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DETERMINANTS OF LIVELIHOOD DIVERSIFICATION AND ITS IMPLICATION ON VULNERABILITY OF PASTORAL AND AGRO-PASTORAL COMMUNITY IN AFAMBO WOREDA OF AFAR REGION, NORTHEASTERN ETHIOPIA

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Declaration

I, Mr. Abnet Sisay hereby declare that the thesis entitled "Determinants of Livelihood Diversification and Its Implication on Vulnerability of Pastoral and Agro-pastoral Community in Afambo Woreda of Afar region, Northeastern Ethiopia" submitted by me for the award of Master Degree in Development Studies of Mekelle university at Mekelle is my original work and it has not been presented for the award of any other degree, Diploma, Fellowship or any other similar titles of any other university or institutions.

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Statement of Certification

This is to certify that this thesis is entitled “Determinants of Livelihood Diversification and Its Implication on Vulnerability of Pastoral and Agro-pastoral Community in Afambo Woreda of Afar region, Northeastern Ethiopia” submitted in partial fulfillment of the requirements for the award of master’s degree in Development Studies to the college of Business and Economics, Mekelle university, through the department of management, done by Abnet Sisay, Id. No. (CBE/PS/062/07) is an authentic work carried out by him under my guidance. The matter embodied in this project work has not been submitted earlier for awards of any degree or diploma to the best of our knowledge and belief.

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Acronyms

CBPP	Contagious bovine pleura-pneumonia
CCPP	Contagious caprine pleura-pneumonia
CFW	Cash for Work
FGD	Focus Group Discussion
GOs	Governmental Organizations
KII	Key Informant Interview
NGOs	Non-government Organizations
PADP	Pastoral development Program
PPR	Peste des petits Ruminants
SID	Simpson Index of Diversity

Abstract

Livelihood diversification has been recognized as a tool to cope with economic shocks and reduce vulnerability. This paper focused, identifying the current livelihoods strategy, determinant factors of livelihood diversification, major constraints of livelihood diversification, and the effects of livelihood diversification to reduce vulnerability of pastoral and agro-pastoral household in Afambo Woreda of Afar region. The study was followed the multi-stage sampling procedure with a sample household of 351 of these 139 from pastoral and 212 from agro-pastoral households. Quantitative and qualitative data types was collected using structured survey questionnaires. Both descriptive statistics and inferential statistics were used for interpretation of the result. The Simpson index of diversity was computed to investigate the degree of livelihood diversification. The findings of the result showed that both pastoral and agro-pastoral households have medium level of livelihood diversification portfolio with a mean value of 0.579 diversity index which covers 55.56 percent. The range of medium level of livelihood diversity were 4 to 6 livelihood options. The maximum level of diversity index was only cover 19.37 per cent of the households which classified a high level of diversified income sources. The major determinate factors of livelihood diversification were households' level of income, access to training, provision of livelihood support, family size, years of experience in age and exposure to shocks contributed positively significant at 5% level. While, consumption expenditure, distance to market, land size and dependency ratio were negatively significant at 5% level. The majority of households' livelihood vulnerability ranges highly vulnerable and moderately vulnerable for both pastoral and agro-pastoralist. Major indicators of vulnerability to shocks and stress include a decline of the pasture lands, death of livestock, reduction of water availability, losses of crop production, food insecurity months and outbreaks of human and livestock diseases. To curve the livelihood diversification challenges, the woreda pastoral development office, local lined sector institutions and Non-governmental development actors should support the pastoral and agro-pastoralists with provision training, provision of livelihood support which would enhance livelihood choices in addition to primary livestock production.

***Keywords**: adaptive-capacity, diversification, exposures, livelihoods, Simpson Index, vulnerability*

Chapter One: Introduction

1.1 Background of the study

Pastoralism is one of the most widely practiced livelihood systems exercised by more than 200 million people across the world including nomads, transhumant herders, and agro-pastoral communities producing high quality of livestock products (UNEP, 2014). Extensive pastoralism exists in all continents except Antarctica, mostly in the dry lands or highlands, where intensive crop cultivation is physically not possible and it accounts for about 25% of the Earth's total land area (FAO, 2001). This system is extremely important and is the most prevalent land use in arid and semiarid environments and it supports (Brooks, 2006). Globally, pastoralism is critically important in supporting huge human populations, providing tremendous ecological services, maintaining long-standing civilizations, and making significant contributions to subsistence economy in some of the world's poorest regions (Blench, 2001).

Africa's dry lands are the center for pastoralists who depend on extensive livestock production system, mainly cattle, camels, sheep and goats, as their most important source of livelihood, food security, nutrition, income and wellbeing (AU, 2010). Arid and semi-arid dry lands of East Africa are home to pastoralism and account for 60% to 100% of the land cover of Ethiopia, Uganda, Kenya, Sudan, Somalia and Djibouti respectively (FAO, 2008; Michael, 2006). Pastoralism contributed a lot to the economy of the Africa in general and east African countries. It is the source for the supply of millions of animals to both regional and global markets through livestock trade channels that link local, regional and cross border markets to neighboring countries and global markets. Generally, pastoralist contributes 10% to 44% to the gross domestic product (GDP) of African countries (AU, 2010). An estimated 1.3 billion people benefit from the livestock value chain (ILRI, 2013). Pastoralists constitute about 5 per cent of the total population of some African countries, while in the Horn of Africa and the Sahel, they comprise between 10 and 20 per cent of the total population. It is estimated that pastoralists contribute about 90 per cent of the meat consumed in East Africa and close to 60 per cent of the meat and milk products consumed in West Africa .

