income, and livestock quintiles with few exceptions. The net commercial off-take rates for sheep in Tigray (19 percent) and Amhara (23.7 percent) is about twice that in SNNP and Oromia, respectively. Net commercial off-take rates for goat in Tigray and Amhara (19 percent) are four times higher than that in SNNP, while the goat net commercial off-take rate is 13.4 percent in Oromia.

#### 4.3.3 SMALLHOLDER MILK PRODUCTION, CONSUMPTION AND COMMERCIAL OFF-TAKE RATE.

Even though Ethiopia boasts the highest livestock population in Africa, average productivity levels in terms of meat and milk yield per animal and per capita livestock product consumption in Ethiopia has remained lower than the respective average figures for East African countries for the last several decades (Negassa 2012). Average annual milk production is 230 liters per household and less than 47 liters per capita (Table 4.6). Milk productivity averaged 177 liters per cow per

year, which is less than half a liter per cow per day. Milk output per cow differs only slightly between female- and male-headed households. Relative to female-headed households, those with male heads produce 10 percent more milk per household, while their per capita milk output is 10 percent lower, given the larger average household size of male-headed households.

**Table 4.6—Milk production, consumption, and commercialization**

Category	Group	Annual milk production (liters)			Annual milk consumption (liters)		Annual milk utilization (share of total production, %)		
		Per household	Per capita	Per cow	Per household	Per capita	Consumption	Sales	Other uses
All households		231	47	177	101	20	37.8	0.9	61.3
Sex of household head	Female	211	51	178	89	23	37.7	1.5	60.8
	Male	240	45	176	106	19	37.9	0.7	61.4
Land Quintile	Q <sub>1</sub>	106	30	152	41	11	35.9	0.9	63.2
	Q <sub>2</sub>	216	46	196	105	22	41.1	0.8	58.1
	Q <sub>3</sub>	277	48	192	138	23	36.7	0.6	62.7
	Q <sub>4</sub>	242	57	178	90	22	37.3	1.1	61.6
	Q <sub>5</sub>	352	56	165	142	25	38.3	0.9	60.8
Income Quintile	Q <sub>1</sub>	115	26	135	38	9	39.3	0.9	59.9
	Q <sub>2</sub>	322	54	204	173	25	33.9	1.5	64.7
	Q <sub>3</sub>	288	49	175	103	22	35.0	0.6	64.4
	Q <sub>4</sub>	193	47	176	80	20	41.7	0.7	57.6
	Q <sub>5</sub>	222	55	183	104	24	40.3	0.9	58.8
Livestock Quintile	Q <sub>1</sub>	4	1	115	1	0.4	49.5	3.5	47.0
	Q <sub>2</sub>	48	19	132	17	7	36.0	0.9	63.1
	Q <sub>3</sub>	122	37	158	40	12	33.2	1.3	65.5
	Q <sub>4</sub>	254	62	167	110	27	36.1	0.5	63.3
	Q <sub>5</sub>	742	116	218	343	56	41.7	0.9	57.4
Regions	Tigray	150	36	135	72	16	46.7	0.4	52.9
	Amhara	84	22	130	30	8	33.5	0.2	66.3
	Oromia	272	53	177	110	24	39.0	0.8	60.2
	SNNP	329	63	217	164	27	37.8	1.6	60.6

Source: Authors' computation using the AGP baseline dataset (2011).

Milk output per cow is about the same in Tigray and Amhara regions. Output per cow in Oromia (177 liters) and SNNP (217 liters) regions is over 30 and 60 percent, respectively, higher than the average in Tigray and Amhara. The per capita milk output of households in both Oromia and SNNP is over 40 percent higher than that in Tigray, and over 140 percent higher than that in Amhara.

Milk output per household and per capita generally increase with land size. Output per cow is the highest in the second land quintile and then declines with land size. All three productivity measures increase with livestock size, while there is no unique pattern in the productivity measures across income size.

Annual milk consumption averaged 101 liters per household and 20 liters per capita. Despite total consumption of households with female heads being 20 percent lower relative to that of male-headed households, their per capita consumption is 20 percent higher given the lower number of members in female-headed households. The relationship between per capita and household milk consumption and land, income, and livestock size, is the same as the relationship between land, income, and livestock size and the corresponding productivity measures, with one exception: per capita consumption is lower in the fourth land quintile than in the third. Household and per capita annual milk consumption are considerably lower in Amhara (30 and 8 liters, respectively), which is followed by Tigray (72 and 16 liters). Both household and per capita milk consumption in Oromia (110 and 24 liters) are at least 50 percent higher than the corresponding numbers in Tigray (72 and 16 liters) and at least 200 percent higher than those in Amhara (30 and 8 liters). Similarly, household and per capita milk consumption in SNNP (164 and 27 liters) are at least 70 percent higher than the corresponding numbers in Tigray and 240 percent higher than those in Amhara.

Per capita milk consumption in the second to fifth land and income quintiles is similar and generally greater than 20 liters, while milk consumption is about 10 liters in the first land and income quintile. In contrast, per capita milk consumption in the first and second livestock quintiles, in which only 4 and 36 percent of the households, respectively, own a cow, is less than one liter and 7 liters, respectively. Hoddinott et al. (2014) use the AGP baseline survey data to

study the relationship between cow ownership, milk consumption, and nutritional outcomes, particularly in children. Their study finds that cow ownership raises children's milk consumption and improves nutritional outcomes. More importantly, they find that the direct nutritional impacts of household cow ownership are less important where there is good access to local markets, suggesting that market development can substitute for household cow ownership (Hoddinott et al. 2014).

More than 99 percent of milk produced is used for home consumption. Out of this, about 38 percent is directly consumed, while about 61 percent is used for other purposes, mainly processed into butter and other cottage dairy products. Less than one percent is sold, indicating that milk production among the households surveyed, both male and female-headed, is almost entirely used for subsistence consumption within the household.

#### 4.4. Farm households' participation in different income generating activities

The data on farm households' participation in different income generating activities, per capita income levels, and the composition of income are summarized in Table 4.7 across regions and by sex of household head. The corresponding results are summarized across land, income, and livestock quintiles in Table A.6.

