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DETERMINANTS OF SMALLHOLDER FARM HOUSEHOLD'S LIVESTOCK PRODUCTION AND ITS INCOME EFFECTS: THE CASE OF LEKA DULECHA WOREDA, WESTERN OROMIA, ETHIOPIA

BY: HIZBU TESFAYE KITILA

MAJOR ADVISOR: GEMECHU MULATU (PhD)

JUNE, 2023

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A Thesis Submitted to School of Graduate Studies College of Business and Economics Department of Economics in Partial Fulfilment of the Requirement for Degree of Masters of Science in Development Economics

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APPROVAL SHEET FOR SUBMITTING FINAL THESIS

As members of the Board of Examining of the Final MSc thesis open defense, we certify that we have read and evaluated the thesis prepared by Hizbu Tesfaye Kitila entitled ***"Determinants of Smallholder Farm Household's Livestock Production and its Income Effects: The Case of Leka Dulecha Woreda, Western Oromia, Ethiopia"*** and recommend that the thesis be accepted as fulfilling the thesis requirement for the Masters of Science Degree in Development Economics.

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Final Approval and Acceptance

Thesis Approved by

Department PGC	Signature	Date
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Certification of the Final Thesis

I hereby certify that all the correction and recommendation suggested by the board of examiners are incorporated into the final thesis entitled **"***Determinants of Smallholder Farm Household's Livestock Production and its Income Effects: The Case of Leka Dulecha Woreda, Western Oromia, Ethiopia"* by Hizbu Tesfaye Kitila.

Dean of SGS	Signature	Date

STATEMENT OF THE AUTHOR

I Hizbu Tesfaye hereby declare that the thesis entitled "*Determinants of Smallholder Farm Household's Livestock Production and its Income Effects: The Case of Leka Dulecha Woreda, Western Oromia, Ethiopia***"** is my own work conducted under the supervision of Dr. Gemechu Mulatu. I have followed all the ethical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. Materials used for the thesis have been properly acknowledged. This thesis is submitted in partial fulfilment of the requirements for MSc degree in Development Economics at Wollega University. I further declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate. In all other instances requests for permission for reproduction of this thesis in whole or in part, may be obtained from the permission of the author and by the head of major department or the Dean of the School of Graduate Studies.

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ACRONYMS

AI: Artificial Insemination

CRC: Cluster Resource Centre

CSA: Central Statistics Agency

ETB: Ethiopian birr

FAO: Food and Agricultural Organization

GDP: Gross domestic product

HICE: Household Income and Consumption Expenditure

IGAD: Intergovernmental Authority on Development

ILCA: International Livestock Centre for Africa

ILRI: International Livestock Research Institute

LDMPS: Livestock Development Master Plan Study

LPI: Livestock Policy Initiative

MOARD: Ministry of Agriculture and Rural Development

MOFED: Ministry of Finance and Economic Development

PADS: Pastoral Areas Development Study

QUAIDS: Quadratic Almost Ideal Demand System

ISIC: International Standard Industrial Classification of All Economic Activities

SNA: System of National Accounts

SNNPR: Southern Nations, Nationalities and Peoples Region

TLU: Tropical Livestock Unit

UN: United Nations

USDA: United States Department of Agriculture

ABSTRACT

Livestock production has significant contribution to income and consumption expenditure of farmers. Nevertheless, how much the life standard of farm households engaged on livestock production was changed is what have to be investigated. The study determinants of livestock production and its income effect on farm households and identified the constraints and opportunity to livestock production in the study area. The study adopted cross sectional survey design. The kebeles were selected from clusters. A total of 378 respondents were participated in the study from the 6 kebeles. Descriptive statistics result showed that opportunities identified in livestock production of the study area were high market demand for livestock, possibility of planting animal feed, availability of local market, availability of water resources availability, favourable climate condition for livestock, low animal disease in Leka Dulecha District. The challenges identified in livestock production were lack supply and quality of animal feed, lack of improved breed, inadequate supply of technology related to livestock production, inadequate veterinary service, lack of grazing land, insufficient supply of drug, high price of drug, insufficient supply of vaccine, inadequate use artificial insemination. Heckman two Stage analysis has been carried out to find out the determinants of smallholder livestock production aand its income effects. The results of Heckman two Stage analysis regression model showed that educational status of household head, total livestock holding, access to credit and availability of grazing land determines the livestock production in the study area. On the other these variables positively influences the income of farmers of the study area. The study recommended the government and other concerned bodies to take part in improving the livestock production income with respect to statistically significant variables.

Keywords: Income, households, Heckman two stage regression Model, opportunities, challenges.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Livestock production is an economic activity that is a part of agricultural activities in a broad sense (FAO, 2018). As defined by WCA (2020), the term "livestock" refers to "all animals, birds and insects kept or reared by the agricultural holdings mainly for agricultural purposes. This includes cattle, buffaloes, horses and other equine animals, camels, sheep, goats and pigs, as well as poultry, bees, silkworms etc." Aquatic animals are excluded. Domestic animals, such as cats and dogs, are excluded unless they are being raised for food or other agricultural purposes (WCA, 2020).

Livestock are the domesticated animals raised in agricultural setting to provide labour and produce commodities such as meat, eggs, fur, leather, and wool. The term is sometimes used to refer solely to animals that are raised for consumption, and sometimes used to solely ruminants such as cattle, sheep, goats, and pigs. The USDA classifies pork, veal, beef, and lamb (mutton) as livestock, and all livestock as red meat (Jonse, 2020).

Livestock production has been an important branch of farming since the start of agricultural practices and even today is a substantial part of the modern agriculture system. The people throughout the world usually raise livestock as a major means to produce food, directly as the meat and dairy products, and indirectly as draught power and manure for crop production. Foods of animal origin i.e. meat and dairy products are a rich source of essential nutrients and usually added in the meals in reasonable amounts to have a balanced diet. However, these items particularly the meats being very tasty are much relished by the people and more frequently overeaten. The economic role of livestock sector is also quite important as it earns about 40% of the agricultural GDP, employs around 1.3 billion people and provides livelihood for almost 1 billion of the world's people. Nowadays, livestock products fulfil one third of protein intake requirement of human beings. However, according to estimation almost 80% of total livestock sector development comes from industrial production system (Kazmi, 2013).

Livestock production is a major component of the agricultural economy of developing countries and goes well beyond direct food production. The roles cattle play in these economies are manifold though their contribution to agricultural and overall development has not been adequately evaluated and is likely to be underestimated. (Ouma, 2013). In developing countries, where it accounts for one-third, its share is rising quickly; livestock production is increasing rapidly because of growth in population and incomes and changes in lifestyles and dietary habits. Growth in the livestock sector has consistently exceeded that of the crop sector. The total demand for animal products in developing countries is expected to more than double by 2030. By contrast, demand for animal products in the industrial world has been growing at low rates, and livestock production in this group of countries is expected to grow only slowly over the projection period (Derib, 2013).

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens in 2020 (CSA., 2020a). Between and 2016, the average stock of livestock, measured in tropical livestock units (TLU) per 100 people, stood at 51 TLU, which is more than double the continental median of 23 TLU. The gross production value average growth rate during the same period was 4.5% also twice the continental median of 2.2% (FAO, 2020). The national herd supports, at least in part, the livelihoods of more than 11.3 million rural households, including 27– 35% of the highland livestock keepers, and a large proportion of the lowland herders, who live below the Government of Ethiopia established poverty line (Shapiro, et al., 2017) Livestock is a major source of animal protein, power for crop cultivation, means of transportation, export commodities, manure for farmland and household energy, security in times of crop failure, and means of wealth accumulation. The sector contributed nearly 20% of total GDP, and 20% of national foreign exchange earnings in 2017 (World Bank, 2017).

The livestock sector contributes considerably to the country's economy. Its functions take the form of provision of food, cash income, input for crop production and soil fertility management, raw materials for industry, energy/fuel, social values (specially for pastoralists) as well as promotes saving and creates employment opportunities to both highland and lowland inhabitants (Shapiro, et al., 2017). Moreover, the livestock subsector provides wide and year-round employment opportunities for surplus family labour in rural Ethiopia. Cash income from livestock production is especially important for the poor and landless Ethiopian households, particularly women. Income from livestock production is also used for income

diversification investment activities. For the average rural farm household with limited investment alternatives, livestock are used as store of wealth and hedge against inflation (CSA, 2020a).

The Ethiopian livestock sector is characterized by low productivity (FAO, 2018) due to, among other factors, limited availability of improved livestock technologies and only few farm households have practiced improved livestock management and technologies(Kebebe, 2019). Moreover, the Leka Dullecha Woreda was characterized by extensive range land, huge livestock resources with best traditional knowledge in extensive livestock production systems. Thus, the purpose of this study was to assess the effect of smallholderfarmer's livestock production and its income effects in Leka Dulecha District.

1.2. Statement of the Problem

In developing countries, livestock production contributes to approximately one third of the value added from agriculture. The prospects of further population growth, urbanization and increased per-capita income are expected to boost the consumption of high-protein animal products such as milk, meat and eggs. Thus, the continued development of the livestock sector has the potential to contribute significantly to the reduction of poverty and the improvement of global human health (FAO, 2018). However Livestock systems have both positive and negative effects on the natural resource base, public health, social equity and economic growth (World Bank, 2017) There are different social, economic, environmental and political constraints to livestock production systems, which are reflected by livestock productivity, natural and social risk of agro systems and natural resources degradation (World Bank, 2017).

Livestock development in Ethiopia is constrained by both technical and institutional factors. Limiting institutional factors include poor linkages between technology sources such as research centres and end users, and limited extension and financial services (MOA, ILRI, 2013). The technical constraints include insufficient and low-quality feed, widespread prevalence of diseases, as well as poor genetic makeup of the animals, in part due to unavailability or prohibitive prices of improved breeds. According to CSA (2020a), 97.8% of cattle, 99.6% of sheep, 81.7% poultry, and almost all goats (99.9%) in the country are indigenous breeds that have relative poor productivity and reproductive performance.

Improved bulls are largely unavailable and artificial insemination (AI) service is insufficient and inefficient, despite high demand for it (Melesse, Mengistu, & Geleti, 2020).

So far, different studies have been conducted on the issue of smallholder livestock production on income of farm households. Kibrom & Ibrahim, (2012) conducted their study on Consumption Patterns of Livestock Products in Ethiopia (Kibrom & Ibrahim, 2012). For data analyses they used descriptive statistics and for the econometric analysis, they choose the Quadratic Almost Ideal Demand System (QUAIDS) model. Their result showed that limited market access, high dependence on subsistence agriculture, poor marketing infrastructure for perishable products (such as a lack of cold chains), low level of urbanization, indivisible nature of the product (specifically for beef and mutton), and lack of rural retail markets for such products all constrain rural households, resulting in a low demand for livestock products.

Belay,(2012), conducted the study on Smallholder Livestock Production System in Dandi District, Oromia Region. He used cross-sectional stratified and random sampling technique to select households. Data were analysed using descriptive statistics. The study revealed that mixed crop-livestock production system was found to be the dominant farming system in the study area. The result showed that feed shortage, diseases prevalence, labour scarcity and lack of capital as the major constraints limiting livestock production in that order of importance.

Obviously, East Wollega in general and Leka Dulecha district in particular is known by livestock production and the livestock production was a backbone the economic activity of farm households in the area. Even though livestock plays a very significant role in the livelihood of smallholder farmers in the study area, how much the life standard of farm households engaged on livestock production was changed is what have to be investigated. It was natural and rational thinking to posing questions as “why the contribution of livestock production to the livelihood of farm house holds is not as expected? What has happened to the income from the livestock to change their life standard of farm households? Since income is the indicator of life standard the study, need to be conducted on determinants of livestock production its income effect on farm households. Thus, this study tried to answer the question by assessing the determinants of smallholder farm households livestock production and its income effect in Leka Dulecha District. Furthermore, it requires that the social, cultural, institutional and other factors that determine the level of income from livestock for the

households have to be identified and analysed to devise solutions for the aforementioned questions.

1.3. Objective of the Study

1.3.1. General Objective

The genera objective of this study was to assess the determinants of smallholder farm household's livestock production and its income effects in case of Leka Dulecha woreda.

1.3.2. Specific Objectives

The specific objectives of this study were:

i. To examine the determinants of livestock production and its income effects;
ii. To examine the major challenges and opportunities of livestock production and marketing in the study area.

1.4. Research Question

Based on the statement of the problem the study needs to answer the following basic questions.

i. What are determinants of livestock production in the study area and what are their effects on income of smallholder farm households?
ii. What are the major challenges and opportunities of livestock production and marketing in the study area?

1.5. Significance of the Study

It is believed that the results of the research is important to provide valuable information to prepare alternative livelihood development programs that was serve as a guideline for interventions to improve farm household income. It is also significant in creating baseline information that may be extrapolated to other woredas and zones of the region. The findings of this study may contribute in policy formulation and development for a framework for livestock production. It also helps researchers in extending their knowledge with respect to livestock production, since it can offer a deeper understanding on livestock production. In

addition, it serves as a reference material for further study on livestock production in the study area.

1.6. Scope of the Study

Studying on livestock production and its effect on income and consumption expenditure is essential for all woredas of East Wollega as they were enriched with livestock. However, because of financial limitation this study was conducted only In Leka Dulecha Woreda. The concept of the study was delimited to examining the effect of smallholder livestock production on income of farm households, examining the determinants of livestock production and assessing the major challenges and opportunities of livestock production and marketing in the study area. In this study, the term livestock embrace cattle, sheep, goats, horses, mules, donkeys, and poultry.

