CHAPTER 1: General introduction

1.1. Background and research objectives

Ethiopia is known for its crop and livestock diversity that is distributed across different agro-ecologies and socio-cultural settings. The country has the largest livestock population in Africa, with 52 million cattle, 25 million sheep, 21 million goats and 38 million chickens (CSA, 2010). Smallholder agriculture is the main economy of the country. More than 84% of the total 90 million people depend on agriculture for their livelihood. The mixed crop-livestock system, which prevails mostly in the highlands of the country, harbours more than 60% of the people and two thirds of the ruminant population (Dejene, 2003; Cecchi et al., 2010). Large areas of the mixed farming systems in Ethiopia experience high population pressure with spatial differences across the country. Particularly in the perennial crop-growing areas of the southern highlands, very high rural population densities per arable land exist (Yilma, 2001; Regassa and Yusufe, 2009). In addition to the spatial differences, a temporal trend shows a sharp decline in per capita farmland holdings in the country; from 0.5 ha to less than 0.2 ha between 1960 and 2000 (Jayne et al., 2003). Consequently, this population growth has implications on ownership and distribution of basic production assets in the agrarian society, notably farmland and livestock.

Regardless of various production challenges and constraints, smallholder farmers integrate livestock with other agricultural activities to fulfil their multiple livelihood goals. Cattle in the mixed crop-livestock system of Ethiopia play an important role in the provision of products and by-products, which also include services in crop cultivation processes. Crop production in Ethiopia typically uses a pair of oxen, while cows are kept for breeding and milk production. Cow milk is among the ten most important agricultural commodities in the country, and was ranked as primary animal product in terms of quantity produced (FAOSTAT, 2009). Due to this potential, a strategic regional agricultural development initiative, that attempted to prioritize agricultural commodities for economic development in Eastern and Central Africa, considered

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milk along with cereals as a priority commodity for Ethiopia (Omamo et al., 2006). However, due to a poor market linkage between producers and consumers, milk is mainly utilized by producer households. For example, Staal et al. (2008) reported that an average of 78% milk produced was directly consumed by producer households in the country.

In contrast to the high population of cattle in Ethiopia, per capita production and consumption of milk and meat is low, even compared to other east African countries (Ayele and Peacock, 2003). The average per capita supply of whole milk and meat (between 1992 and 2009) were 16 and 8 kg, respectively (FAOSTAT, 2013). The apparent paradox of huge cattle populations and low per capita supply of milk and meat is mainly due to low per capita production of products (Jabbar et al., 2003). Due to high value and nutrient density nutrients in animal source foods, even low levels of consumption have been shown to substantially ensure dietary adequacy, preventing under-nutrition and nutritional deficiencies (Neumann et al., 2002). Animal source foods (ASF) were found to play an important role in the supply of micronutrient needs, growth and cognitive functions of children (Neumann et al., 2002; Allen, 2003; Murphy and Allen, 2003). However, low accessibility and availability often compromise ASF consumption by the poor. Recognition of the nutritional benefits of ASF consumption is clearly limited.

While on-farm produced ASF of different livestock species directly contribute to family nutrition, numerous other livestock services (traction, manure, savings and cash from live animal sales) indirectly contribute to food and nutrition security of farming households. Low production level is a key challenge in subsistence farming systems. Low production levels are caused by various factors including resource availability, genetic potential of animals, livestock management, production objectives of farmers, as well as physical and institutional infrastructures (Ayele and Peacock, 2003; Shiferaw et al., 2003; Mekonnen et al., 2010). On the other hand a growing need for animal source foods, including milk, is driven by population growth, urbanization and increased incomes in developing countries (Delgado, 2003). Thus,

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there is a need to develop efficient livestock production that can optimize use of resources, while fulfilling the demand for products by rural and urban consumers. As a prerequisite of efficient livestock development, the existing production conditions, production constraints, livestock roles and functions as well as farmers' production objectives have to be understood.

In addition to its role at farm household level, livestock make an important contribution to the national economy. However, the multidimensional contribution of livestock to farm households and the national economy is often underestimated, mainly due to the absence of adequate information at farm and national levels (Alary et al., 2011). A recent initiative of the Inter-Governmental Authority on Development (IGAD) evaluated the currently applied valuation methods of livestock to the economic development of two pilot countries: Ethiopia and Kenya (Behnke and Metaferia, 2011). Accordingly, the currently working method of estimating the contribution of livestock to the gross domestic product (GDP) of the country is reported to neglect various forms of livestock services. It was found out that its role in the crop cultivation process and its financial services like asset and saving values, and its role in mitigating shocks against crop failures were not included. The two major causes mentioned for the undervaluation of livestock contributions in Ethiopia were lack of up-to-date livestock census data and lack of appropriate methods that could capture and value the different forms of livestock services in various production systems.