##### 4.4.1 PARTICIPATION IN INCOME GENERATING ACTIVITIES

The results indicate that an average household is engaged in about two income generation activities (Table 4.7). The number of income sources averaged 2.2 in all land and livestock quintiles, except for lower numbers, 1.9 and 2.0, in the first and second land quintiles, respectively, and in the first livestock quintile (1.6). This implies that, given the opportunity, households participate in a diversity of livelihoods irrespective of the size of their land and livestock holdings. The number of income sources increases linearly with per capita income. Another way of viewing this is that households' income increases with the number of sources from which they derive income.

**Table 4.7—Participation in different income generating activities and level of income by source**

Income source	Sex of head			Regions			
	All HHs	Female	Male	Tigray	Amhara	Oromia	SNNP
Proportion generating income (%)							
Crop production	91	85	93	82	91	92	89
Livestock production	67	59	71	62	79	69	52
Off-farm employment	28	24	29	34	34	27	21
Non-farm business	23	20	24	18	16	27	25
Average number of income sources	2.1	1.9	2.2	1.9	2.2	2.1	1.9
Per capita income by source (ETB/Year)							
Crop production	750	681	780	631	806	810	600
Livestock production	85	75	90	99	116	82	55
Off-farm employment	495	465	508	816	715	452	295
Non-farm business	129	91	146	200	83	147	139
Total income	1,460	1,312	1,523	1,746	1,720	1,491	1,089
Share in income of source (%)							
Crop production	64.2	65.1	63.8	52.4	60.0	65.6	67.6
Livestock production	9.4	9.2	9.5	11.8	11.6	9.0	7.4
Off-farm employment	18.3	18.0	18.4	25.8	23.6	16.7	14.3
Non-farm business	8.1	7.6	8.3	9.9	4.8	8.6	10.7
Income diversification index	0.2	0.2	0.3	0.2	0.3	0.2	0.2
Income per hectare (ETB)							
Crop income per hectare	4,343	3,663	4,631	1,987	3,925	3,608	6,315
Livestock income per hectare	417	394	426	387	531	379	366
On-farm income per hectare	4,760	4,057	5,058	2,374	4,456	3,987	6,681
Commercialization indices							
Crop output commercialization index	25.9	23.7	26.7	25.1	20.7	25.1	33.2
Crop input commercialization index	12.3	12.2	12.3	15.2	11.4	14.9	8.3
Livestock input commercialization index	14.1	13.6	14.3	12.8	12.4	16.6	11.4

Source: Authors' computation using the AGP baseline dataset (2011).

A large majority of the households are likely to engage in crop production. The proportion engaged in crop production averaged 91 percent for the entire sample, 85 percent among female-headed households. The proportion that generated income from crop production is at least 89 percent in all regions, except in Tigray, and, with the exception of

the first quintile, in all land, income, and livestock quintiles. Participation in crop production increases until reaching the fourth land, income, and livestock quintiles.

Households that participated in livestock production averaged 67 percent. Households that participated in off-farm employment or households with members employed on others' farms, in businesses, or in any other wage labor, averaged 28 percent. A quarter of households participated in non-farm activities, which includes the production and sale of food, handicrafts and traditional drinks, and trade in agricultural products and merchandise. The proportion of households that participate in livestock production generally increases with land and income size, while participation in off-farm activities generally declines with land and livestock size. Participation in non-farm activities generally declines with livestock size and has no relation with land size.

#### 4.4.2 PER CAPITA INCOME AND ITS COMPOSITION

Table 4.6 indicates that annual per capita income averaged just over 1,000 birr. Per capita income is relatively higher in Tigray (1,746 birr) and followed closely by Amhara (1,720), while per capita incomes are lower in Oromia (1,491 birr) and much lower in SNNP at less than 1,100 birr. Female-headed households earn lower income per capita. This is consistent with evidence indicating that a lower proportion of female-headed households participate in off- and non-farm income generation activities and are endowed with fewer farming assets, and hence produce lower crop and livestock outputs. About 71 percent (764 birr) of average total income (1,020 birr) was generated from crop production, 11 percent from livestock production, 10 percent from off-farm employment, and 8 percent from non-farm activities. The contribution of the various income sources to total income for the most part was similar across female- and male-headed households.

Given the critical importance of land and livestock as a means of livelihood to a large proportion of households, total per capita income increases with land and livestock size. As expected, income from crop and livestock production increases with land and livestock size. Moreover, the share of crop income in total income increases across land, income, and livestock sizes. The share of livestock income increases with livestock size, although this pattern is not seen with income and land size. Income derived from off farm employment declines with land and livestock size, which is consistent with the decline in the proportion of households that generate income from off-farm employment with land and livestock size. Moreover, the share of off-farm income uniformly declines across land, income, and livestock size, which indicates the importance of this income source for households endowed with few agricultural assets. Consistent with the decline in the proportion engaged in non-farm activities, the share of non-farm income generally declines with an increase in livestock holdings. Moreover, the share first declines and then increases across land and income quintiles. However, the share of non-farm income is considerably higher for households in the first land, income, and livestock quintiles relative to the other quintiles, particularly relative to the highest two quintiles. Again, this signifies the importance of non-agricultural income sources in total income of households endowed with few agricultural assets. This, in turn, indicates the need for agricultural development strategies to promote non-farm and off-farm employment opportunities and to integrate these income sources with farming as an important means to reduce poverty given the current level of productivity and low per capita land ownership.

The number of farm holders in Ethiopia increased faster than the area of land cultivated in the last decade such that average landholding size declined annually by 1.4 percent over this period (Bachewe et al. 2015). Furthermore, Headey et al. (2014), using the AGP baseline survey data, show that younger farmers cultivate substantially less land than previous generations. We further investigate the relationship between the type and number of activities in which households are engaged, their land and livestock endowments, and other household characteristics using the correlation between these variables. The correlation coefficients are provided in Table A.7. Some of the simple correlations in the table are consistent with research findings noted above and with observations made in previous sections regarding the relationship between participation in income generating activities, on the one hand, and land and livestock asset ownership, on the other. For instance, cultivated land size and number of livestock increase and participation in off-farm and non-farm activities decline with age of household head. This may imply that households with younger heads who have smaller land holdings resort to alternative income sources than crop farming. This is implied also by the negative correlation between land size and participation in off- and non-farm activities. Furthermore, the correlation between earning income from crop production and engaging in non-farm activities are negative, while participation in off- and non-farm activities are negatively correlated with owning livestock or number of livestock owned.