1.7. Organization of the study

This thesis was organized in to five chapters. Chapter one deals with back ground of the study, statement of problem, objective of the study, research questions, and significance of the study, scope of the study and organization of the study. The second chapter a review of theoretical and empirical literatures that discusses earlier and recent empirical information related to the effect of livestock production on income. Chapter three provides description of the study area, study design, types and source of data, target population, Sample size and Sampling techniques, Method of data collection and methods of data analysis, hypothesis and description of variables, reliability and validity of instruments. The fourth chapter describes the descriptive analysis of data and econometric results. The results of descriptive analyses were presented first, followed by econometric results. Generally, fourth chapter was organized in the following manner: First, demographic information were analysed and presented. Second, descriptive results were presented and analysed in the form of tables; third the econometric results of the effects of the smallholder farmers livestock production on income and consumption expenditure were presented and analysed. The fifth chapter deals with the summary of the major findings, general conclusion drawn on the bases of the findings and recommendations which are assumed to be valuable for all concerned bodies.

CHAPTER TWO

REVIEW OF LITERATURE

2.1. Definition of Basic Terms

Livestock: Raising and breeding livestock is an economic activity that is a part of agricultural activities in a broad sense. As defined in the World Census of Agriculture 2020 (WCA, 2020), the term "livestock" refers to "all animals, birds and insects kept or reared by the agricultural holdings mainly for agricultural purposes. This includes cattle, buffaloes, horses and other equine animals, camels, sheep, goats and pigs, as well as poultry, bees, silkworms etc." Aquatic animals are excluded. Domestic animals, such as cats and dogs, are excluded unless they are being raised for food or other agricultural purposes (WCA, 2020).

Livestock Production: Livestock production can be defined as the animal production raised and bred by agricultural holdings and of animal products, such as milk, eggs, meat and skins. Livestock productivity analyses the relationship between the livestock production and the resources used to obtain it. The indicator groups and livestock products to focus on for the collection of livestock statistics will necessarily vary by country and region, depending on national priorities (World Bank, 2017).

Consumption Expenditure: In this study consumption expenditure is a list of all staple food consumed per month such as, teff , barely wheat ,niger seed ,nut ,oils ,meat ,salt , and etc .

Farm households' income: In this study farm household income is sum of income from all activities non-farm, off –farm, livestock sales, crop sales etc

2.2. Theoretical Literature Review

2.2.1. Livestock in Ethiopia

The Livestock economic and social importance both at the household and national levels, and have in the past provided significant export earnings. The sector contributed up to 40% of agricultural Gross Domestic Product (GDP), nearly 20% of total GDP, in 2017 (World Bank, 2017). Livestock have multiple uses aside from income generation, including cash storage for those beyond the reach of the banking system, draught and pack services, milk and meat for

household consumption, and manure for fuel and fertilizer. In addition to these non-market values, a thriving informal export trade in live animals further emphasizes the significance, albeit unrecognized by official statistics, of livestock and particularly cattle in the Ethiopian economy. This importance is pronounced in pastoral regions, and women's crucial role is widely acknowledged: both directly in primary production, and indirectly through the contribution of livestock to household assets and food security.

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens in 2020 (CSA., 2020a).Based on CSA,(2020a), the estimated numbers of livestock in Ethiopia by regions is described in table below.

Table 1: Estimated Numbers of Livestock in Ethiopia by Region

Region	**Cattle**	**Sheep**	**Goats**	**Poultry**
Tigray	4,908,964	2,097,619	4,838,969	6,317,518
Afar	1,952,394	4,040,176	8,531,082	92,941
Amhara	16,318,446	10,386,223	6,883,316	16,827,119
Oromia	25,031,068	9,260,493	7,526,644	16,668,657
Somale	3,646,940	9,188,394	17,001,672	354,264
Benshangul Gumuz	626,537	72,284	404,015	884,660
SNNP	12,404,963	4,735,604	4,819,573	7,347,205
Gambela	327,801	43,903	134,206	229,151
Harari	69,615	4,236	103,567	104,585
Dire Dawa	67,364	65,462	258,629	129,575
Total	65,354,092	39,894,394	50,243,044	48,955,675

Source: CSA (2020a)

The Ethiopian livestock population is almost entirely composed of indigenous animals. Recent estimates showed that 97.8%, 1.9%, and 0.3% of cattle are indigenous, hybrid, and exotic breeds, respectively. The estimates for sheep are 99.6% and 0.3% for local breeds and hybrids, respectively; for poultry 81.7%, 10.9%, and 7.4% are indigenous, hybrids and exotic, respectively. Nearly all goats (99.9%) are indigenous breeds (CSA, 2020a).

2.2.2. The Role of Livestock Production on Income and Consumption

Livestock production contributes approximately one third of the value added of agricultural operations in developing countries (FAO, 2018). This proportion is expected to increase in the future due to population growth, urbanization, and increases in per-capita income, which will enable the populations of developing countries to purchase greater quantities of high-value foods such as animal proteins (meat, milk and eggs). Continued development of the livestock sector has the potential to contribute significantly to the reduction of poverty and the improvement of global human health (FAO, 2018).

Source of Food Consumption: According to CSA (2020b), out of the total annual milk production, 50% was used for household consumption, 10% was sold, only 0.56% was used for wages in kind, and the rest (39%) was used for other purposes (such as to produce butter, cheese, yogurt, etc.). For butter, 55% of the production was used for household consumption although a considerable portion (39%) was sold. Most of the total cheese produced was used for household consumption (57%), 17% was sold, and the rest (6%) was used for wage in kind and other purposes (CSA, 2020b).

The average per capita protein consumption from eggs (0.11– 0.13 g/capita/day) and poultry meat (around 0.22 g/capita/day) from 1961-2013 was very low (FAO, 2019). Hirvonen & Wolle (2019) estimated that consuming 2.5 eggs per week per person (i.e., 13 grams per person per day) would cost approximately 4% of the total consumption budget for the average household in Tigray (Hirvonen & Wolle, 2019). For the poorest quintile, the corresponding budget share is 10%. The high price of animal-source foods (ASF) is a major concern. Bachewe *et al.* (2017) analysed ASF price patterns in the last decade (2007-2016), relying on a large-scale price dataset collected in 116 urban retail markets in Ethiopia. In addition to important seasonal and spatial patterns, the authors revealed that real prices of ASF have been increased in the last decade by between 32 to 36% for three major ASF – milk, eggs, and meat. Similar price increases were evident in rural and urban areas and for tradable and non-tradable ASFs. This price trend is in contrast with staple cereals for which real prices stayed at similar levels over the last decade (Bachewe, Minten, & Yimer, 2017).

The estimate of total cow milk production for the rural sedentary areas of the country in 2019/2020 was about 3.89 billion litres (CSA, 2020a). The estimate of camel milk for pastoral areas of the country was about 1.82 billion litres. The estimate for total number of

eggs produced was 317 million. According to CSA (2020b), of the total annual milk production, 50% was used for household consumption, 10% was sold, 0.56% was used for wages in kind, and the rest (39%) was used for other purposes (e.g., to produce butter, cheese, yogurt, etc.). With respect to the utilization of butter, 55% of the produce was used for household consumption although a considerable portion (39%) was sold. Most of the total cheese produced was used for household consumption (77%), 17% was sold, and the rest (6%) was used for wages in kind and other purposes

Industrial inputs: Livestock is a key source of industrial raw materials (milk, meat, hides and skin) and high value protein to potential consumers in Ethiopia (USAID, 2018). Due to low productivity, the average live weight of cattle is estimated at 250 kg; with 14% off take rates and 110 kg carcass weight at 44% dressing (USAID, 2018). The off take rates for sheep were 40% with 10kg of average carcass weight per sheep, whereas the off take rate for goats was 27% with average carcass weight of 8kg/goat(MOA, 2013). The per capita consumption of meat in the country is very low (8.5kg) and is lower than the average per capita consumption in Africa.

Livestock Wastes as fertilizer fuels and biogas: Use and disposal of manure and waste varies according to production system. Usage is generally low with less than 10% of the animal manures and crop residues available to smallholder farmers in Ethiopia applied to soils (Nigussie & Kuyper, 2015). Some smallholders use livestock manure to fertilize farmlands, and cow dung is made into cakes and used as a fuel or used for house plastering, or it is sold for income (Tesfay, 2014)

Livestock as source of income: Within the broader agriculture sector, livestock production is a particularly significant and growing source of rural income and growth in the developing world. Approximately 60 % of rural households in developing countries are partially or fully dependent on livestock for their livelihoods. Livestock rearing provides them with a wide spectrum of benefits, such as cash income, food, manure, draft power and hauling services, savings and insurance and social status (Pica-Ciamarra, 2014).

When coming back to home, about 80% of Ethiopian farmers use animal traction to plough their fields (MOA, ILRI, 2013). Despite these contributions to agricultural output, no attempt is currently made by MoFED to impute the monetary value of animal traction for Ethiopian agriculture. The value of the animal draught power input into arable production is about a

quarter (26.4%) of the value of annual crop production. Based on these figures, nearly a third (31%) of the total gross value of livestock output is represented by the value of animal draught power as an input into crop cultivation, an estimated 21.500 billion EB in 2012-13 (MOA, ILRI, 2013)..

Livestock provide cash income or income in kind through the sale of animals and / or the sale and consumption of milk, meat, eggs and other animal products (Pica-Ciamarra, 2014). Livestock are a form of savings (capital growth through herd growth) and insurance, as the sale of animals provides immediate cash to deal with significant or unexpected expenditures (for example, school or medical fees). Livestock provide manure, draft power and transport services, which can be used on the household farm or exchanged on the market (for example, rental of bull for ploughing) (Pica-Ciamarra, 2014). A study in Ada'a district of Oromia in central Ethiopia showed that 93% of survey respondents collected manure for household fuel and 24% of them sold it to get additional income; in 99% of the cases, manure is sold by women (Minase, 2013).

The Contribution of Livestock to the Wider Economy: Contribution of livestock to the economy traces the economic career of livestock and livestock products after leaving the agricultural sector and entering the economy at large. The Ethiopian economy exploits the livestock outputs made available by the agricultural sector as items of household consumption, as exports, or as inputs into other industrial processes. For a variety of reasons, most of these values cannot be accurately estimated (Birthal, 2014).

Even at low productivity and off-take rates, livestock contribute significantly to economic development. Their developmental role in the mixed farming systems transcends direct economic benefits. Use of manure contributes to agricultural sustainability and conservation of the environment. Using draught animal power helps save non-renewable energy such as petroleum. Livestock provide raw material for industry. Additionally, livestock act as a storehouse of capital and an insurance against crop failure. With production concentrated among small landholders, livestock help improve income distribution (Birthal, 2014).

With respect to household consumption, there is a disjunction between what households in CSA surveys claim to consume and the estimated amount of livestock goods and services that the agricultural sector produces. For the Ethiopian economy as a whole, total private final consumption absorbs about 85% of national GDP. On the other hand, the goods and services

derived from livestock that are consumed by private households are worth little more than half of livestock's contribution to agricultural GDP. It would appear that Ethiopian households consume an unexpectedly small portion of national livestock production (Birthal, 2014).

The export of livestock and livestock products is a potential alternative to domestic consumption, and does indeed absorb a significant portion of Ethiopia's livestock output. However, because the cross border trade in live animals is deemed by the authorities to be illegal, there are no reliable national estimates of the scale of this trade. Informal livestock traders use the proceeds gained by exporting livestock to finance the illicit and unrecorded importation of consumer goods such as food, clothing and electrical items. Revenues from informal livestock trading are much greater than those from legal livestock exports. Much of what Ethiopians consume – from CD players to macaroni or used clothes – may be financed by the informal livestock trade, and ultimately by livestock production, but bear no outward resemblance to a livestock product (IGAD LIP, 2017).

2.2.3. Type of livestock system

Grazing system is characterized by ruminants (e.g. cattle, sheep, goats and camels) grazing mainly on grasses and other herbaceous plants, often on communal or open-access areas and often in a mobile fashion. In this system, more than 90 % of the dry matter fed to animals comes from grazed grasses and other herbaceous plants. The following categories can be considered (WCA, 2020):

i. ***Nomadic or totally pastoral****:* refers to livestock raised in a situation where the agricultural holder has no permanent place of residence and does not practice regular cultivation. Livestock moves from place to place with the agricultural holder and his/her household, depending on the season and the availability of feed or water.
ii. ***Semi-nomadic, semi-pastoral or transhumant****:* refers to livestock raised by holders who live a semi-nomadic life. Typically, the holder has a permanent residence to which he/she returns for several months of the year according to seasonal factors. For semi-nomadic and semi-pastoral systems, the holder establishes a semi-permanent home for several months or years and may cultivate crops as a supplementary food source. Herds are moved on transhumance to assure forage and water.

iii. ***Sedentary pastoral****:* refers to livestock raised by holders who have a permanent residence. Ranching refers to large-scale livestock activities carried out on large areas of land set aside for extensive grazing, where livestock graze mainly on grasses and other herbaceous plants. In recent years, the numbers of nomadic and semi-nomadic holdings are declining and the majority of holdings within the grazing system are sedentary pastoral.

iv. ***Mixed system:*** describes the largest and the most heterogeneous livestock system, in which cropping and livestock rearing are linked activities. It is defined as a system in which grazing may be largely practiced but more than 10 % of the dry matter fed to animals comes from crop or crop by-products or stubble; and less than 90 % of the dry matter of the animal feed is off-farm produced.

v. ***Industrial system:*** refers to intensive livestock-raising methods in which (at least 90 % of the dry matter) of the animal feed is off-farm produced. It often consists of a single species (beef cattle, pigs or poultry) fed in feedlots or other in-house systems of feeding.