Milk production in Ethiopia is mainly from indigenous cattle breeds, which are kept for multiple purposes in the different agro-ecologies and production systems. In order to enhance the development of smallholder dairy production in Ethiopia, national dairy development programs and projects were implemented in selected highland areas, where mixed crop livestock production prevails. The introduction of exotic dairy breeds and crossbreeding technologies, along with some feeding and marketing packages were some of the constituents of the programs. The first attempt for the improvement of dairy cattle production targeting smallholder rural

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farmers in Ethiopia was founded in the late 1960s (Ahmed et al., 2003; Felleke and Geda, 2001), with the establishment of a state-owned artificial insemination service centre, as well as crossbreeding and multiplication centres in different parts of the country. Two of the prominent dairy cattle crossbreeding and multiplication centres were established in the southern region of Ethiopia. The Gobe ranch, located in Kofele district of Oromiya Regional State, existed since the early 1960s (Taye, 2006). The objective of this breeding and multiplication centre was to crossbreed the local Arsi cattle with Holstein Friesian cattle in order to distribute F1 heifers to smallholder farmers in the nearby districts. Likewise, in 1970 another government-owned breeding centre was established in Wolayita district of southern Ethiopia as a Jersey breed multiplication and distribution centre, which has been used as gene pool for the national AI centre and nearby districts. In addition to the above mentioned dairy development initiatives, the Smallholder Dairy Development Project (SDDP), which was implemented between 1993 and 1998, resulted in the introduction of different dairy technology packages to smallholder farmers in the region.

The biological performances of local and crossbred dairy cattle in Ethiopia have been assessed in on-station trials (Demeke et al., 2004; Taye, 2006; Gebeyehu et al., 2007; Haile et al., 2009; Bitew et al., 2010) and on-farm studies in different production systems (Shiferaw et al., 2003; Lobago et al., 2006; Mureda and Zeleke, 2007; Mekonnen et al., 2010). However, information that tailors biological performance of livestock with that of its economic, social and nutritional contributions to smallholder farmers in the crop-livestock mixed farming systems of Ethiopia is still lacking.

Within the crop-livestock mixed farming systems of Ethiopia, while livestock are integrated with annual crops in the central, northern and eastern highlands of the country, in the southern and south-eastern highlands integration is mainly with perennial and annual food and cash crops such as *Enset* (*Ensete ventricosum*) and coffee (Getahun, 1978; Fekadu, 2009; Yigrem et al.,

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2008). *Enset* is a perennial staple energy food crop that feeds approximately 20 million people in southern and south-west Ethiopia. Parts of the plant, particularly the leaves and pseudo stems, are important sources of feed for livestock. In both the annual and perennial crop dominated mixed production systems, livestock complement cropping activities and serve as a livelihood diversification strategy.

The current study was designed to quantify the various forms by which cattle contribute to the livelihood needs of smallholder farmers in southern Ethiopia. Three districts with previous dairy development interventions were purposively selected to represent households with both, local and crossbred cows. The selected districts also represent different human population densities (medium, high and very high). Moreover, each district represents a different ethnicity with resulting cultural differences. It was hypothesized that the form and magnitude of cattle contributions to the farming system, cash income and family nutrition are different depending on human population densities, which were assumed to affect the resource base, farm endowments, perceived objectives of farmers, cattle management, as well as the performance of local and contemporary crossbred dairy cows. Those are assumed to affect the resource base, the perceived objectives of farmers, cattle management, as well as the performance of local and contemporary crossbred dairy cows.

The objectives of this study were therefore to asses and quantify the contribution of dairy cattle to a) the farming system, b) household income and c) family nutrition, and to determine underlying factors that change the form and magnitude of cattle contributions to farm households. This main study objective led to the following specific research questions:

- What are the characteristics of the farming systems? How do differences in district specific population densities result in changes of farm endowments, the resource base for cattle production and cattle management? How do cultural differences of farmers affect cattle management practices?

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- Are there differences between farmers' perceived and actual contributions of cattle? What underling factors change the production objectives of farmers?
- How do dairy cattle perform in the existing farming system? What are the underlying factors that affect the reproduction and production performances of milking cows in the study area?
- What are the contributions of cattle to the existing mixed crop-livestock farming system? How are crop and livestock activities integrated?
- What is the relative contribution of cattle to the total cash income of smallholder farmers? What factors determine market participation and the magnitude of cash income from milk and milk products?
- What is the level of on-farm produced milk and milk products role to household nutrition and dietary diversity of farmers compared to other ASFs? What is the impact of milk and milk products' availability on the nutritional status of children?

1.2. Overall framework of the study

The present study was carried out in the southern highlands of Ethiopia, where livestock keeping is integrated with annual and perennial food and cash crops. The study area is characterized by varying levels of population densities. Three districts, i.e. Kofele, Awassa Zuria and Kedida Gamela representing medium, high, and very high population densities, respectively, were purposively selected (Figure 1). The people in the three districts represent three major ethnic groups, and hence have different cultural practices. Due to past smallholder dairy development interventions in the area, crossbred dairy breeds were introduced. This enabled the current study to make comparisons in the performance of local and contemporary crossbred milking cows managed under the crop-livestock production systems.