### 4.4.3 INCOME DIVERSIFICATION INDEX

The overall income diversification index (HDI), which is summarized in Table 4.7 and Table A.6, is computed using equation (10). The HDI based on the four income sources averaged 0.24 for the whole sample.<sup>8</sup> The HDI of female-headed households (0.22) is lower than that of male-headed households (0.25). HDI ranges from 0.21 in SNNP to 0.27 in Amhara. Although HDI generally declines across land quintiles, its range only was between 0.23 and 0.25 across land quintiles. HDI is unrelated with livestock holding size – highest HDIs are observed in the middle livestock quintile – and ranges only between 0.22 and 0.25 across livestock quintiles. The greatest range in HDI is seen across income quintiles, starting from 0.14 in the first quintile to 0.30 in the fifth, with HDI increasing linearly across income quintiles. The fact that the poorest households have the least diversified income sources indicates the importance of income diversification in reducing poverty. However, given the limited availability of land and increasing rural population, other sources of income other than crop and livestock production, need to play a major role.

## 4.5. Market orientation of smallholder household crop and livestock production

The market orientation in crop and livestock production of farm households is assessed using the output commercialization index given by equation (1). Crop and livestock input commercialization indices are computed using equation (2). Results of the computations are provided in the last three rows of Table 4.7 and Table A.6

### 4.5.1 COMMERCIALIZATION OF CROP OUTPUTS AND INPUTS

The households surveyed have generally low levels of commercialization. The average crop output commercialization index (HCI) is 26 percent for the entire sample, while the crop input commercialization index (HCII) averaged 12.3 percent. Farm households that are completely subsistence oriented or which sold no crop output, accounted for 21 percent of the total number. Households with female heads have an HCI of 23.7 percent and those with male heads 26.7 percent, while the performance in HCII is similar by sex of household head. Households in Amhara have the lowest HCI at 21 percent and those in SNNP have the highest at 33 percent, while Tigray and Oromia are equal at 25 percent. In contrast, SNNP has the lowest HCII at 8.3 percent, followed by Amhara at 11.4 percent. Tigray and Oromia are similar at about 15 percent.

Although smallholder farmers are characterized by generally low levels of commercial crop output, there is variation across households. HCI linearly increases with land, income, and livestock size. HCI increases from 21 (18 and 24) percent in the first land (income and livestock, respectively) quintile to 32 (33 and 28) percent in the fifth quintile, indicating a positive correlation between households' levels of commercialization, on the one hand, and resource endowment and welfare, on the other. HCII generally decreases with land and income size, while it linearly increases with livestock holdings. The fact that the intensity of crop production, measured by the crop input commercialization index decreases along the income quintiles, may imply that farm households follow a less intensive crop production strategy as their income increases. This is reinforced also by the negative land size-HCII relationship, whereby households with larger land size use little purchased inputs, such as fertilizer and improved seeds.

### 4.5.2 COMMERCIALIZATION OF LIVESTOCK INPUTS

Results of the Livestock Input Commercialization Index (HLCII), which is computed using equation (2), are provided in the last rows of Tables 4.7 and A.6. HLCII averaged 14.1 percent in all households, 13.6 in female-headed households, and 14.3 in male-headed households. It varied from 11.4 percent in SNNP to 16.6 percent in Oromia, while Amhara (12.4 percent) and Tigray (12.8 percent) exhibited similar values. HLCII generally increases with land and livestock size, while it first decreases and then increases with income size.

## 4.6. The role of income sources in income risk and inequality reduction

### 4.6.1 ROLE OF INCOME SOURCE IN INCOME RISK REDUCTION

Income diversification reduces the risk of decreases in total income. This can be analyzed using the covariance structure of different income sources. The pairwise correlation coefficients of different income sources are used to assess how different income sources reduce income risk (Table 4.8). As expected, all income sources are positively and significantly correlated with per capita total income. It is important to note that livestock income is positively correlated with crop income, indicating that livestock income does not negatively impact total income because it is not negatively associated

<sup>8</sup> Note that HDI considers both the number and relative importance of income sources. HDI approaches 1, which is the ideal level of diversification, when there are a large number of income sources that contribute equally but small shares to total income. In our analyses, which considers only four income sources, the highest HDI that a household can achieve is 0.75 when all four sources account for a quarter of the total income.

with crop income. However, off-farm and non-farm income are not correlated with both crop and livestock income, which indicates that off- and non-farm income sources are not related to decreasing risk in total income due to decreases in crop income or livestock income. The correlation between off-farm and non-farm income is positive, indicating that off-farm income does not decrease the risk of total income diminishing because of decreases in non-farm income.

**Table 4.8—Coefficients of correlation between per capita incomes generated from different sources**

Income	Per capita (total)	Crop	Livestock	Off-farm
Crop	0.9072*			
Livestock	0.2694*	0.1485*		
Off-farm	0.2165*	0.0087	0.0064	
Non-farm	0.3749*	0.0255	0.0083	0.0603*

Source: Authors' computation using the AGP baseline dataset (2011).

Note: Coefficients with \* are significant at 5 percent.

#### 4.6.2 ROLE OF INCOME SOURCE IN REDUCING INCOME INEQUALITY

Based on equation (11), the decomposition of the Gini coefficient of per capita total income for all households is executed using the Stata command *descogini* (L'opez-Feldman 2006). The results are presented in Table 4.9. Per capita total income is highly unequally distributed among smallholder farmers. The observed Gini coefficient for total income is 0.70 on a 0 to 1 scale (Table 4.9, column (3)). For individual income sources, the Gini coefficient varied from 0.62 for crop income to 0.94 in non-farm income livestock income. The highest correlation between the inequality of individual income source and the inequality in per capita total income is observed for crop income, while the lowest correlation coefficient is observed for livestock income.