2.2.4. Factors Constraints Livestock Production

Livestock development in Ethiopia was constrained by both technical and institutional factors. Limiting institutional factors include poor linkages between technology sources such as research centres and end users, and limited extension and financial services (MOA, 2013). The technical constraints include insufficient and low-quality feed, widespread prevalence of diseases, as well as poor genetic makeup of the animals, in part due to unavailability or prohibitive prices of improved breeds. According to CSA (2020a), 97.8% of cattle, 99.6% of sheep, 81.7% poultry, and almost all goats (99.9%) in the country are indigenous breeds that have relative poor productivity and reproductive performance. The average daily milk production and lactation length for a local cow are 1.5 litres/day over seven months, respectively; production and lactation length are relatively better for camels at 5.16 litres/day and nine-months, respectively. The mean age at first calving and the calving interval are around 50 and 22 months, respectively (Duguma et al., 2012). The mean annual egg production is 45 eggs per hen. Improved bulls are largely unavailable and artificial insemination (AI) service is insufficient and inefficient, despite high demand for it (Melesse, Mengistu, & Geleti, 2021)

Feed demand vastly exceeds feed supply, especially in years of drought (MOA, 2015) .The dominant feed resource is poorly managed roughage with low nutritional value. Improved

feed accounts for only 0.7% of the total feed available in the country (CSA, 2020a), and the price of concentrates is high. Feed availabilitywas seasonal and producers/farmers lack knowledge to conserve extra feed during the wet season for the dry season (Duressa, et al., 2014). In addition, feed production was affected by shortage of land. Increased cropping and urbanization have resulted in encroachment on grazing lands, particularly in the highland mixed farming areas. For instance, grazing land in northwestern Ethiopia declined by 30.5% from 1986 to 2013. Credit services for livestock development are inadequate because the amount provided is small; the procedures to get the credit are complex, and producers lack awareness of the opportunities and their importance (Duressa et al., 2014). Women have less access and are considered less creditworthy than their male counterparts for various reasons (Yisehak, 2018).Moreover, the livestock mortality rate is very high; the death estimates for 2020 fiscal year were 3.11 million cattle (4.8%), 5.52(13.8%) million sheep, 0.22 (2.75%) million camels, and 34.71 (70.8%) million chickens (CSA, 2020). These estimates do not include the non-sedentary (nomadic) areas of the country.

2.3. Empirical Literature review

Kibrom & Ibrahim (2012) conducted their study on Consumption Patterns of Livestock Products in Ethiopia: Elasticity Estimates Using HICES (2004/05EC) Data (Kibrom & Ibrahim, 2012). Their study attempts to estimate elasticity's of livestock products. They used the Household Income, Consumption, and Expenditure Survey (HICES), the Welfare Monitoring Survey, and Retail Prices of Goods and Services of 2004/05 data sets of the Ethiopian Central Statistical Agency (CSA). Descriptive analysis of budget shares from livestock products shows that such products account for a very small share of total household expenditure and food expenditure, even by African standards. There is also a remarkable difference in the composition of livestock products between rural and urban areas. When viewed across income categories, the study also reveals that richer households tend to have higher consumption of livestock products. For the econometric analysis, they choose the Quadratic Almost Ideal Demand System (QUAIDS) model for its efficiency and reliability of results. The estimated figures reveal that there is a considerable expenditure and price response for livestock products in Ethiopia. It also appears that rural areas have higher expenditure elasticity's than urban areas. Furthermore, price responses are higher in rural areas than urban areas. Similarly, own-price responses exhibit wide variation across commodities. They also found a strong substitution relationship among most livestock

products. Limited market access, high dependence on subsistence agriculture, poor marketing infrastructure for perishable products (such as a lack of cold chains), low level of urbanization, indivisible nature of the product (specifically for beef and mutton), and lack of rural retail markets for such products all constrain rural households, resulting in a low demand for livestock products. Their results also suggest that there is an opportunity to take advantage of the country's huge livestock resources and to increase the consumption of livestock products through policies aiming at raising household income. The findings also suggest that improving the country's marketing infrastructure for livestock products could also improve opportunities for substitution among livestock products in response to preferences and market signals.

Belay,(2012) conducted the study on Smallholder Livestock Production System in Dandi District, Oromia Regional State, Central Ethiopia with objective of assessing livestock production system, productive and reproductive performance of animals and to identify constraints to livestock production. Cross-sectional stratified random sampling technique was used to select and administer pre-tested, structured questionnaire to 78 randomly selected households. Data were analysed using descriptive statistics. The study revealed that mixed crop-livestock production system was found to be the dominant farming system in the study area. In the study area, cattle are kept mainly for draught purposes. Small ruminants are used to generate income and meat production for household consumption. The major feed resources were natural pasture, hay, crop residues and crop-aftermath and tree/shrub fodders. Feed shortage, diseases prevalence, labour scarcity and lack of capital were the major constraints limiting livestock production in that order of importance.

Ahmed (2019) investigated the response pattern of income earned from livestock farming to livelihood assets in Punjab (Pakistan). Primary data was collected from three regions (northern, central, and southern) of Punjab. A multi-stage sampling technique was adopted to gather the information. The information collected from 347 farm households were processed and analysed (descriptively and inferentially) to generate and interpret the results. On average, a farm household was earning nearly 50% of its total annual income from crops, 23% from livestock and 27% from nonfarm sources. Amongst the four livelihood assets, financial capital could be ranked first in terms of its significant contribution to the annual income earned by a livestock farmer. Own farmland size, qualitative and quantitative attributes of human capital, and status of the physical and financial capital available to the

farmer, all translate into the income generated through livestock. Results of this study indicate that farmer's own land size, farmer level of education, and managerial constraints have negatively associated with the income earned from livestock. While farmer's level of participation in livestock rearing activities, herd size , income from crops , and nonfarm sources have a positive impact on income earned from livestock. A portfolio of the available financial capital may enable a predominantly illiterate and resource-deficient livestock farmer to bear the expenditures made for the overall livestock production activities, which eventually enable him to earn higher income from livestock in a mixed farming system.

Kazmi,(2013) conducted the study on the same title with purpose of finding out, how the agronomists specialized in Animal husbandry perceive and respond to the on-going debate initiated by 'Livestock's long shadow' report about the risks with global livestock production. Moreover, to investigate also their perspective regarding different attempts to reduce the risks as well as the nature of the reactions shown by the farmers and general citizens. His study is based on the qualitative semi-structured interviews with fourteen agronomists regarding the research questions about how they understand and evaluate the above mentioned debate concerning the expansion of livestock activities and the related problems. The results are interpreted through the interview quotes of the respondents rather than using any direct statistical data. The results show that the interviewed agronomists are aware of the on-going debate and confirm that many of the problems raised in 'Livestock's long shadow' report are relevant and need to be addressed on a global level. Whereas, they do not consider any need for substantial changes in the Swedish production system. However, they indicate that Sweden is indirectly responsible for deforestation and expansion of the on-going livestock activities of Brazil and other South American countries because of importing soya bean and red meat from those countries. The implication of his study was that, the agronomists argue that decrease in red meat consumption side by side with increase in livestock production within the safe limits in Sweden would help to decrease risks for the society and reduce the import of red meat in the country, as well.

Ermias, Pau and Joseph, (2015) presented their study on The Role of Livestock in the Tanzanian Economy: Policy Analysis Using a Dynamic Computable General Equilibrium Model for Tanzania (Ermias, Paul, & Joseph, 2015). The study tries to overcome this problem. They extend an existing DCGE model for Tanzania with a separately built herd dynamics module which enables us to specify stock flow relationship, distinguishing between

the capital role of livestock and the flow of livestock products. The results from realistic TFP shocks on different agricultural sub-sectors clearly show that livestock sub-sector has better growth elasticity greater than the cereal and cash crop subsectors in contrast to previous literature. Factors reallocation among activities is observed which leads us to emphasize on livestock – cereal sub-sectors joint growth plan rather than cereal sub-sector growth alone.

Adams, Ohene-Yankyera, Aidoo, & Wongnaa, (2021) were conducted their study on Economic benefits of livestock management in Ghana. According to their study, the traditional system of producing small ruminants (sheep and goats) contributes significantly to the socioeconomic wellbeing of farm households in northern Ghana. Besides serving as an important source of income, sheep and goats also offer important non-pecuniary benefits such as the provision of manure, savings, insurance, farm portfolio diversification, and strong social relations. However, technical evaluation of traditional small ruminant systems places much emphasis on financial gains to farmers and abstracts on the non-conventional utilities derived from the livestock system. Using a multistage sampling technique, they collected cross-sectional data small ruminant farmers for empirical analysis. The results show that at least 60% of the net benefits from sheep and goat production in northern Ghana are in non-marketable (non-cash) forms. The study demonstrates that the traditional free-range system of managing sheep and goats is economically viable when the non-market value derived from the system is incorporated in the economic analysis. The findings have practical implications in improving the traditional small ruminant system for higher meat productivity and income generation in northern Ghana and elsewhere in sub-Saharan Africa.

Table 2: Summary of Empirical Literatures

Author (year)	Title	Methodology	Finding	Limitation
Kibrom & Ibrahim (2012)	Consumption Patterns of Livestock Products in Ethiopia	Quadratic Almost Ideal Demand System(QUAIDS) model	Limited market access, high dependence on subsistence agriculture, poor marketing infrastructure for perishable products, low level of urbanization, indivisible nature of the product , and lack of rural retail markets for such products all constrain rural households, resulting in a low demand for livestock products	Didn't describe the effect of livestock income on consumption expenditure. Excluding necessary variables
Belay (2012)	Smallholder Livestock Production System in Dandi District, Oromia	descriptive statistics	mixed crop-livestock production system was found to be the dominant farming system in the study area	Analysed data only by descriptive statistics (absence of econometric model. Poorly described the findings
Ahmed (2019)	response pattern of income earned from livestock farming to livelihood assets in Punjab (Pakistan)	Descriptive Statistics	Farmer's own land sizes, farmer level of education, and managerial constraints have negatively associated with the income earned from livestock. While farmer's level of participation in livestock rearing activities, herd size , income from crops , and nonfarm sources have a positive impact on income earned from livestock	Didn't used inferential statistics for analysing data,

Author (year)	Title	Methodology	Finding	Limitation
Kazmi,(2013)	response pattern of income earned from livestock farming to livelihood	Descriptive statistics	the interviewed agronomists are aware of the on-going debate and confirm that many of the problems raised in 'Livestock's long shadow' report are relevant and need to be addressed on a global level. Whereas, they do not consider any need for substantial changes in the Swedish production system	Haven't used econometric model.
Ermias, Pau and Joseph, (2015)	The Role of Livestock in the Tanzanian Economy:	Policy Analysis Using a Dynamic Computable General Equilibrium Model	livestock sub-sector has better growth elasticity greater than the cereal and cash crop subsectors	Excluding necessary variables
Adams, Ohene-Yankyera, Aidoo, & Wongnaa, (2021)	Economic benefits of livestock management in Ghana	Descriptive Statistics	✓ Traditional free-range system of managing sheep and goats is economically viable when the non-market value derived from the system is incorporated in the economic analysis. ✓ sheep and goats also offer important non-pecuniary benefits such as the provision of manure, savings, insurance, farm portfolio diversification, and strong social relations	Model gap Excluding necessary variables

2.4. Conceptual Framework

After exploring literatures, independent variables for the study were identified. For the sake of simplicity, a conceptual frame work of some 13 factors (variables) was depicted (Figure 1). However, these are not the only factors affecting livestock income; but also it affect consumption expenditure and combinations of factors exert impact either positively or negatively.

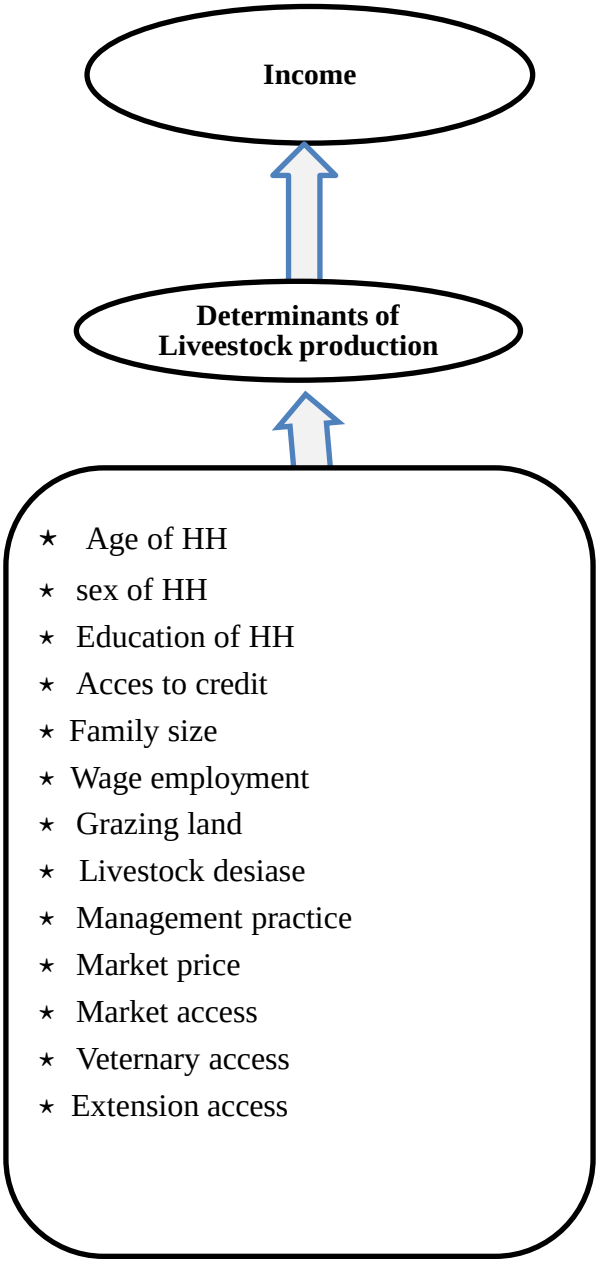

Figure 1: Conceptual Framework

Source: Adapted from different literatures (2022)

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1. Description of the Study area

Leka Dulecha is one of the districts of Eastern Wollega Zone, Oromia region Of Ethiopia. It's part of the East Wollega Zone and it was part of former Diga Leka district. It is bounded by Nunu kumba and Guto Gida in east, Buno Bedele Zone in the west, Diga in north and Jimma Arjo to the south. The centre of leka Dulecha Woreda is found at 354 km of west of Addis Ababa, the capital city of Ethiopia. Agriculture is the main livelihood in which cattle and sheep are kept as the major livestock. The rearing system of cattle in study sites depends on natural grass and crop residues that kept in traditional management system. The 2007 national census reported a total population for this district of 72,057, of whom 35,479 were men and 36,578 were women; 4,056 or 5.63% of its population are urban dwellers. The majority of the inhabitants observed Protestantism, with 44.3% reporting that as their religion, while 43.15% observed Ethiopian Orthodox Christianity, and 8.58% were Muslim (PHCE, 2012) to current.