Data collection was conducted between September 2011 and August 2012, using various survey methods. Following a multi-stage random sampling of 270 cattle keeping households, a cross-sectional survey was applied to characterize the production system and describe the socio-economic characteristics of farmers in the study area. Performances of both, local and

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contemporary exotic crossbred milking cows were investigated using a Progeny History Survey (PHS), which was accompanied by a monthly farm monitoring and measurements of milk off-take for one year. In-depth farm and household monthly monitoring were applied to collect data on the uses of various cattle products and by-products (like oxen power for traction and manure), income from and expenditures for farm and non-farm activities. This survey technique was also applied to record the number of days and quantities of dairy products and other ASF utilized by farming households throughout the survey year. To complement the monthly monitoring on ASF consumption, a household dietary diversity survey (HDDS) was conducted on the same number of farm households. In order to further analyze the contribution of on-farm produced milk on the nutritional status of children, anthropometric measurements of 225 children between the age of 6 and 59 months were taken. Besides descriptive statistics, general linear, mixed linear, binary logistic, probit and tobit models, as well as a canonical correlation analysis were applied to different data sets using SAS version 9.3. Farmers were grouped by wealth indicator variables into lower, middle and upper terciles.

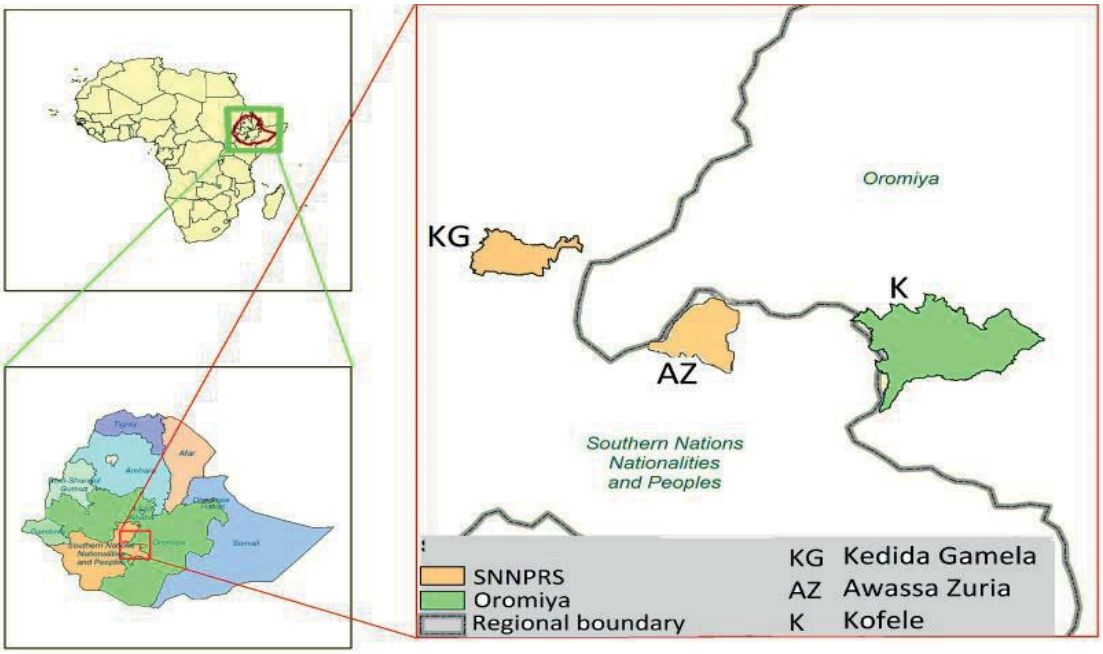

Figure 1.1: Location of the study districts in southern highlands of Ethiopia

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1.3. Structure of the thesis

The general introduction, as **Chapter 1,** is followed by three journal articles as subsequent chapters. **Chapter 2** corresponds to the manuscript 'Contribution of milking cows to smallholder crop-livestock production systems of Ethiopia depending on cattle management and performance'. The chapter contains main findings on cattle management practices, resources for cattle keeping, performance evaluation of milking cows and the quantitative contribution of cattle to the farming systems. **Chapter 3** is entitled 'Perceived and actual contributions of cattle and dairy products to the cash income of smallholder farmers in the mixed production systems of Ethiopia'. Main findings in this chapter include the relative income contribution of cattle and dairy products to smallholder farmers, underlying factors that change this contribution such as production objectives, quantity of surplus dairy products available for income generation, and other socio-economic factors that influence market participation and magnitude of income from dairy products. **Chapter 4,** 'Assessing the relative importance of dairy products to family nutrition in mixed crop-livestock production systems of Ethiopia' presents quantitative results on the contribution of cattle and dairy products to family nutrition. **Chapter 5** is a general discussion which links main findings documented in the three journal articles and finally highlights the potentials and limitations of the research methodologies applied in this study.

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