**Table 4.9—The contribution of income sources to per capita income inequality**

Income source	Share in total income ( $S_k$ )	Gini coefficient for source income ( $G_k$ )	Gini correlation with rank of total income ( $R_k$ )	Absolute contribution of income source to total inequality ( $R_k G_k S_k$ )	Relative contribution of source of income to total inequality ( $R_k G_k S_k / G$ )	Gini income elasticity ( $R_k G_k / G$ )	Percent change in overall Gini coefficient
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crop	0.75	0.62	0.93	0.78	1.12	0.82	0.03
Livestock	0.08	0.78	0.50	0.06	0.08	0.56	-0.02
Off-farm	0.08	0.88	0.50	0.07	0.09	0.62	-0.02
Non-farm	0.08	0.94	0.66	0.09	0.13	0.88	0.01
All income		0.70					

Source: Authors' computation using the AGP baseline dataset (2011).

In general, increases in livestock and off-farm income results in an increase in income and a decrease in income inequality, while the crop and non-farm income are activities that increase inequality (Table 4.9, column (8)), indicating that crop and non-farm income favor the rich more than the poor. Crop and non-farm income contribute 112 and 13 percent, respectively, to total income inequality (Table 4.9, column (6)). The lowest contribution to total income inequality is from livestock at 8 percent.

Table 4.9 also presents the Gini income elasticity which distinguishes between inequality-decreasing and inequality-increasing income sources. According to the Gini coefficient decomposition, crop income and non-farm income sources are income inequality increasing activities. For example, a one percent increase in crop income increases the Gini coefficient by 0.82, which is equivalent to a 0.03 percent increase in inequality at the margin (Table 4.9, column (7)). On the other hand, livestock and off-farm income sources have an income equalizing effect. For example, a one percent increase in livestock income decreases the Gini coefficient by 0.02 percent at the margin. Thus, from our calculations, increases in livestock income contribute to reducing rural income inequality.

## 5. CONCLUSIONS AND POLICY IMPLICATIONS

Agriculture, particularly crop outputs, contributed significantly to the remarkable economic growth recorded in Ethiopia in the last decade. Despite the rapid growth in domestic and exports demand for live animal and animal products and the

considerable potential in livestock production, growth in livestock production was slower and the importance of livestock outputs in agriculture declined throughout the 2004/05 to 2013/14 period.

This work studies livestock production and productivity of mixed crop-livestock producing households in Ethiopia. Particularly, the work investigates the access of farm households to livestock assets and production practices, their marketing behavior, their income diversification strategies, and the impact of different income sources on poverty and income inequality. For this purpose, we use data collected in the Agricultural Growth Program baseline survey, which covered the four agriculturally important regions of the country using a sample of 7,928 households. The sampled households represented over 9 million households which account for over 65 percent of rural households in the country in 2010/11.

This study finds that a low proportion of households have access to most livestock species and that the average livestock holding also is small. Livestock production is characterized by low productivity in terms of low calving rates and high mortality rates, such that annual growth rate is negative in almost all livestock species. Milk productivity averaged less than half a liter per cow per day. Less than one percent of milk produced is sold. Net commercial off-take rates of livestock is low because sales off-take rates are low, on-farm slaughter is negligible, and farmers' purchases of different livestock species accounted for at least half of the total sales. Moreover, this limited market orientation with livestock means that farmers' capacity to take advantage of emerging livestock market opportunities was limited. However, the same results also imply that there is a room for improving the productivity of smallholder livestock production by increasing calving rates or by reducing mortality rates and by improving farmers' market orientation.

These descriptive analyses indicate the existence of a high degree of heterogeneity in access to livestock assets, production practices, and marketing and livelihood strategies among the households studied. The latter implies that a single blanket policy recommendation might not work for all farmers. The data also indicate that a limited number of farm households generate their livelihood from off-farm and non-farm activities. While the share of off-farm and non-farm income sources in total income of an average household is low, their share is considerably higher for households with few agricultural assets. This fact highlights the need for rural and agricultural development strategies that promote non-farm and off-farm employment opportunities, and the importance of exploiting the positive synergies between the means of livelihoods for different households.

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## APPENDIX

**Table A.1—Structure and composition of livestock ownership**

	Land Quintile					Income Quintile					Region			
	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Tigray.	Amhara	Oromia	SNNP
<b>Households that own livestock (%)</b>														
Livestock	82	91	94	97	96	73	95	95	97	97	93	92	93	89
Cattle	68	79	85	91	91	63	83	85	89	88	80	80	83	83
Sheep	34	42	40	44	42	27	42	44	46	38	19	36	43	41
Goats	9	18	18	21	22	15	21	18	18	14	27	18	17	17
Chicken	38	49	57	63	67	39	54	58	60	58	60	65	54	41
Horses	11	12	15	16	16	8	13	17	16	14	1	5	21	12
Mules	1	1	1	1	5	1	1	2	1	2	1	1	2	1
Donkeys	9	23	28	37	40	14	24	29	33	32	40	36	31	8
Camels	0.0	0.1	0.0	0.2	0.5	0.1	0.1	0.1	0.3	0.1	2	0.3	0.0	0.0
<b>Livestock owned (head count)</b>														
Cattle	2.1	2.9	3.6	4.8	6.4	2.5	3.6	4.1	4.2	4.5	4.2	3.0	4.6	3.2
Sheep	1.3	1.6	1.8	2.0	2.3	1.0	1.8	1.9	2.4	1.7	1.1	1.7	2.1	1.3
Goats	0.3	0.6	0.6	0.8	1.2	0.5	0.8	0.7	0.6	0.5	1.8	0.7	0.7	0.5
Chicken	1.8	2.2	2.9	3.4	3.9	1.6	2.7	2.8	3.4	3.3	3.8	3.1	3.2	1.5
Horses	0.2	0.2	0.3	0.3	0.3	0.1	0.2	0.3	0.3	0.3	0.0	0.1	0.4	0.2
Mules	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Donkeys	0.1	0.3	0.4	0.5	0.7	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.1
Camels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Livestock owned (TLU)</b>														
Cattle	1.5	2.1	2.5	3.3	4.5	1.8	2.5	2.9	2.9	3.1	2.9	2.1	3.2	2.2
Sheep	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1
Goats	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Chicken	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horses	0.1	0.2	0.2	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.0	0.1	0.3	0.1
Mules	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Donkeys	0.1	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.0
Camels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Livestock	1.8	2.6	3.2	4.2	5.5	2.2	3.2	3.6	3.7	3.9	3.6	2.7	4.1	2.6
<b>Composition of livestock (% TLU)</b>														
Cattle	71.3	71.6	73.5	77.0	77.7	74.1	71.6	72.7	74.7	76.0	28.3	80.2	84.7	79.9
Sheep	9.6	9.3	7.8	6.8	5.4	7.5	9.3	7.5	8.8	6.5	22.6	7.9	4.7	5.4
Goats	2.5	3.7	2.5	2.1	2.4	4.0	3.3	2.5	1.7	2.0	6.0	2.6	1.9	2.0
Chicken	8.8	6.5	6.1	3.9	4.6	7.0	6.6	7.1	5.3	5.2	39.6	2.3	0.9	0.9
Horses	5.0	3.7	3.6	3.5	3.2	3.3	3.4	4.3	3.7	4.1	0.0	2.6	2.6	4.3
Mules	0.2	0.1	0.1	0.2	0.4	0.1	0.2	0.2	0.2	0.3	0.1	0.1	0.1	0.3
Donkeys	2.5	5.1	6.3	6.5	6.1	3.9	5.5	5.5	5.5	5.8	3.4	4.3	5.2	7.1
Camels	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1