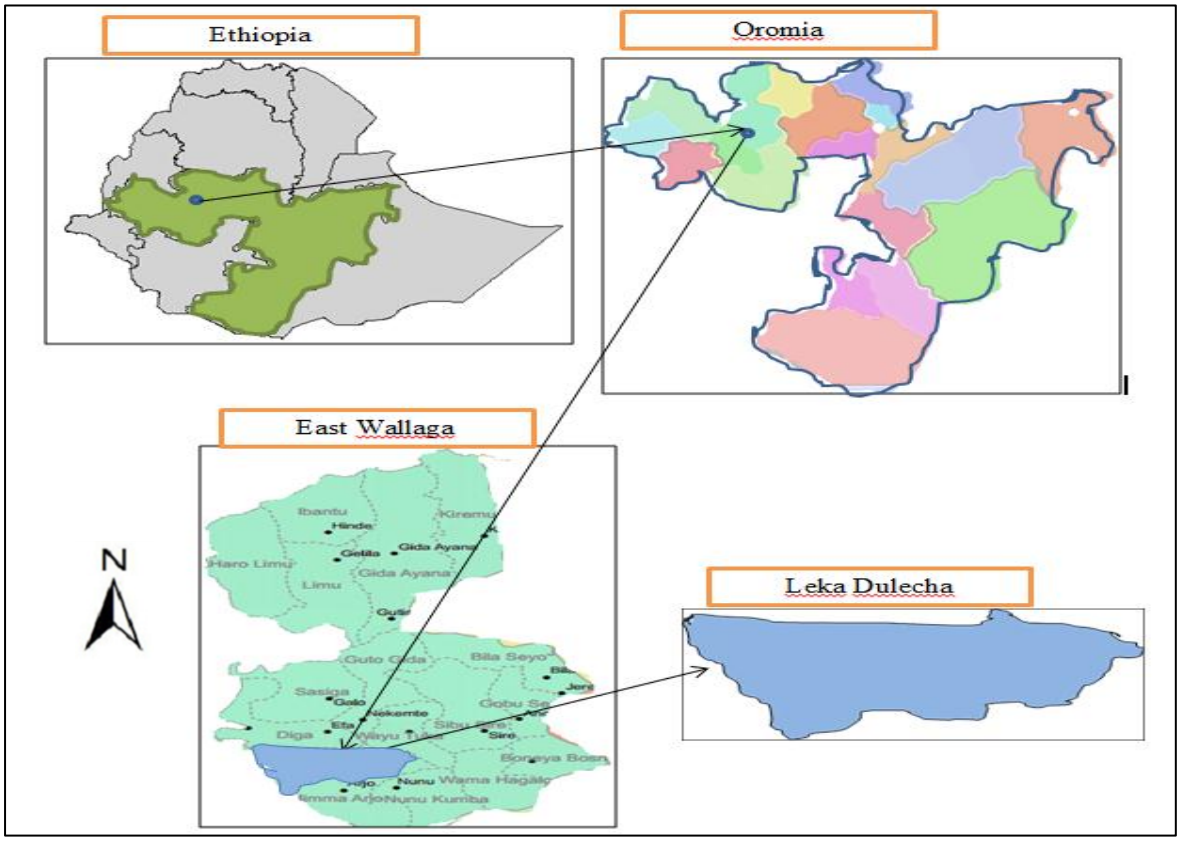

Figure 2: Study Area

3.2. Research Design

In this study, descriptive and explanatory research designs have been employed with quantitative and qualitative methods. Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data. Quantitative research is a means for testing objective theories by examining the relationship among variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures (Creswell, 2009)..

3.3. Types and Sources of Data

This study has employed both primary and secondary sources of data. The primary sources of data for this study have been the residents of Leka Dulecha woreda. Secondary sources of data have been obtained from recorded documents about livestock in government offices. The respondents included in this data collection were: farm households, DA workers, office workers concerned with livestock production and others.

3.4. Sampling Techniques and Sample Size

3.4.1. Sampling Techniques

Cluster sampling technique and simple random sampling techniques were used to get information from different clusters resource centre (CRC) of Leka Dulecha Woreda. First, the population was classified to cluster, where the cluster is division of kebeles in cluster. Next, in each cluster, kebeles have been selected randomly and then respondents who are element of selected kebele were also selected randomly.

3.4.2. Sample Size

Sampling may be defined as the selection of some part of an aggregate or totality based on which a judgement or inference about the aggregate or totality is made (Kothari, 2004). In other words, it is the process of obtaining information about an entire population by examining only a part of it. In most of the research work and surveys, the usual approach

happens to be to make generalisations or to draw inferences based on samples about the parameters of population from which the samples are taken (Kothari, 2004).The optimal sample size in a study is determined by the characteristics of the population and the study's goal, according to (Dawson, 2013). There are several methods to determining sample size; besides this study used Kothari. (2004) sample size determination formula. The sample size was determined by the Kothari, (2004) for unknown population size which is given as:

$$n = \frac{Z^2 pq}{e^2} = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384$$

Where: n= the required sample size, $P = q = 0.5$ is the probability of success in livestock production and assumed to be 0.5 since this would provide the maximum sample size , Z=1.96 which is the confidence interval of 95% with a significance level of 5%, $e =$ is the desired level of precision or margin of error (5% error or 0.05). Accordingly, 384 respondents was taken as the sample of the study.

3.5. Method of Data Collection

In this study, the researcher has used questionnaires to collect data. A questionnaires were developed by reviewing the relevant literature and previously used instruments.

3.6. Method of Data Analysis

Both descriptive statistics and econometrics model were employed to address the specific objectives of the study.

3.6.1. Descriptive Statistics

Using descriptive statistics, specifically, statistical tools like percentages, mean, standard deviation, were employed during analysis and interpretation of the household quantitative characteristics. Besides, statistical tests such as tests of significance and correlation have been used for interpretation of data and drawing conclusions.

3.6.2. Econometric Model

In this study, the first objectives was analysed using Heckman two stage regression model to estimate the relationship between the variables. To select a proper model of statistical analysis follows, among other criteria to consider, the nature of the dependent and independent variables. In this case the dependent variables are livestock income and livestock producing status of farm households.

Heckman Two-Stage model was employed because of its advantages over the probit model in its ability to eliminate selectivity bias and it separates the effect of variables on the probability of producing livestock from the effect on the amount of income (Heckman, 1979). Using the Heckman sample selection model, the first stage is participation in livestock production equation, which helps to identify factors affecting livestock production participation decision using Probit. Then in the second stage, OLS regression was fitted along with the probit estimate of the Inverse Mill's ratio to identify factors that determine the amount of income obtained from livestock production.

(1). The probability of a household's head to engage in livestock production was given by the selection equation as:

$Y_i = \beta_i X_i + \varepsilon_i$ Where $\varepsilon i \sim N(0, 1)$; i= 1, 2. . . n.

Yi = A dummy variable that takes a value of 1 if a household's head has participated and 0 otherwise

βi = Parameters to be estimated in the model

Xi= Explanatory variables that determines livestock production

εi =error term and it is normalized to 1 since a farmer who produce livestock is observed and it is assumed to bivariate, and normally distributed (with correlation coefficient, ρ)

The amount of income was given by the following equation by including an estimate of the inverse Mill'sRatio (λj) as:

$$Y_j = \beta_i X_i + \lambda_j \mu + \varepsilon_j$$

Where $\varepsilon i \sim N(0, \delta^2)$

Yj=the amount of income and observed if only the farmer produces livestock, that is Yj =1

β_j = Unknown parameter to be estimated in the outcome equation

X_j = Explanatory variable that can affect the amount of income

λ= A correction factor for selection bias (Inverse Mill's Ratio)

$$\lambda = \frac{f(Y_i)}{1 - f(Y_i)}$$

εj = Error term, this is assumed to be bivariant, and normally distributed with correlation coefficient , δ2

If IMR is insignificant, interpretation of the results from the Heckman two-step procedure was not relevant for the fact that the procedure is highly sensitive to model misspecification. If the IMR included in the supply equation by regressing all the variables in the selection equation is insignificant, we need to drop it because it creates bias due to inclusion of irrelevant variable. This problem can be accounted for by estimating the two equations (participation and supply equations) simultaneously by the Heckman ML method where the IMR is omitted from the set of the explanatory variables.

Since the Heckman two stage model uses the OLS at the second stage it is vital to consider the OLS assumptions. According to Field, (2013), to run linear regression, checking critical assumptions is essential and it is helpful to conclude the population under study. In this regard, the regression diagnostics were operated to verify the assumptions & classical linear regression model like linearity, normality, Multicollinearity, homoscedasticity test and autocorrelation.

Multicollinearity Test: The term multicollinearity refers to a situation where two or more explanatory variables can be highly linearly related (Gujarati, 2004). If multicollinearity is perfect, the regression coefficients of the X variables are indeterminate and their standard errors are infinite. If multicollinearity is less than perfect, the regression coefficients, although determinate, possess large standard errors (in relation to the coefficients themselves), which means the coefficients cannot be estimated with great precision or accuracy (Gujarati, 2004). Hence, this study checked multicollinearity by means of VIF.

Linearity test: According to Gujarati, (2004) the relationship between the independent and dependent variable needs to be a linear functions to conduct linear regression analysis. Based on this, the linearity of the relationship between independent and dependent variables were tested using Stata 13 software.

Normality tests: normality shows that the data output was normally distributed (Gujarati, 2004). For this study, to test the normality of the data, Shapiro-francia normality test was applied.

Homoscedasticity Test: Homoscedasticity is the extent to which the data values for the dependent and independent variables have equal variances (Gujarati, 2004). At each level of the predictor variables, the variance of the residual terms should be constant. It means that the residuals at each level of the predictors should have the same variance; therefore, checking for this assumption is helpful for the fitness of the regression model. In this regard, to plot the homoscedasticity test, the researcher plotted the standardized residuals, or error (ZRESID) on the Y-axis and the standardized predicted value of the dependent variable based on the model (ZPRED) on the X-axis.

3.7. Definition of Variables

Definition of Dependent Variable:

The effect of smallholder livestock production on income of farm households and consumption have been measured by two dependent variables household`s income and consumption expenditure. In this study, both variables have positive relationship since income of household is related to consumption expenditure. Therefore, the hypothesis tests for explanatory variables take the same sign in both dependent variables.

Definition of Independent Variables

Age of the Household Head (AGE): Age refers to the number of years from the birth of the respondent to the time of the interview. Age by its nature is a continuous variable. Age of the household head is assumed to have a direct relation with experience of keeping livestock, in which case young aged respondents are hypothesized to be disadvantaged. On the other hand, livestock production needs physical strength. However the study done by Jones, (2020)

indicated that household head age has no significant effects on the probability of attaining more income from livestock production.

Educational Status of the Household Head (ED): Education refers to the level of schooling but a discrete number of years. Therefore, it is treated as dummy variable where score “0" represents illiterates, "1” represents literate. Household education head is positively associated with the probability of vaccinating livestock and this leads to improve income from livestock and consumption expenditure (Jonse, 2020). It was hypothesized that education to have a positive impact on the level of income and consumption expenditure from livestock for the household.

Total Livestock Holding (TLH): It is a continuous independent variable Total livestock holding by the respective household is referred to as the number of livestock species (in this case, cattle, sheep, goats, and donkey, horses, mule hens) owned per household during the survey period. Owner of more number of livestock is expected to have positive relationship with households’ annual livestock income and consumption expenditure. If the family has a livestock asset the income and consumption levels of the family increases (Mekore & Yaekob, 2018)

Access to credit (AC): It is measured as dummy variable taking a value “1” if the household responded for having access to credit, and “0”, otherwise. Households will pass the bad times if they have access to credit. They will have bargaining power to wait for good times and receiving good prices for their animals. Moreover, access to credit for the herders helps them to purchase concentrates (alternative feed) for their animals. Households can improve the livestock production and productivity by adopting different production technologies (Baidoo, Yusif, & Anwar, 2016). Credit access eases access and use of all these production inputs. It is hypothesized that access to farm credits affects livestock income and consumption expenditure positively.

Access to Veterinary Services (AVS): It is a dummy variable assigned “1” for having access to veterinary services and “0”, otherwise. It refers to the availability of animal health centres and adequate animal health services near the residences of respondents. Animal health extension workers assist herders to have continuous animal health care which prevents their animal’s die of easily curable diseases (Baidoo, Yusif, & Anwar, 2016). It is expected to affect livestock income and consumption expenditure positively.