Source: Authors' computation using the AGP baseline dataset (2011).

**Table A.2—Structure and composition of cattle ownership**

	Land Quintile					Income Quintile					Region			
	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Tigray	Amhara	Oromia	SNNP
<b>Of households that own cattle (%)</b>														
Calves	36	47	49	57	60	36	48	53	54	52	46	42	52	51
Bulls	12	19	25	29	39	17	24	25	23	30	23	23	28	16
Heifers	28	35	39	43	45	26	41	42	39	36	28	29	41	41
Cows	45	54	57	67	70	48	58	61	59	62	58	46	61	64
Oxen	27	46	59	69	71	32	48	56	64	64	64	61	61	28
<b>Cattle owned (head count)</b>														
Calves	0.5	0.7	0.7	1.0	1.3	0.6	0.8	0.9	0.9	0.9	0.9	0.6	0.9	0.8
Bulls	0.2	0.3	0.4	0.5	0.8	0.3	0.4	0.4	0.4	0.5	0.4	0.3	0.5	0.2
Heifers	0.4	0.4	0.6	0.7	1.0	0.4	0.7	0.7	0.6	0.6	0.5	0.4	0.7	0.6
Cows	0.7	0.8	0.9	1.3	1.6	0.8	1.0	1.1	1.1	1.1	1.3	0.6	1.2	1.1
Oxen	0.4	0.8	1.0	1.3	1.7	0.5	0.8	1.0	1.2	1.3	1.2	1.0	1.3	0.4
<b>Cattle owned (TLU)</b>														
Calves	0.3	0.5	0.5	0.7	0.9	0.4	0.5	0.6	0.6	0.7	0.6	0.4	0.7	0.5
Young bulls	0.1	0.1	0.1	0.2	0.3	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.1
Bulls	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Heifers	0.3	0.3	0.4	0.5	0.7	0.3	0.5	0.5	0.4	0.4	0.4	0.3	0.5	0.4
Cows	0.5	0.6	0.7	0.9	1.1	0.5	0.7	0.8	0.8	0.8	0.9	0.4	0.8	0.8
Oxen	0.3	0.5	0.7	0.9	1.2	0.4	0.6	0.7	0.9	0.9	0.8	0.7	0.9	0.3
<b>Composition of cattle (% TLU)</b>														
Calves	22	21	18	19	19	21	20	20	19	19	18	18	19	23
Young bulls	4	4	5	5	5	4	5	4	4	5	3	6	4	2
Bulls	3	4	5	5	5	5	4	4	4	4	4	4	5	4
Heifers	19	18	17	14	14	16	20	19	15	12	11	13	16	22
Cows	31	26	24	24	25	32	26	25	24	24	26	19	24	35
Oxen	21	27	32	34	33	22	25	28	34	36	38	41	32	13
<b>Breed composition of cattle (%)</b>														
Local	98.3	98.6	99.0	99.3	99.5	98.8	98.9	98.9	98.9	99.2	98.1	99.9	98.4	99.1
Cross-bred	1.2	1.2	1.0	0.7	0.4	1.1	0.9	0.7	1.1	0.6	1.5	0.0	1.4	0.8
Exotic	0.5	0.1	0.1	0.0	0.1	0.0	0.2	0.3	0.0	0.1	0.3	0.0	0.2	0.1

Source: Authors' computation using the AGP baseline dataset (2011).