Grazing Land Availability (GLA): It refers to the availability of grazing land in required quantity and quality in nearby areas. It is measured as a dummy variable which takes a value "0" for those respondents having problem of grazing land and "1", otherwise. Grazing pasture and water are the major inputs for healthy livestock production. Livestock produced with sufficient grazing land will be more productive and cost well in the market resulting in boost in output (production). Grazing land is an important asset for rural households, and hence owning larger plots of land is positively and significantly associated with the likelihood of adopting improved income from livestock production (Jonse, 2020). It is expected to influence livestock income and consumption expenditure of households positively.

Livestock Disease (LD): It is dummy variable taking "0" for livestock disease risk and "1", otherwise. It is defined as the occurrence of any form of livestock diseases during the production year preceding the survey. Livestock diseases are the likely causes of animals' death. The study of Jonse, (2020) indicated that Livestock disease is inversely related to the probability to get adequate income from livestock production. Therefore, it is hypothesized that occurrence of livestock disease outbreak has a negative impact on the annual livestock income and consumption expenditure of households.

Access to Livestock Market (ALM): It refers to the availability of livestock market center in the vicinity area to the livestock owners. It is a dummy variable where "1" represents for access to livestock market and "0" otherwise. The closer the market, the lesser would be the marketing costs; reduced walking time; better access to market information and facilities (Dejene, 2014). Generally, those respondents with least walking hours to market are advantageous as they are more likely to cover production and marketing costs. Access to livestock market is expected to influence livestock income and consumption expenditure of households positively.

Livestock Management Practice (LMP): It is measured as a dummy variable, "1" representing for the respondents adopting modern management practices in their livestock production systems and "0", otherwise. It refers to carrying out of all activities in livestock production tradition in a way to receive maximum possible output. Improved/modern livestock management practice is likely to boost production (Jonse, 2020). Households using improved livestock management methods such as feeding their livestock improved or mixed animal feed have achieved higher income than those not using better animal feed (Jonse,

2020). It is hypothesized that household' involvement in modern management practice has a positive impact on livestock income and consumption expenditure of households.

Access to extension services (AES): It is a dummy variable taking a value of "1" if the household has access to extension service and "0" otherwise. The provision of extension services to the households directly affects their knowledge, productivity and income; mainly because they have a tendency of using production technologies, learn to practice modern production techniques, and are prone to change. Access to extension agents has positive effects on the probability of adopting better income from livestock production (Jonse, 2020).Therefore access to extension service is expected to influence livestock income and consumption expenditure positively.

Table 3: Summary of definitions and measurements of variables used in the model

Notation	Variable Description	Measurement	Expected Sign
Y1	Income	Continuous: In ETBr	
Y2	Households livestock production	Dummy : 1 if engaged in livestock production, 0 if not engaged in livestock production	
AGE	Age of the household head	Continuous : in years	+
ED	Educational status of household head	Dummy: 1literate, 0= illiterate	+
TLH	Total livestock holding	Continuous: in number	+
AC	Access to credit	Dummy: accessed=1 Otherwise=0	+
GLA	Availability of grazing land	Dummy: Enough grass land availability=1; Otherwise=0	+
LD	Livestock disease	Dummy: No risk of disease =1 Otherwise = 0	-
LBT	Livestock breed type	Dummy : improved livestock breed=1; Otherwise=0	+
ALM	Access to livestock market	Dummy: accessed=1; Otherwise=0	+
LMP	Livestock management practice	Dummy: modern = 1; Otherwise 0	+
AES	Access to extension service	Dummy: accessed =1; Otherwise =0	+

3.8. Ethical Consideration

Ethical issues arise in discussions about codes of professional conduct for researchers and in commentaries about ethical dilemmas and their potential solutions (Creswell, 2009).Researchers need to protect their research participants; develop a trust with them; promote the integrity of research; guard against misconduct and impropriety that might reflect on their organizations or institutions; and cope with new, challenging problems (Creswell, 2009). Therefore, all the research participants included in this study were appropriately informed about the purpose of the research and their willingness and consent were secured before the commencement of distributing questionnaire and asking interview questions. Regarding the right to privacy of the respondents, the study maintained the confidentiality of the identity of each participant. Generally, in all processes of this study ethical issues were considered.

CHAPTER FOUR

RESULT AND DISCUSION

In this section, the results of descriptive analyses are presented first, followed by econometric results. Generally, this section is organized in the following manner: First, demographic information were analysed and presented. Second, descriptive results were presented and analysed in the form of tables; third the econometric results were presented and analysed

4.1. Descriptive results

Under this section descriptive statistics like frequency, percent, mean, standard deviation, maximum and minimum of items were analysed. Calculating mean and standard deviation for nominal scale variables is meaningless. Therefore nominal scale (dummy & categorical) variables were analysed by frequency and percentage and continuous variables were analysed by mean and standard deviation.

4.1.1. Demographic Details of the Respondents

In this section, gender, occupation and marital status of respondents were briefly described.

Table 4: Demographic details of the Respondents

Variables		Frequency	Percent
Gender	Female	20	5.29
	Male	358	94.71
	Total	378	100.0
Occupation	Farmer	376	99.5
	Religious leader	2	.5
	Total	378	100.0
Marital Status	Single	9	2.4
	Married	349	92.3
	Divorced	12	3.2
	Widowed	8	2.1
	Total	378	100.00

Source: Own survey, (2022)

In order to determine the proportion of gender distribution, respondents were asked to indicate their gender. As a result as it can be seen from table 4, of the total number of

respondent, 20 (5.29%) and 358 (94.71%) of the respondents were found to be female and male farm households respectively.

Regarding occupation of respondents, of 378 farm households only two of them (0.5%) were religious leaders and the remaining 99.5% of respondents were engaged in farmer occupation. This means two religious leaders were engaged on both livestock production works and religious leading works.

Farm households were also asked about their marital status in order to compare the proportion of married farm households with that of unmarried and divorced operators. With this regard, table 5 demonstrates that the majority (379 or 92.3%) of the respondents were married, while 9 (2.4%) of them were single and the divorced and widowed respectively were 12(3.2%) and 8(2.1%). This finding suggests that married farm households were in most engaged in livestock production activity.

4.1.2. Livestock's Type and its Contribution in Income at the Study Area

Livestock income is defined as the value of sales and barter of livestock, plus the value of sales, barter and self-consumption of livestock products (such as milk, meat, eggs, honey, and so forth) minus the expenditures related to livestock production which, depending on the country, may include feed, labour and veterinary services. With respect to the majority of studies in the literature, the livestock income variable is calculated only for livestock-keeping households, which ensures that results are not influenced by the pattern of livestock ownership among the population (Alary et. al., 2011).

Table 5 below shows the contribution of net livestock income to total household net income in the sample kebeles

Table 5: Livestock's Type and its Contribution in Income at the Study Area

S. No	Type of livestock owned		Number owned now	Current value in Birr	Percent of income
1	Cattle	Cow	712	15850040	44.85
		Ox	321	6904350	19.54
		Heifer	461	5288200	14.96
		Calf	269	3175500	8.99
		Total cattle	1763	31218090	88.33
2	Sheep		711	2916060	8.25
3	Goats		10	37900	0.11
4	Hens		1020	437210	1.24
5	Horses		50	310600	0.88
6	Donkeys		96	420900	1.19
	Total		3650	35340760	100.00

Source: Own survey, (2022)

As it is described on table 5 above the total income capital obtained from livestock production in the study area was 35,340,760 (thirty five million three hundred forty thousands and seven hundred sixty) Ethiopian birr. Of this income the production of cattle has a major contribution representing 88.33% of income obtained from the whole livestock. Following cattle the greater income for farm households in the study area was obtained from production of sheep representing 8.25% of income from livestock. The smallest income is gained from goats which represents 0.11% of total income.

The result obtained from interview also indicated that livestock contribute to household livelihoods through a variety of direct and indirect pathways. Firstly, livestock provide cash income or income in kind through the sale of animals and / or the sale and consumption of milk, meat, eggs and other animal products. Second, livestock are a form of savings (capital growth through herd growth) and insurance, as the sale of animals provides immediate cash to deal with significant or unexpected expenditures (for example, school or medical fees). Third, livestock provide manure, draft power and transport services, which can be used on the household farm or exchanged on the market (for example, rental of bull for ploughing). Fourth, being a source of wealth, livestock not only contribute to social status but may possibly facilitate access to financial services, both in formal and informal markets.

4.1.3. Income Sources and Share of livestock in household income

The rural household in the study district had different income sources such as crop production, animal production, off-farm and non-farm activities are the main source of income. Among the income source income generating from crop production had a substantial role in income generation. The following table shows sources of income and share of livestock production in household income.

Table 6: Income Sources and Share of livestock in household income

No	Source of income	Annual income in Birr.	Percent	Rank
1	Livestock	35340760	74.60	1
2	Crop	8788515	18.55	2
3	Non-farm incomes	2592340	5.47	3
4	Off-farm incomes	742650	1.57	4
	Total	47375423	100.00	

Source: Own survey, (2022)

Household income may come from different sources. In this research, four major sources of household income are identified. According to this survey, household income of the study area is composed of income from livestock, crop, nonfarm income and off-farm income. The shares of each sources of household income are computed. The result of descriptive analysis shows that majority of household income in the study area is from livestock. Livestock income contributes 74.6% of the total household income in the study area followed by crops cultivation represesnting18.55 percent of income. Whereas, 5.47% of income found to be from Nonfarm and 1.57% of income is gained from off-farm income.

4.1.5. Comparison of the income of livestock between selected kebeles

Table 7: Comparison of the income of livestock between selected kebeles

Kebeles	Net income from livestock	Percent	rank
Gojji	5654522	16	4
Busano Negesso	4947706	14	5
Diggo	6007929	17	3
Badho	6361337	18	2
Bata Yakkin	4594299	13	6
Dini	7774967	22	1
Total	35340760	100	

Source: Own survey, (2023)

The table 8 above showed that Dini kebele was the first ranking kebele in generating income from livestock production by conquering 22% of income generated from livestock in sampled kebeles. The second top ranking kebele in generating income from livestock production was Badho kebele by generating 18% of income generated from livestock in sampled kebeles. The third, fourth, fifth and sixth raking kebeles were Digo kebele, Gojji Kebele,Busano Nagesso and Bata Yakin Kebele respectively by occupying 17%,16%,14% and 13% of income obtained from livestock production in these selected kebeles.

4.1.6. Descriptive Summary of continuous variables

Continuous variables incorporated in this study were income of households livestock holding, family size age and education level of households.

Table 8: Descriptive Summary of continuous variables

Variable	Minimum	Maximum	Mean	Std. Deviation
Income of households	12280	448340	125331.81	65364.388
Total livestock holding	3	34	9.63	4.305

Source: Own survey,(2022)

As it is observed on table 9 the minimum score in annual income of households under investigation in 2022 was 12280 birr and the maximum income recorded by farmers was 448340 birr. The mean income in the year of households under consideration was 125331.81 ETB and the standard deviation was 65364.39. The mean total livestock holding of farmers under consideration was approximately ten and the standard deviation of total livestock holding was approximately four. The maximum total livestock holding recorded by farmers under investigation was 34 and the minimum number of livestock holding was 3.

4.1.7. Descriptive Summary of Dummy variables

Dummy variables included in this study were price of livestock in the market, access to credit, access to veterinary service, availability of grazing land, livestock disease, livestock breed type, access to livestock market, access to extension service, livestock management practice and they were analysed by frequency and percentage on table 10 below.

Table 9: Descriptive Summary of Dummy variables

Variables		Frequency	Percent
Access to credit	did not provided with credit	73	19.3
	provided with credit	305	80.7
	Total	378	100.0
Availability of grazing land	inadequate grass land	289	76.5
	adequate grass land	89	23.5
	Total	378	100.0
Livestock disease	Risk of diseases	177	46.8
	No risk of disease	201	53.2
	Total	378	100.0
Access to livestock market	No access of market	191	50.5
	Accessed market	187	49.5
	Total	378	100.0
Access to extension service	not accessed	235	62.2
	Accessed	143	37.8
	Total	378	100.0
Livestock management practice	Traditional	220	58.2
	Modern	158	41.8
	Total	378	100.0

Source: Own survey, (2023)

A. Access to credit

Table 10 also directed that 86(26.8%) of households haven't provided any credit from micro-finance institutions, banks, NGOs or other credit giving institutions. However, 305 (80.7%) of farm households under consideration were provided with credit from different institutions such as micro-finance institutions, banks, NGOs or other credit giving institutions.

B. Availability of grazing land

Availability of grazing land is one of the most figurative constraints of smallholder livestock producing farm households in the study area. The study showed that 289 (76.5%) of the sampled respondents responded that they have a problem of grazing land availability and

perceive that the problem affects their income from livestock and 89(23.5%) of respondents approved that, there exist adequate grass land for their livestock. This means inadequate adequate grass land has some negative effect on income of households.

C. Livestock disease

The study confirmed that 177 (46.8%) of the respondents agreed that their livestock production was affected by risk of diseases. On the other hand, the rest 201 (53.2%) of the respondents agreed that no risk of diseases is affecting their livestock production.

D. Access to livestock market

The survey data show that among the sampled respondents only 187 (49.5%) have access to livestock market near to their residents. On the other hand, the rest 191 (50.5%) of the respondents agreed that there is a problem of market access to their livestock which enable them to obtain satisfactory income from livestock production.

E. Access to extension service

Regarding extension access 235(62.2%) of farmers haven't got adequate extension service. 143 (37.8%) of respondents agreed that they have got adequate extension service. This indicates more than half of households did not get adequate extension service.

F. Livestock management practice

According to this survey the livestock management practice of farm households of the study area was mainly characterized by traditional way. That is 220(58.2%) of respondents evaluated their livestock management practice as traditional way of management. Only 158(41.8%) of respondents evaluated their livestock management practice as modern.