**Table A.3—Livestock technical performance parameters**

Group	Calving rate of cattle (%)	Annual death rate (%)								Annual growth rate (%)						
		Calf	Bull	Heifer	Cow	Ox	Sheep	Goat	Calf	Bull	Heifer	Cow	Ox	Sheep	Goat	
<b>Land Quintile</b>	Q <sub>1</sub>	43.1	14.0	3.4	7.8	13.3	5.2	29.3	22.8	-18.7	-9.5	-8.9	-11.7	-2.7	-1.7	-3.6
	Q <sub>2</sub>	50.4	16.5	11.4	5.1	9.3	8.2	25.7	18.6	-1.1	-11.6	-8.4	-8.0	-11.1	-5.9	-6.4
	Q <sub>3</sub>	45.1	21.7	13.6	7.5	11.5	4.4	17.9	24.6	1.0	-19.6	-10.6	-11.9	-7.6	-2.6	-0.9
	Q <sub>4</sub>	47.1	21.2	7.8	10.5	10.0	5.6	20.3	19.6	15.7	-15.1	-7.8	-9.5	-7.2	-5.4	-0.1
	Q <sub>5</sub>	46.9	23.1	9.7	8.4	10.8	7.2	24.0	16.3	20.8	-10.7	-8.1	-9.5	-5.7	-5.4	2.3
<b>Income Quintiles</b>	Q <sub>1</sub>	46.6	17.6	7.7	5.4	10.7	5.2	27.2	18.7	14.0	-7.1	-0.6	-6.9	-2.6	-7.6	-1.2
	Q <sub>2</sub>	45.8	19.9	12.8	7.6	12.8	7.8	22.3	17.6	-3.4	-11.1	-6.8	-9.6	-7.1	-2.7	7.3
	Q <sub>3</sub>	48.2	21.6	7.8	7.1	9.1	9.0	24.8	21.8	12.3	-17.0	-10.1	-10.0	-9.1	-9.9	-1.4
	Q <sub>4</sub>	48.2	19.0	14.1	9.6	12.2	4.7	21.6	20.2	-3.8	-23.8	-10.6	-12.3	-8.4	2.9	-6.0
	Q <sub>5</sub>	43.3	18.1	5.9	8.9	9.9	3.5	20.7	23.5	13.7	-8.8	-13.7	-10.8	-6.6	-8.1	-7.9
<b>Livestock Quintile</b>	Q <sub>1</sub>	4.3	17.4	14.8	28.3	42.5	18.2	26.6	27.3	-71.0	-40.9	-35.4	-58.2	-47.9	-18.2	-15.7
	Q <sub>2</sub>	36.1	23.9	18.1	10.8	18.6	7.1	26.1	25.4	-35.7	-22.8	-19.0	-19.3	-11.1	-2.8	-22.5
	Q <sub>3</sub>	44.5	16.9	15.2	10.9	13.2	7.3	25.2	21.2	-17.0	-18.9	-11.2	-12.4	-10.3	-18.0	4.5
	Q <sub>4</sub>	49.7	11.0	8.5	7.6	7.2	5.0	22.0	21.4	-0.2	-16.8	-8.9	-6.2	-1.7	5.1	4.0
	Q <sub>5</sub>	52.6	26.3	5.7	3.5	6.9	4.5	19.5	15.4	39.0	-8.3	-2.2	-5.2	-4.3	-2.9	4.2
<b>Regions</b>	Tigray	37.4	15.0	9.0	5.8	10.3	6.8	15.6	21.0	8.3	-12.2	-9.2	-11.8	-6.8	-2.1	-16.2
	Amhara	44.6	11.3	6.8	6.0	10.3	4.1	22.8	19.1	5.1	-6.1	-8.2	-11.2	-6.0	-12.0	-5.3
	Oromia	48.1	22.1	8.6	5.0	9.7	4.5	20.5	18.8	13.8	-15.7	-6.6	-9.9	-4.5	1.9	3.5
	SNNP	46.4	22.4	17.4	14.0	13.7	15.3	28.5	23.7	-10.3	-21.2	-13.2	-9.5	-20.0	-9.7	-1.9

Source: Authors' computation using the AGP baseline dataset (2011).

**Table A.4—Proportion participating in livestock markets**

	Land Quintile					Income Quintile					Livestock Quintile					Region			
	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Tigray	Amhara	Oromia	SNNP
<b>Livestock sales (%)</b>																			
Calves	1.2	1.3	1.7	2.5	2.4	0.7	1.3	2.8	1.4	2.6	0.0	0.6	3.4	3.1	2.2	1.0	1.6	1.8	2.2
Bulls	0.4	1.1	2.9	2.4	4.7	0.5	1.7	2.3	2.7	4.3	0.2	0.8	1.3	3.1	6.1	1.6	1.4	3.0	1.9
Heifers	1.6	2.1	3.3	2.8	3.8	1.0	2.1	3.5	3.4	3.1	0.4	1.9	1.6	2.6	6.7	2.1	0.9	3.3	3.5
Cows	2.5	3.6	4.0	5.2	6.1	1.4	2.6	5.4	5.5	5.7	0.6	2.7	3.9	4.7	9.0	5.4	2.2	4.9	4.8
Oxen	2.9	6.7	11.2	14.5	18.1	2.4	5.9	10.3	15.2	17.3	1.0	6.2	10.6	14.5	19.1	8.0	13.0	11.5	5.0
Sheep	11.0	14.5	14.7	14.7	13.6	7.0	13.7	17.9	16.4	12.9	5.9	10.4	11.6	18.5	22.9	6.1	16.9	14.8	9.5
Goats	3.2	3.7	5.3	6.0	7.8	2.2	5.5	6.1	5.9	4.9	0.8	4.4	4.3	5.5	10.1	10.3	6.9	5.0	2.3
<b>Livestock slaughtered (%)</b>																			
Calves	0.1	0.0	0.0	0.2	0.3	0.0	0.0	0.1	0.3	0.2	0.0	0.0	0.0	0.5		0.1	0.0	0.2	0.1
Bulls	0.2	0.0	0.1	0.6	0.6	0.2	0.0	0.1	0.6	0.9	0.0	0.1	0.1	0.8	0.6	0.3	0.0	0.4	0.5
Heifers	0.2	0.0	0.1	0.3	0.1	0.1	0.1	0.2	0.0	0.4	0.0	0.2	0.0	0.2	0.3	0.2	0.1	0.0	0.3
Cows	0.7	0.6	0.1	1.0	2.2	0.1	0.2	0.8	1.1	2.0	0.2	0.4	0.3	2.1	1.1	0.7	0.8	1.2	0.2
Oxen	0.0	0.2	0.5	0.2	0.9	0.1	0.5	0.4	0.6	0.2	0.0	0.1	0.0	0.5	1.0	1.0	0.4	0.4	0.1
Sheep	6.8	8.9	9.4	11.2	11.5	4.2	7.3	10.7	12.2	11.9	1.9	5.3	7.4	12.5	19.9	7.8	15.6	7.6	5.7
Goats	0.4	2.5	3.0	4.4	8.1	2.0	4.0	3.0	3.4	4.5	0.2	1.4	2.5	4.0	9.1	10.4	4.1	3.4	1.8
<b>Livestock purchases (%)</b>																			
Calves	0.6	0.9	1.1	0.9	1.5	0.3	0.5	0.5	1.3	2.3	0.1	0.2	0.9	1.6	2.2	0.1	0.7	1.0	1.2
Bulls	0.6	0.6	1.4	2.7	1.7	0.4	1.9	1.8	0.5	2.1	0.0	0.7	1.3	1.6	3.2	0.5	1.1	1.6	1.3
Heifers	1.6	1.9	2.1	1.9	2.0	1.8	1.8	2.4	1.8	1.5	0.5	1.0	2.0	1.1	4.7	0.1	0.8	1.9	3.2
Cows	1.2	2.1	1.2	3.2	3.8	1.2	1.7	1.6	3.2	3.3	0.2	0.9	2.5	3.2	4.3	0.9	1.8	1.9	3.2
Oxen	3.3	6.4	8.1	11.0	14.3	2.9	5.1	8.3	10.4	14.5	0.2	5.7	8.3	12.4	14.7	5.6	11.0	9.5	3.0
Sheep	6.6	6.1	5.4	6.2	5.3	3.5	5.7	5.9	6.8	7.6	3.0	5.0	4.8	9.8	7.3	1.8	6.4	6.4	5.1
Goats	1.3	2.3	1.8	2.0	2.9	1.1	2.2	2.6	2.3	1.5	0.8	1.1	2.4	2.8	2.9	1.5	2.1	2.0	1.8