4.1.8. Possible Opportunities for Livestock production in the Study Area

The major opportunities identified in livestock production were high Market demand for livestock, Possibility of Planting animal feed, Availability of local market, availability of Water resources availability, Favourable climate condition for livestock , low animal disease in Leka Dulecha District. The following table indicates the assumption of respondents on these identified opportunities.

Table 10: Possible Opportunities for Livestock production in the Study Area

Variable	Frequency	Frequency	Percent
Market demand for livestock	Low	0	0
	Medium	110	29.1
	High	268	70.9
	Total	378	100.0
Availability of local market	No	40	10.6
	Yes	338	89.4
	Total	378	100.0
Water resources availability	Adequate	378	100.0
	Inadequate	0	0
	Total	378	100
Favourable climate condition for livestock	Yes	378	100.0
	No	0	0
	Total	378	100
Animal disease	Low	367	97.1
	Moderate	9	2.4
	High	2	0.5
	Total	378	100.0

Source Own survey, (2023)

According to the result of this survey there is high demand of livestock in the market and no problem of marketing for livestock producers. Majority of respondents responded that there was high market demand of livestock to their area. The result of interview also indicated that demand for livestock is increasing over time due to population growth, urbanization and increase of income. Meat consumption is considered as an excellent indicator of a person's economic position, and people in higher social classes have a stronger demand for high-quality meat products and this leads to the high demand of livestock. The other opportunity of livestock production in the study area was availability of market. Majority of respondents (89.4%) agreed that livestock market is available to their local area. Interviewers also responded that livestock market avail in some villages of the district and in towns of the district. Another opportunity for livestock producers was that access of water resource. This survey indicates no shortage of water for livestock in the study area. The interviewers also responded that no fear of shortage of water even in winter season. The result of this study

also shows that the study area has favourable climate condition for livestock and no recurrent climatic change was ever happened in the study area. With this regard all (100%) respondents responded that the climatic condition of the study area is favourable for all existing types of livestock. The other Opportunity with respect to livestock production is that no fear of high livestock disease in the study area. Diseases have a variety of detrimental effects on herd productivity, such as animal death, weight loss, slowed growth, poor fertility performance, and physical weakness. According to the result of this survey 97.1 % of respondents agreed that there is a low level livestock disease in the study area.

4.1.9. Major Challenges in Livestock Production in the Study Area

The major challenges identified in livestock production were lack supply and quality of animal feed, lack of improved breed, inadequate supply of technology related to livestock production, inadequate veterinary service, lack of grazing land, insufficient supply of drug, high price of drug, insufficient supply of vaccine, inadequate use artificial insemination. These major challenges were presented on table below.

Table 11: Major Challenges in Livestock Production in the Study Area

Variables		frequency	Percent
supply and quality of animal feed	Low	358	94.7
	Medium	20	5.3
	Total	378	100.0
Improved breed	Insufficient	354	93.7
	Sufficient	24	6.3
	Total	378	100.0
Supply of technology related to livestock production	Low	358	94.7
	Moderate	20	5.3
	Total	378	100.0
veterinary service	Available only at woreda	9	2.4
	Available in a neighbour kebele	352	93.1
	Available in their kebele	17	4.5
	Total	378	100.0
Grazing land	Inadequate	348	92.1
	Adequate	30	7.9

	Total	378	100.0
Reason to decrease grazing pasture	Use for irrigation	1	.3
	Urbanization	12	3.2
	soil erosion	10	2.6
	expansion of crop cultivation	355	93.9
	Total	378	100.0
supply of drug	Insufficient	373	98.7
	Sufficient	5	1.3
	Total	378	100.0
price of drug	Ineffective	376	99.5
	Effective	2	.5
	Total	378	100.0
supply of vaccine	Insufficient	338	89.4
	Sufficient	40	10.6
	Total	378	100.0
use artificial insemination	Not used artificial insemination	367	97.1
	Used artificial insemination	11	2.9
	Total	378	100.0
Reasons not use artificial insemination	Lack of professional	35	9.3
	Lack of supply service of AI	122	32.3
	No awareness	221	58.5
	Total	378	100.0

Source, Own survey, (2023)

One of the major constraints of livestock production of this study was low in quantity and quality of animal feed. About 94.7% of the sampled households responded that there is low supply and quality of animal feed. The result of interview also suggested that only a few farmers feed their animals with concentrate and feed supplement. This result is related with the study of in Dani Districts, Oromia regional state by Duguma, (2012). The study also identified that the majority of smallholder livestock producing farm households haven't improved breed type of livestock. 93.7% of respondents said that improved breed type of livestock are insufficient at the study area.

According to the result on table 12 above, the study area was characterized by low Supply of technology related to livestock production. About 94.7% of the participants of the study concluded that supply of technology with respect to livestock production was at low level. Availability of veterinary service was another challenge to smallholder livestock producer farmers of the study area. 93% of farm households of the study area use the veterinary service from their neighbour kebeles and only 4.5% of farmers have access to veterinary service at their own kebele.

Moreover the finding of the present study indicated that there is shortage of grazing land in the study are due to expansion of crop cultivation (93.9%), and to a lesser extent through soil erosion, urbanization and use of irrigation .The present finding is in agreement with the result of Duguma, (2012) which indicated that grazing land has declined markedly particularly in the highlands, for the same reason.

Other important limiting constraint for farmers of the study area was insufficient supply of drugs for livestock. 98.7% of respondents responded that the drug for livestock available to their livestock clinic was insufficient. Similarly 99.5% of respondents tell that the prise of drag at the study area was ineffective. This may be due to current inflation circumstance.

The other challenge to livestock producers was insufficient vaccination service for livestock. 89.4% of respondents agreed that their supply of vaccine for their livestock was insufficient.

Artificial insemination was one of the deficiencies of farm households of the study area. Artificial insemination is the process of collecting sperm cells from a male animal and manually depositing them into the reproductive tract of a female. Artificial insemination offers several potential advantages over natural service. Historically, the most important reason was the control of venereal diseases, particularly in cattle. The result of this study identified that 97.1% of farm households haven't ever used artificial insemination for their livestock. The major constraints to do not use of artificial insemination service revealed by small holder livestock producing farm households were lack of awareness (58.5%) followed by Lack of supply service of artificial insemination (32.3%) and lack of professional (9.3%).

4.2. Econometric Results

In this section a multivariate regression analysis was carried out using software called stata version 13 and Statistical Package for Social Sciences (SPSS) version 15.0 was applied to

show the plots of diagnostic tests of the assumption of multivariate regression model. Before running the model, however, the independent variables are checked for diagnostic tests such as exhibiting multicollinearity effect using variance inflation factor (VIF).linearity, normality and homoscedasticity tests were held.

4.2.1. Diagnostics Tests

Before analysing data in Heckman two stage model it is necessary to understand the OLS assumptions. Therefore the following diagnostic tests were done to achieve the assumptions.

i. Multicollinearity Test

Multicollinearity is a problem when the explanatory variables in the model highly correlated and provides redundancy information about the response. The existence of multicollinearity in the model may cause large variance, large T-value and misleading results (Hosmer, & Lomeshow, 1980). Thus, the two popular methods which used to detect the presence of multicollinearity are variance inflation factor (VIF) and tolerance (TOL). Therefore, variance inflation factor (VIF) was calculated as follows; LMP | 4.20 0.238167

Table 12: Multicollinearity tests

Variables	VIF	1/VIF
ALM	3.15	0.317416
AES	3.14	0.317992
AGE	2.20	0.455303
LD	1.81	0.551847
GLA	1.50	0.665826
AC	1.37	0.728710
ED	1.11	0.897013
TLH	1.09	0.920316

Source: Own survey 2022

From coefficients output under VIF on table14 above collinearity statistics obtained for each variable is less than 10 and the mean variance inflation factor is 2.26. Therefore, it can be concluded that there is no multicollinearity symptom.

ii. Homoscedasticity Test

Homoscedasticity is the extent to which the data values for the dependent and independent variables have equal variances (Gujarati, 2004). At each level of the predictor variables, the variance of the residual terms should be constant. It means that the residuals at each level of the predictors should have the same variance; therefore, checking for this assumption is helpful for the fitness of the regression model. In this regard, to plot the homoscedasticity test, the researcher plotted the standardized residuals, or error (ZRESID) on the Y-axis and the standardized predicted value of the dependent variable based on the model (ZPRED) on the X-axis.

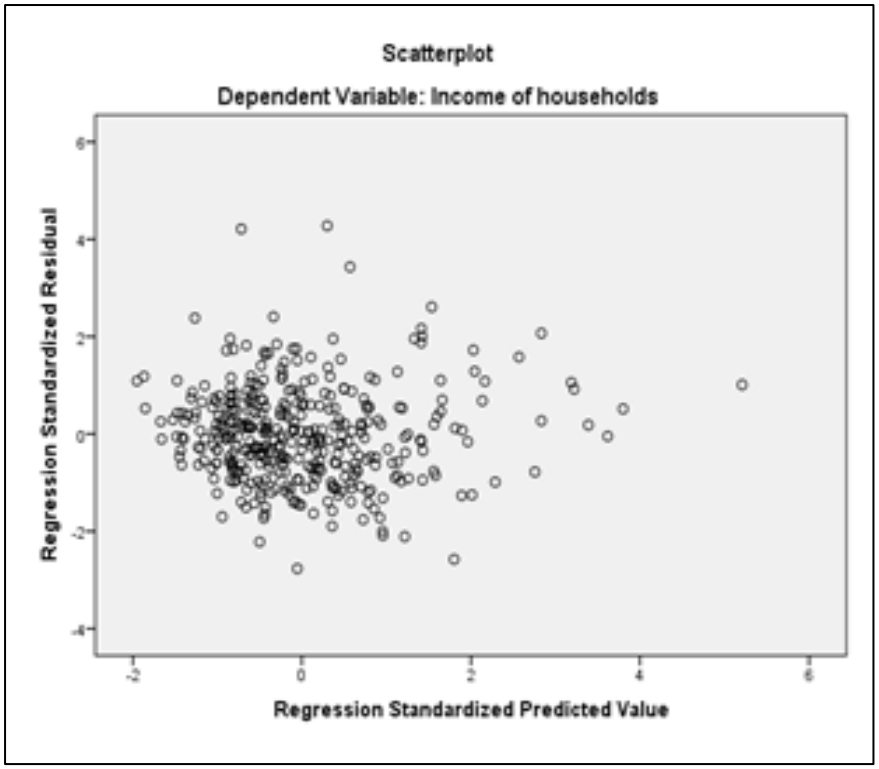

Figure 3: Plot of the standardized residuals

The above scatter plot shows that the majority of the point are concentrated around zero (0) for dependent variables. However, for more clarity there is another test which is called Breautch Pagan test.

Table 13: Breuchs Pagan test of heteroscedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance	
Variables:	fitted values of Y1
chi2(1)	10.22
Prob > chi2	0.14

Source: Own survey computation,(2023)

From table above it is observed that Prob > chi2 is insignificant which is greater than 0.05. The null hypothesis in table 13 says, Ho: Constant variance. So, the insignificant p-value indicates that the null hypothesis of constant variance is accepted, which implies the alternative hypothesis of heteroscedasticity is rejectedted. Therefore, the data has no problem of heteroscedasticity.

iii. Linearity test:

According to Gujarati, (2004) the relationship between the independent and dependent variable needs to be a linear functions to conduct linear regression analysis. Based on this, the linearity of the relationship between independent and dependent variables were tested using SPSS Version 20 software. The normal P-plots of RSR over independent variables was illustrated as figure below

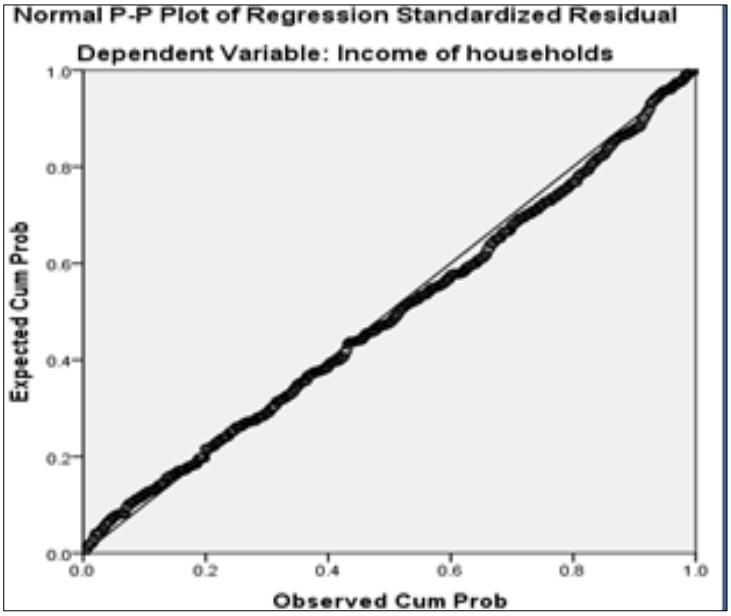

Figure 4: linearity tests

iv. Normality tests:

Normality shows that the data output was normally distributed (Gujarati, 2004). To test the normality of the data, Shapiro Francia test was held using Stata version 13. The test for normality was indicated as table below.

Table 14: Normality tests

Variable	Obs	W'	V'	Z	Prob>z
Y1	378	0.98574	4.025	3.001	0.00135
Y2	378	0.96392	10.187	5.001	0.00001
AGE	378	0.97319	7.567	4.361	0.00001
ED	378	1.00000	-0.000	.	0.00001
TLH	378	0.86558	37.946	7.835	0.00001
AC	378	1.00000	-0.000	.	0.00001
GLA	378	1.00000	-0.000	.	0.00001
LD	378	1.00000	0.000	-58.175	1.00000
ALM	378	1.00000	0.000	-65.503	1.00000
LMP	378	1.00000	-0.000	.	0.00001
AES	378	1.00000	0.000	-62.036	1.00000

Source: Own survey, (2022)

The values reported under *W'* are the Shapiro–Francia test statistics. The tests also report *V'*, which are more appealing indexes for departure from normality. The median values of *V'* is 1 for samples from normal populations. Large values indicate non-normality. The above Shapiro-Francia normality test table indicated some of variables included in the model were normally distributed.