Source: Authors' computation using the AGP baseline dataset (2011).

**Table A.5—Intensity of livestock commercialization**

	Land Quintile					Income Quintile					Livestock Quintile					Region			
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Tigray	Amhara	Oromia	SNNP
<b>Sales off-take rate (%)</b>																			
Calves	2.6	2.1	2.5	2.9	2.9	1.5	2.2	3.8	1.8	3.7	0.0	1.6	4.7	3.3	1.3	1.6	3.1	2.4	3.0
Bulls	1.9	3.6	7.2	4.8	8.1	1.8	3.5	5.5	8.0	9.7	9.2	4.5	4.0	7.5	6.4	4.3	4.3	6.8	6.8
Heifers	3.0	3.9	4.7	3.4	4.5	2.3	2.5	4.7	5.0	4.8	6.2	5.4	3.0	3.4	4.1	3.5	1.6	4.5	4.8
Cows	3.2	3.9	3.8	3.8	4.0	1.5	2.4	3.9	4.7	5.6	9.5	5.2	3.9	3.2	3.2	4.4	2.9	3.8	4.2
Oxen	6.0	9.3	11.4	11.2	13.8	4.2	7.0	9.7	14.2	15.3	12.5	12.1	12.2	11.5	8.8	6.7	13.1	9.9	10.8
Sheep	14.8	16.5	15.7	15.2	11.9	11.5	14.9	18.0	14.0	15.1	21.3	14.3	15.7	15.5	12.9	11.2	20.4	14.3	11.4
Goats	16.4	10.0	13.7	13.9	12.3	6.1	12.3	13.7	17.9	13.7	13.5	17.5	11.5	10.7	13.2	13.0	18.6	13.4	5.6
<b>Slaughter off-take rate (%)</b>																			
Calves	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.2	0.7	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.1
Bulls	0.6	0.1	0.1	2.0	0.9	0.5	0.1	0.1	1.5	2.5	0.0	1.0	0.3	2.4	0.6	0.7	0.1	1.2	1.8
Heifers	0.4	0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.0	0.4	0.0	0.4	0.1	0.3	0.1	0.3	0.3	0.1	0.2
Cows	1.1	0.8	0.0	0.7	2.1	0.2	0.1	0.8	1.1	2.3	3.4	1.0	0.3	1.7	0.5	0.6	1.3	1.2	0.1
Oxen	0.1	0.2	0.3	0.2	0.6	0.1	0.5	0.2	0.5	0.1	0.0	0.2	0.0	0.3	0.5	0.7	0.2	0.3	0.2
Sheep	6.9	6.6	7.1	7.5	7.9	5.7	5.2	6.5	7.9	10.4	3.6	5.6	7.9	8.0	8.0	12.4	14.5	5.1	3.7
Goats	1.0	5.2	5.6	6.4	9.8	4.3	5.3	5.6	5.7	9.8	2.8	3.6	5.1	5.1	8.6	9.9	7.0	6.1	3.8
<b>Commercial intake (purchase) rate (%)</b>																			
Calves	1.4	1.4	2.1	1.0	1.2	0.6	0.8	0.9	1.6	3.2	2.3	0.6	1.4	1.5	1.6	0.2	1.2	1.5	1.6
Bulls	3.4	2.4	3.5	6.9	2.5	1.5	5.0	5.0	1.2	4.9	2.6	4.2	4.0	4.7	3.1	1.3	3.6	3.8	4.0
Heifers	4.8	4.0	3.3	2.4	2.5	4.2	3.1	3.6	3.1	2.5	8.2	4.0	4.1	1.5	3.2	0.4	1.7	3.1	4.9
Cows	1.9	2.8	1.2	2.8	3.3	1.7	1.8	1.3	3.3	3.7	2.3	2.1	2.7	2.8	1.9	0.8	2.8	1.8	3.1
Oxen	8.4	8.6	8.5	10.6	11.2	6.4	6.7	9.2	10.4	13.0	2.8	12.2	9.9	10.4	8.0	5.6	11.5	9.2	7.2
Sheep	10.0	8.4	6.6	8.1	6.3	7.5	7.6	6.7	8.0	9.9	9.5	9.7	8.2	9.6	4.7	4.4	9.8	7.9	6.2
Goats	7.3	7.0	5.5	5.9	4.5	4.2	5.6	7.5	7.5	3.5	12.8	5.4	8.5	5.7	3.8	3.0	6.5	6.4	4.7
<b>Net commercial off-take rate (%)</b>																			
Calves	1.3	0.7	0.5	2.0	1.9	1.0	1.5	3.1	0.2	0.7	-2.9	1.2	3.3	1.7	-0.1	1.6	2.1	0.9	1.4
Bulls	-0.9	0.4	4.1	-0.1	6.2	0.9	-1.7	0.5	8.4	5.2	8.3	1.6	-0.5	4.0	3.6	3.2	0.7	3.6	3.2
Heifers	-1.2	0.1	1.9	1.3	2.1	-1.8	-0.3	1.2	2.3	3.0	-2.6	2.9	-1.0	2.2	1.0	3.4	0.2	1.7	0.3
Cows	0.9	1.9	2.8	1.7	2.2	0.1	0.8	2.7	2.5	3.2	2.8	4.3	1.0	1.8	1.8	4.1	1.0	2.7	1.2
Oxen	-4.7	-0.7	2.8	1.3	3.5	-1.9	0.4	-0.2	3.7	2.2	9.3	-0.7	2.4	0.8	1.2	2.2	1.2	0.7	3.0
Sheep	10.7	14.2	15.0	15.2	13.9	9.7	12.5	15.2	14.8	15.9	15.8	9.0	16.9	12.4	16.2	19.1	23.7	11.2	9.6
Goats	10.7	9.0	13.5	13.4	17.8	7.0	11.0	12.2	16.4	20.1	5.0	13.3	7.0	11.5	18.3	18.9	19.5	13.4	4.4

Source: Authors' computation using the AGP baseline dataset (2011).