4.2.2. Estimation Results

In this section Estimator variables were used to estimate the Heckman two stage regression model to analyse the determinants of livestock production and its income effect on farm households.

4.2.2.1. Determinants of Livestock Production

As indicated in table 15 below the Pseudo R2 was 0.6861. It means that about 68.61of the variation in the dependent variable is explained by the independent variables, indicating relatively high explanatory power (goodness of fit) of the model

Table 15:Heckman two stage regression results(First-stage probit estimation results of the determinants of livestock production)

Probit regression						Number of obs=378	
						LR chi2(9) =156.54	
						Prob > chi2 = 0.000	
Log likelihood = -124.4324						Pseudo R2 =0.6861	
Variables	Dy/dx	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
AGE	.2583	-.541539	.3622781	-1.49	0.1351	. 251591	.1685126
ED	.21937	.9121777	.2265886	4.03	0.000	.4680723	1.356283
TLH	.4765	.0840355	.0315426	2.66	0.008	.0222131	.1458578
AC	.32661	1.381101	.2174688	6.35	0.000	.9548699	1.807332
GLA	.1105	.0431235	.0190874	2.26	0.024	.0057129	.0805341
LD	-0.2330	.6544968	.2615661	2.50	0.12	.1418367	1.167157
ALM	.12257	.5941393	.3538813	1.68	0.093	-.0994553	1.287734
LMP	-10089	.1161914	.4404181	0.26	0.792	-.7470123	.979395
AES	13845	-.25978	.3472504	-0.75	0.454	-.9403786	.420818
_cons		-3.4937	.7614777	-4.59	0.000	-4.986208	-2.00127

Source: Own Survey,(2022)

The results of first stage Heckman two-step selection model estimation of the determinants of livestock production participation of the sample households are given in Table 15. Out of 11potential variables, 4 variables significantly influence the decision to participate in livestock production. These variables were, education level of households, total livestock holding, access to credit and grazing land availability.

A. Educational status of household head,

Educational status of household head showed positive relation with a likelihood of producing livestock and significant at 1% level of significance. The model output showed that, if a school attendance improved by one year, the probability of households' participation in

livestock production increases by 25.8% ceteris paribus assuming the other variables remain constant. The result of this study is consistent Zander et al. (2012) who found that education improves income of farm households. The probable justification is that education helps farmers to acquire livestock producing related job skills and creates more opportunities for them.

B. Total livestock holding,

The size of a household livestock has a significant positive influence on a likelihood of household livestock production at 1% significance level. The marginal effect showed that, if a size of livestock unit improved by one, the probability of households' participation in livestock production increases by 47.6% ceteris paribus assuming the other variables remain constant.

C. Access to credit,

Access to credit showed positive relation with a likelihood of livestock production and significant at 1% level of significance. The model output showed that, if a dummy changed from being not provided to provided with a credit, the probability of households' participation in livestock production increases by 32.66% ceteris paribus. The positive relation implies that the more the household is likely to get credit access from any source, the higher is the probability that the family's income from livestock improved. This is justifiable from many angles. In rural areas farm families mostly challenged by production failures which leads them to loss of assets (most probably livestock). Moreover, access to credit helps them to purchase concentrates (alternative feed) for their animals. This can improve the livestock production and productivity by adopting different production technologies such as improved livestock breeds.

D. Availability of grazing land

Availability of grazing land service influences the a likelihood of livestock production of households positively and significantly at 5% significance level. The result showed that a unit increase in grazing land increases the probability of household's livestock production by 11.05%, assuming the other variables remain constant.

4.2.2.2. Determinants of livestock production effects on household's income

The Heckman's second stage estimation identifies the factors that influence the extent of income obtained from livestock using the OLS model. Table 16 below shows the regression results of variables that affect the level of income obtained from livestock for farmers in study area.

Table 16: Heckman two stage regression results(second-stage OLS estimation results of the determinants of livestock production effects on households income)

Heckman selection model -- two-step estimates (regression model with sample selection)					Number of obs = 378 Censored obs = 86 Uncensored obs = 292	
Variables	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
AGE	2583.014	6667.658	0.39	0.698	-10485.36	15651.38
ED	21937.14	7699.722	2.85	0.004	6845.958	37028.31
TLH	4765.153	520.1584	9.16	0.000	3745.662	5784.645
AC	32661.44	17569.38	1.86	0.063	-1773.903	67096.79
GLA	1105.584	424.3266	2.61	0.009	273.9189	1937.249
LD	2330.581	5772.014	0.40	0.686	-8982.358	13643.52
ALM	12257.14	7195.361	1.70	0.088	-1845.509	26359.79
LMP	-10089.25	7595.448	-1.33	0.184	-24976.06	4797.555
AES	13845.39	6735.826	2.06	0.040	643.4103	27047.36
_cons	-88050.53	41437.59	-2.12	0.034	-169266.7	-6834.358
mills lambda	33600.96	20571.29	1.63	0.102	-6718.032	73919.96
Rho	1.00000					
Sigma	33600.964					

Source: Own survey, (2022)

The result of Heckman two stage regression model on table 15 above showed that educational status of household head, Total livestock holding, Price of livestock in the market, Availability of grazing land and Access to extension service affect the livestock with P values of 0.004, 0.00, 0.009,and 0.04, respectively.

A. Educational status of household head,

Number of years of schooling of the household head has a positive effect on income of farm households of the study area. By the second stage of Heckman two stage regression model, a

one-year increase in school attendance improves the income of farm households by 21937.14. This conclusion contradicts the result of Amenu & Jiregna, (2012).As the finding of Amenu & Jiregna,(2019) education level negatively and significantly determines livestock production development of smallholder farmers in the study area for the reason of as education level of farm household increase more focus on quality rather than quantity. The result of this study is consistent Zander et al. (2012) who found that education improves income of farm households. The probable justification is that education helps farmers to acquire livestock producing related job skills and creates more opportunities for them.

B. Total livestock holding,

The size of a household livestock has a significant positive influence on both household incomes of farm households at 1% significance level. The coefficient 4765.15indicated that a unit increase in livestock unit increases household income by 4765.153. By implication, increase in livestock production enables farm households to produce and sell more animals as well as animal-source products hence increase in income, *ceteris paribus*. This result is consistent with the findings by Kafle (2014) and Ntanyoma (2010). Similarly, the coefficient 0.0586 indicated that a unit increase in livestock unit increases household income by a multiple of 1.0604.

C. Availability of Grazing Land,

The result of the two stage Heckman regression analysis shows that availability of grazing land observed to have a positive relationship with the income that the household derives from the livestock. The impact of credit access on the level of livestock income to the household is significant at less than 5% level. The coefficient 1105.58 indicates that, a unit increase in grazing land availability improves the income of farm households by 1105.584.

D. Access to extension service

This variable has a positive coefficient and is significant at the 5% significance level. The coefficient 13845.39 shows that when the number of extension visits increases by 1, the income improvement increases by 13845.39; which mean that when the number of extension visits increases by 1, income increases by 13845.39. This is true by expanding and encouraging the household participation rate for the use of extension program is still important for the livestock production enhancement since the extension user households are more productive than non-user. A study supported by the FAO (1999:28) revealed that access

to extension service has a positive impact on the income of rural households engaged on livestock production.

Moreover, contacting veterinary extension workers is often helpful because it encourages farmers to receive advisory services from them. Farmer training centres were established to demonstrate technology and train farmers to implement specific technologies and practices. When farmers are trained, they receive advice from the extension program to adopt (buy technology) and practice on their livestock producing business. Therefore, extension services should promote a higher degree of diversification.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary of Findings

This study was sought to examine the determinants of the small holder livestock production and its income effects in Leka Dulecha Woreda, East Wollega Zone of Oromia Region with objective of examining the determinants of smallholder livestock production and identifing its income effects and assessing the major challenges and opportunities of livestock production and marketing in the study area. It targeted the selected six kebeles of Leka dulecha woreda namely Gojji, Busano Negesso, Diggo, Badho, Bata Yakkin and Dini kebeles. Accordingly, out of the 384 proposed respondents 378 respondents were successfully filled and returned the questionnaires and this was 98.44% response rate. The study used descriptive statistics, inferential statistics and econometric model to analyse data. Econometric models used for this study was Heckman two stage regression models. The summary of the findings is presented below.

i. Findings of descriptive statistics

The result of descriptive statistics were analysed on variables such as income of households, , age of the household head, educational status of household head, family size, total livestock holding, , access to credit, availability of grazing land, livestock disease, access to livestock market, livestock management practice access to extension service and other variables related to them.

The minimum score in annual income of households under investigation in 2022 was 12280 birr and the maximum income recorded by farmers was 448340 birr. The mean income in the year of households under consideration was 125331.81 ETB and the standard deviation was 65364.39. The mean total livestock holding of farmers under consideration was approximately ten and the standard deviation of total livestock holding was approximately four.

Descriptive of dummy variables showed that Some 86(26.8%) of households of the study area haven’t provided any credit from micro-finance institutions, banks, NGOs or other credit giving institutions. However, Majority, 305 (80.7%) of farm households under consideration were provided with credit from different institutions such as micro-finance institutions,

banks, NGOs or other credit giving institutions. Availability of grazing land is one of the most figurative constraints of smallholder livestock producing farm households in the study area. The study showed that 289 (76.5%) of the sampled respondents responded that they have a problem of grazing land availability and perceive that the problem affects their income from livestock. The study also confirmed no noteworthy risk of diseases is affecting their livestock production. The survey data show that among the sampled respondents only 187 (49.5%) have access to livestock market near to their residential area. Regarding extension access 235(62.2%) of farmers haven't got adequate extension service. This indicates more than half of households did not get adequate extension service. According to this survey the livestock management practice of farm households of the study area was mainly characterized by traditional way. That is 220(58.2%) of respondents evaluated their livestock management practice as traditional way of management.

Regarding the possible opportunities for livestock production in the study area, there is high demand of livestock in the market and no problem of marketing for livestock producers. Majority of respondents (89.4%) agreed that livestock market is available to their local area. Interviewees responded that livestock market avail in some villages of the district and in towns of the district. Another opportunity for livestock producers was that access of water resource. That is no shortage of water for livestock in the study area. The study area has favourable climate condition for livestock and no recurrent climatic change was ever happened in the study area. The other Opportunity with respect to livestock production is that no fear of high livestock disease in the study area. According to the result of this survey 97.1 % of respondents agreed that there is a low level livestock disease in the study area.

Regarding the existing challenges in livestock production system of the study area, one of the major constraints of livestock production of this study was low in quantity and quality of animal feed. About 94.7% of the sampled households responded that there is low supply and quality of animal feed. The study also identified that the majority of smallholder livestock producing farm households haven't improved breed type of livestock. 93.7% of respondents said that improved breed type of livestock are insufficient at the study area. The study area was characterized by low Supply of technology related to livestock production. Availability of veterinary service was another challenge to smallholder livestock producer farmers of the study area. 93% of farm households of the study area use the veterinary service from their neighbour kebeles and only 4.5% of farmers have access to veterinary service at their own kebele. The study also indicated that there was shortage of grazing land in the study area due

to expansion of crop cultivation (93.9%), and to a lesser extent through soil erosion, urbanization and use of irrigation. Other important limiting constraint for farmers of the study area was insufficient supply of drugs for livestock. 98.7% of respondents responded that the drug for livestock available to their livestock clinic was insufficient. Similarly 99.5% of respondents tell that the prise of drag at the study area was ineffective. The other challenge to livestock producers was insufficient vaccination service for livestock. 89.4% of respondents agreed that their supply of vaccine for their livestock was insufficient. Artificial insemination was one of the deficiencies of farm households of the study area. The result of this study identified that 97.1% of farm households haven't ever used artificial insemination for their livestock. The major constraints to do not use of artificial insemination service revealed by small holder livestock producing farm households were lack of awareness.

ii. Findings from econometric model

The result of Heckman two stage regression model identified that, educational status of household head has positive relation with a likelihood of producing livestock and significant at 1% level of significance. Accordingly, if a school attendance improved by one year, the probability of households' participation in livestock production increases by 25.8% ceteris paribus assuming the other variables remain constant. On the other hand a one-year increase in school attendance improves the income of farm households by 21937.14

The size of a household livestock has a significant positive influence on a likelihood of household livestock production. If a size of livestock unit improved by one, the probability of households' participation in livestock production increases by 47.6% ceteris paribus assuming the other variables remain constant. While a unit increase in livestock unit increases household income by 4765.153.

Access to credit has positive relation with a likelihood of livestock production. If a households have provided with a credit, the probability of households' participation in livestock production increases by 32.66% ceteris paribus.

Availability of grazing land service influences the a likelihood of livestock production of households positively. A unit increase in grazing land increases the probability of household's livestock production by 11.05%, assuming the other variables remain constant. On the other hand a unit increase in grazing land availability improves the income of farm households by 1105.584.

5.2. Conclusion

This research was conducted with the main objective of assessing the determinants of livestock production and its income income effects farm households in case of Leka Dulecha woreda. Taking the data analysis and the findings in to account the following conclusions could be reached to answer the research questions.

The most important determinants of livestock production of farm households were identified as educational status of household head, total livestock holding, access to credit and grazing land availability. All of these variables positively affect the income of farmers of the study area.