**Table A.6—Participation in different income generating activities, level of income by source and composition**

Income source	Land Quintile					Income Quintile					Livestock Quintile				
	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	Q <sub>5</sub>
<b>Participation in income generating activity (%)</b>															
Crop income	82	91	93	95	95	67	96	96	97	95	65	96	97	99	97
Livestock income	53	63	74	74	77	36	68	72	79	78	40	65	71	80	82
Off-farm income	30	27	29	28	25	1	12	26	41	60	33	30	29	25	21
Non-farm income	27	22	24	21	24	11	20	21	26	37	27	27	22	20	19
Average number of income sources	1.9	2.0	2.2	2.2	2.2	1.2	2.0	2.2	2.4	2.7	1.6	2.2	2.2	2.2	2.2
<b>Per capita income (ETB/year)</b>															
Crop income	505	595	759	912	1,194	72	310	593	970	1,876	482	720	759	875	929
Livestock income	51	78	94	109	113	11	57	91	123	145	48	76	90	102	113
Off-farm income	94	81	73	73	59	1	40	156	418	1,978	661	595	479	473	255
Non-farm income	80	71	82	110	105	9	32	52	118	460	137	137	104	116	149
Total income	730	825	1,008	1,203	1,470	92	439	892	1,629	4,459	1,328	1,527	1,433	1,566	1,446
<b>Composition (share) in income (%)</b>															
Share of crop income	63.7	71.7	73.9	74.3	75.6	75.6	71.6	67.1	59.7	49.3	50.9	63.0	65.4	69.3	70.4
Share of livestock income	9.9	11.1	10.7	11.8	10.5	12.6	12.7	10.4	7.6	4.2	5.7	8.8	9.8	10.3	11.8
Share of off-farm income	14.1	10.1	9.0	7.4	6.8	0.5	8.2	16.8	25.5	36.0	31.0	19.1	18.3	14.6	10.5
Share of non-farm income	12.3	7.1	6.4	6.5	7.2	11.3	7.6	5.7	7.2	10.5	12.4	9.1	6.6	5.8	7.3
Income diversification index	0.3	0.2	0.3	0.2	0.2	0.1	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3
<b>Income per hectare (ETB)</b>															
Crop income per hectare	4,469	3,401	2,791	2,048	1,462	1,065	3,253	4,022	5,903	7,527	2,886	5,043	4,336	4,964	4,463
Livestock income per ha	387	348	314	253	145	130	431	450	521	533	262	459	433	443	485
On-farm income per ha	5,066	3,812	3,122	2,307	1,608	1,195	3,683	4,473	6,424	8,060	3,148	5,502	4,769	5,407	4,948
<b>Commercialization indices</b>															
Crop output commercialization index	21.2	24.1	25.3	28.6	31.6	18.3	21.6	25.0	29.6	33.1	23.8	25.4	25.2	26.7	27.7
Crop input commercialization index	13.4	12.6	12.3	12.9	10.5	19.5	12.8	11.3	10.2	10.3	10.6	10.9	12.5	12.7	14.4
Livestock input commercialization index	10.9	12.1	14.2	16.9	15.4	15.9	12.2	16.2	14.1	13.0	5.2	11.0	14.7	15.7	19.1

Source: Authors' computation using the AGP baseline dataset (2011).

**Table A.7—Correlation coefficients of income sources, land and livestock endowment, and household characteristics**

	Number activities engaged	Pro-duced crop	Pro-duced live-stock	Off-farm em-ployed	Non-farm em-ployed	Age of head	House-hold size	Land size per house-hold	Land size per adult equiv.	Own live-stock	TLU per house-hold
Produced crop	0.53*										
Produced livestock	0.69*	0.46*									
Off-farm employed	0.56*	-0.01	0.07*								
Non-farm employed	0.52*	-0.01	0.04*	0.13*							
Age of head	-0.11*	0.01	-0.02*	-0.09*	-0.13*						
Household size	0.16*	0.21*	0.17*	-0.01	0.02	0.03*					
Land size per household	0.07*	0.10*	0.12*	-0.03*	-0.01	0.03*	0.18*				
Land size per adult equivalent	-0.02*	0.00	0.02*	-0.03*	-0.04*	0.01	-0.23*	0.78*			
Own livestock	0.37*	0.69*	0.34*	-0.03*	-0.01	-0.00	0.22*	0.11*	-0.01		
TLU per household	0.11*	0.21*	0.22*	-0.1*	-0.03*	0.05*	0.42*	0.26*	0.02*	0.27*	
TLU per capita	0.06*	0.19*	0.17*	-0.12*	-0.06*	0.01	-0.03*	0.17*	0.15*	0.28*	0.76*

Source: Authors' computation using the AGP baseline dataset (2011).

Notes: TLU stands for tropical livestock unit. Coefficients with \* are significant at 5 percent.

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## About ESSP

The Ethiopia Strategy Support Program is an initiative to strengthen evidence-based policymaking in Ethiopia in the areas of rural and agricultural development. Facilitated by the International Food Policy Research Institute (IFPRI), ESSP works closely with the government of Ethiopia, the Ethiopian Development Research Institute (EDRI), and other development partners to provide information relevant for the design and implementation of Ethiopia's agricultural and rural development strategies. For more information, see <http://www.ifpri.org/book-757/ourwork/program/ethiopia-strategy-support-program>; <http://essp.ifpri.info/>; or <http://www.edri-eth.org/>.

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