The major opportunities identified in livestock production of the study area were high market demand for livestock, possibility of planting animal feed, availability of local market, availability of water resources availability, favourable climate condition for livestock, low animal disease in Leka Dulecha District. The major challenges identified in livestock production were lack supply and quality of animal feed, lack of improved breed, inadequate supply of technology related to livestock production, inadequate veterinary service, lack of grazing land, insufficient supply of drug, high price of drug, insufficient supply of vaccine, inadequate use artificial insemination.

5.3. Recommendation

Based on the results and findings of the study, to improve households' income from livestock the following recommendations are forwarded about the variables which determine the smallholder livestock production to improve the contributions of livestock production in the study area.

- Intensive public education and extension activities should be done on the District in particular to efficient utilization of existing opportunities.
- The effort is commendable to give long-term commitment, to increase the productivity of livestock, thereby improving the livelihood of farmers as livestock production contributes the higher source of income to the study area.
- Affordable community-based animal health service delivery, encompassing rural populations, should be implemented, as this may increase livestock production competitiveness

- Since access to credit has positive influence on farmers' livestock production engagement, it is better if the smallholder farmers are provided with credit and engaged in livestock production.

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APPENDICES

Appendix I: Questionnaires

Dear respondent, I am graduate student in Wollega University and I am conducting the research for partial fulfilment of MSc Degree. The aim of this questionnaire is to collect data about the determinants of smallholder livestock production and its income effect. The information you provide me is believed to have a great value for the success of this research. I kindly request you to spare some of your precious time for filling this questionnaire. In line with this, I confirm that all data will be used for academic purpose and will be analysed anonymously and you are not exposed to any harm because of the information you give. Finally, I highly appreciate in advance to your kind cooperation in providing the necessary information.

Thank you!

1. Age of the respondent (in number of years) _____
2. Sex of the household head; ☐ Female; ☐Male
3. Marital status of the household head; ☐ Single ☐ Married; ☐ Divorced;
4. Level of education of the household head; ☐ Illiterate; ☐ Read and write ☐ Primary cycle; ☐Above primary cycle; Other (Specify)_____
5. Family size _____ (list the family members, including head).
6. What is your main occupation? ☐ Farmer ☐ Merchant; ☐ government employee; ☐ Religious leader , Other (specify)_____
7. Do you own land? ☐ Yes; ☐ No
8. If yes, what is the total size of your land (in ha. Or other local measurement): _____
9. What for is the land allotted? in ha. Or other local measurement) Grazing_____ ; Crops _____ Rent _____ ; other purpose (specify) _____
10. Do you own livestock (now)? ☐Yes; ☐ No

12. If your answer is yes for question(10), please fill the following table; (**hint Conversion rate & total in table below is to be filled by researcher**)

S. No	Type of livestock owned		Number owned now	Current value in Birr	Conversion rate	Total = (conversion rate × quantity)
1	Cattle	Cow				
		Ox				
		Heifer				
		Calf				
2	Sheep					
3	Goats					
4	Hens					
5	Horses					
6	Donkeys					
7	Mules					
	Total					

13. What are the sources of income for your household? ☐ Livestock; _____ ☐ Crops; ☐ Employment; ☐ land rent ☐ Others (specify) _____

14. What are the levels of income from different sources?

No	Source of income	Annual income in Birr.	Rank
1	Livestock		
2	Crop		
3	Non-farm incomes		
4	Off-farm incomes		
5	Employment		
6	Renting land		
7	Other		
	Total		

15. What is your say about the price you receive for your livestock in the market? ____ reasonable/fair; _____ Not fair

16. If not fair, what do you think are the reasons?

_____

17. What do you think are the major factors affecting your income from livestock? Thick under the option given in table below.

No	Dummy Variables	Yes	No
1	The Price of livestock in the market is at good price level.		
2	Do you have access to take credit from microfinance institution?		
3	Does enough grazing land is available for your livestock?		
4	Have you face the risk of livestock disease frequently?		
5	Is there any nearby access to livestock market		
6	Your livestock management practice is modern		
7	Have you accessed extension service recurrently?		

18. What opportunities were there in your area with regarding livestock production? Indicate your assumption from alternative given in table below

Variable	Frequency	Yes	No
Market demand for livestock	Low		
	Medium		
	High		
	Total		
Availability of local market	No		
	Yes		
	Total		
Water resources availability	Adequate		
	Inadequate		
	Total		
Favourable climate condition for livestock	Yes		
	No		
	Total		
Animal disease	Low		
	Moderate		
	High		
	Total		

19. What are Challenges in Livestock Production in the Study Area? Indicate your assumption from alternative given in table below.

Variables		Yes	No
supply and quality of animal feed	Low		
	Medium		
	Total		
Improved breed	Insufficient		
	Sufficient		
	Total		
Supply of technology related to livestock production	Low		
	Moderate		
	Total		
veterinary service	Available only at woreda		

	Available in a neighbour kebele		
	Available in their kebele		
	Total		
Grazing land	Inadequate		
	Adequate		
	Total		
Reason to decrease grazing pasture	Use for irrigation		
	Urbanization		
	soil erosion		
	expansion of crop cultivation		
	Total		
supply of drug	Insufficient		
	Sufficient		
	Total		
price of drug	Ineffective		
	Effective		
	Total		
supply of vaccine	Insufficient		
	Sufficient		
	Total		
use artificial insemination	Not used artificial insemination		
	Used artificial insemination		
	Total		
Reasons not use artificial insemination	Lack of professional		
	Lack of supply service of AI		
	No awareness		
	Total		

RARRAATUU

Gaaffii barreeffamaa I

Kabajamoo namoota gaaffii afaaniin isin gaafachuuf anaaf eeyyamamoo taatanii ani Yuuniivarsiitii Wallaggaatti , barataa gosa barnoota Ekoonoomiksii digirii 2^{ffaa} ta'ee otuun jiruu dhiibbaa horii horsiisuun galii fi itti fayyadama namoota qooda fudhattoota gaaffii kanaa ta'an irrattu qabu irratti qorannoo geggeessuuf daataa isaa walitti qabachuuf kanan isin gidduutti argame dha. Odeeffannoo gaaffii Kanaan walqabateen qorannoon koo kun akka inni gahee guddaa taphatu amanaa, yeroo gaaffii kana anaaf deebistanitti dhiibbaa yookiin miidhaa fidu tokko illee akka hinqabne isin hubachiisa. Akkasumas yeroo keesssan qabdan irraa naaf qoduun gaaffii kootiif deebii naa laachuu keessaniif galata guddaa ana biraa qabdu.

Galatoomaa!

1. Umurii nama gaaffii deebisuu(umurii lakkoofsaan)_____
2. Saala; ☐ Dhalaa ☐ Dhiira
3. Haala gaa'elaa; ☐ Hinfuune ☐ Kanfuudhe ☐ Kan hiike
4. Rkaa barnootaa; ☐ Hinbaranne ☐ Barreessuu fi Dubbisuu ☐ Marsaa ☐ duraa marsaa ☐ ffaa ol ☐ Kan biro
5. Baay'ina matii abbaa warraa dabalatee_____
6. Hojiirratti bobba'anii jiran; ☐ Qonna ☐ Daldala ☐ Hojii moot. ☐ Geggeessaa Amantii ☐ Kan biro
7. Lafa dhuunfaa qabaa? ☐ Eeyyee ☐ Lakki
8. Yoo qabaate bal'ina lafichaa hektaaraan: _____
9. Lafichi heektaaraan maaliif kan fayyadu dha? ☐ Margaaf ☐ Midhaaniif ☐ Kiraayiif ☐ Kan biroof
10. Amma horii dhuunfaa kee qabdaa? ☐ Eeyyee ☐ Lakki
11. Gaaffii 10ffaaf yo eeyyee jedhe gabatee armaan gadii guuti

Lakk.	Gosoota horoo qabu		Lakkoofsaan hamma qabu	Qarshiin amma kan qabu
1	Horii gaanfaa	Sa'a		
		Sangaa		
		Goromsa		
		Jabbii		
2	Hoolaa			
3	Re'ee			
4	Lukkuu			
5	Farda			
6	Harree			
7	Gaangee			
	Waliigala			

12. Maddi galii maatii keetii maali? ▭ Horsiisa horii ▭ Midhaan ▭ Hojii moot. ▭ Lafa kireessuu ▭ Kan biro
13. Sadarkaan galii wantoota adda addaa irraa argattu maalfakkaata?

Lakk.	Madda Galii	Galii waggaatti qarshiin	Sadarkaa
1	Horsiisa horii		
2	Midhaan		
3	Galii qonnaan alaa		
4	Galii		
5	Hojii moot.		
6	Lafa kireessuu		
7	Kan biro		
	Waliigala		

14. Gatii horii gabaan siif kennuu irratti yaada maal qabda? _____ iftoomina qaba /sababa ;_____ iftooma hinqabu
15. Iftoomina yoo hinqabaanne sababni isaa maali jettee yaadda?

    _____

    _____
16. Wantootni ijoon sababoota dhiibbaa horsiisa horiin galii fi baasii kee irraatti fidu jettee yaaddu maal faadha? Gabatee armaan gadii keessatti guutun ibsi

Lakk	Jijjiiramoota dam-lamee	Eeyyee	Lakki
1	Gatiin horii gabaa irratti sadarkaa gaarii irra jiraa?		
2	Dhaabbata liqii fi qusannoo irraa liqii gahaa ni argattuu?		
3	Tajaajila fayyaa horii gahaa ni argattuu?		
4	Lafa margaa gahaa ta’e horii keessaniif qabduu?		
5	Dhukkubni horii irra deddeebiin isin quunamaa?		
6	Horiiwwan keessan kan diqaalomanidhaa?		
7	Gabaan horii gahaa naannoo keessanitti ni argattuu?		
8	Akkaataan qabaa fi kunuunsa horii keessanii ammayyaawaa dha?		
9	Yeroo ammaatti tajaajila horsiisa horii babal’isuu ni argattuu?		

APPENDICES

A. Regression Results

Probit regression — Number of obs = 378; LR chi2(9) = 156.54; Prob > chi2 = 0.0000; Log likelihood = -124.4324; Pseudo R2 = 0.3861

Y2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
AGE	-.5415394	.3622781	-1.49	0.135	-1.251591	.1685126
ED	.9121777	.2265886	4.03	0.000	.4680723	1.356283
TLH	.0840355	.0315426	2.66	0.008	.0222131	.1458578
AC	1.381101	.2174688	6.35	0.000	.9548699	1.807332
GLA	.0431235	.0190874	2.26	0.024	.0057129	.0805341
LD	.6544968	.2615661	2.50	0.012	.1418367	1.167157
ALM	.5941393	.3538813	1.68	0.093	-.0994553	1.287734
LMP	.1161914	.4404181	0.26	0.792	-.7470123	.979395
AES	-.2597803	.3472504	-0.75	0.454	-.9403786	.420818
_cons	-3.493739	.7614777	-4.59	0.000	-4.986208	-2.00127

note: two-step estimate of rho = 1.1293323 is being truncated to 1

Heckman selection model -- two-step estimates (regression model with sample selection) — Number of obs = 378; Censored obs = 86; Uncensored obs = 292; Wald chi2(9) = 126.93; Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Y1						
AGE	2583.014	6667.658	0.39	0.698	-10485.36	15651.38
ED	21937.14	7699.722	2.85	0.004	6845.958	37028.31
TLH	4765.153	520.1584	9.16	0.000	3745.662	5784.645
AC	32661.44	17569.38	1.86	0.063	-1773.903	67096.79
GLA	1105.584	424.3266	2.61	0.009	273.9189	1937.249
LD	2330.581	5772.014	0.40	0.686	-8982.358	13643.52
ALM	12257.14	7195.361	1.70	0.088	-1845.509	26359.79
LMP	-10089.25	7595.448	-1.33	0.184	-24976.06	4797.555
AES	13845.39	6735.826	2.06	0.040	643.4103	27047.36
_cons	-88050.53	41437.59	-2.12	0.034	-169266.7	-6834.358
Y2						
AGE	-.5415394	.3622781	-1.49	0.135	-1.251591	.1685126
ED	.9121777	.2265886	4.03	0.000	.4680723	1.356283
TLH	.0840355	.0315426	2.66	0.008	.0222131	.1458578
AC	1.381101	.2174688	6.35	0.000	.9548699	1.807332
GLA	.0431235	.0190874	2.26	0.024	.0057129	.0805341
LD	.6544968	.2615661	2.50	0.012	.1418367	1.167157
ALM	.5941393	.3538813	1.68	0.093	-.0994553	1.287734
LMP	.1161914	.4404181	0.26	0.792	-.7470123	.979395
AES	-.2597803	.3472504	-0.75	0.454	-.9403786	.420818
_cons	-3.493739	.7614777	-4.59	0.000	-4.986208	-2.00127
mills						
lambda	33600.96	20571.29	1.63	0.102	-6718.032	73919.96
rho	1.00000					
sigma	33600.964					

B. Multicollinearity test and Homeskedasticity test

```
. vif
```

Variable	VIF	1/VIF
LMP	4.20	0.238167
ALM	3.15	0.317416
AES	3.14	0.317992
AGE	2.20	0.455303
LD	1.81	0.551847
GLA	1.50	0.665826
AC	1.37	0.728710
ED	1.11	0.897013
TLH	1.09	0.920316
Mean VIF	2.18	

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Y1

         chi2(1)      =    10.22
         Prob > chi2  =   0.0014
```

Tropical Livestock conversion factors

S. no	Description (livestock type)	Conversion rate
	Cow	1.00
	Ox	1.00
	Weaned calf	0.34
	Heifer	0.75
	Horse/mule	1.10
	Donkey(adult)	0.70
	Donkey(young)	0.35
	Sheep & goat (adult)	0.13
	Sheep & goat (young)	0.06
	Chicken	0.013

(Source: Storch et.al, 1991)