In Ethiopia, pastoralism and agro-pastoralism as a mode of production cover 63% of the country's land area, are a means of livelihood for 16 - 21% of the country's population, and

consist of 26% livestock population (Samuel, 2016; Aboud, et al., 2012). Ethiopia has the largest livestock population in Africa, and the livestock sector contributes 20% to the total GDP and more than 40% to the agricultural GDP (Aboud, et al., 2012; Behnke & Metaferia , 2010). More than 40% of the cattle and goats supplied to the domestic markets originate from the pastoral system (Aklilu & Catley, 2014). According to (WISP, 2008), the total economic value of pastoralism in Ethiopia is estimated to be 26.87 billion birr (3.18 billion USD). These results clearly show the huge economic and social benefits of this livelihood system for the country.

However, despite its importance recent trends show that in Ethiopia and elsewhere in the world, pastoralists have been facing serious livelihood challenges due to economic, social, environmental and political stresses and unexpected negative changes (Coffey, 2008; Gashaw, et al., 2014). The most adverse impacts of these changes severely affect pastoralists in developing countries like Ethiopia because of their geographic exposure, already fragile environments, highly sensitivity of the sector and due to low adaptive capacity (Deressa & Hassan, 2010; IPCC, 2007). Many studies indicated that, climate change is significantly posing adverse impacts on the life of pastoralists (Koocheki & Gliessman, 2005) such as death of livestock (due to shortage of water and heat stress), conflict over resource utilization and ownership, loss of land to agricultural encroachment, an increase in frequency of flooding, spread of human and livestock diseases thriving in the wet season, weakening of social institutions and ultimately increasing poverty and weak adaptive capacity (GebreMichael & Kifle, 2008).

The dreadful effects of climate change have plagued the livelihoods of rural communities in East Africa for generations. Land degradation attributed to human, drought and climate factors is increasingly threatening the pastoralism as a in the dry lands of East Africa (Stringer et al, 2009). Adaptation strategies, such as livestock mobility, diversification, feed purchases and animal restocking, have increasingly become unable to support their livelihoods (Wassie & Fekadu, 2014). Moreover, dependence on livestock rearing is increasingly constrained by population growth, which results in the occupation of grazing areas by human settlements (emergence of new villages) and urbanization (Tsegaye et al. 2013).

Due to the increasing pressure on pastoralism, studies have been recommending livelihood diversification strategies as a very indispensable development approach to support pastoralists arguing that it increases their adaptive capacities against the negative impacts of natural and

manmade stresses (Tariku et al., 2020; Zigale , 2016; and Tsegaye et al., 2013). Livelihood diversification an attempt by a given household or community to find new ways of getting income and engaging in so as to supplement or replace the traditional or existing means of living with the intention to reduce risk that might occur due to environmental or economic hazard and risk. Diversification of income generating activities is a core livelihood strategy of rural livelihoods systems in developing countries (Ellis, 2000). Berhanu et al., 2007), describe how Borana pastoralists in southern Ethiopia adapt a strategy of increased involvement in natural resource-based, non-pastoral income activities such as dry land farming. This is a response to both opportunities and constraints including the effects of shocks such as drought. The Afar also survive through livelihood diversification strategies such as labor migration, opportunistic cultivation, by keeping multispecies of livestock, and by keeping a number of goats and sheep for cash income (Hogg, 1997).

In a study conducted at regional level by FAO and Tufts University (2019), its concluded that the traditional pastoral system of the Afar pastoralists has evolved into three major livelihood pathways, depending on the wealth status of the household: (1) pastoralism with commercialization of livestock; (2) keeping livestock along with income diversification; and lastly (3) apath into non-livestock alternative livelihoods. In line with this, it is widely agreed that better understanding of the nature of livelihood diversification in pastoral areas along with its associated factors and its contributin to sustainable developmet of pastoral communities is very important. Hennce, studies that focus their scale of analysis to local level could have been very crucial to come up with important findings that support policy and developmet intervantion. This is due to the fact that, livelihood diversification varies with the conditons of every local circumstance that needs due attention. Hence, this study is intended to exmine the level and factors associated with livelihood diversification and its impact on the level of vulnerability at local level in Afambo woreda.

1.2 Statement of the problem

Pastoral areas in Ethiopia are characterized by frequent drought with high livestock mortality which often results in threatening viability of pastoral livelihood, famine and deaths in human population. The pastoral areas in Ethiopia are regarded as drought vulnerable with chronic food deficiencies (Tariku et al., 2020; Zigale , 2016). Afar regional state is one of the merging, major pastoralist regions in Ethiopia. Its 96.7 thousand km2 area is characterized by an arid and semi-arid climate. It has a population of 1.8 million of which 81% are rural residents depending on pastoral and agro-pastoral livelihood systems. The population in the Afar region had relatively low access to major services and facilities. They were particularly and relatively poorer in accessing urban centers, safe drinking water, sanitation facilities, and human and veterinary health/medical services (EEPRI, 2021).

The region is dominated by pastoralism (90%) while the remaining population is practicing Agro-pastoralism (Tsegaye et al., 2013; CSA, 2017); with about 1.4 million people depend on mixed livestock production of camels, cattle, sheep and goats (CSA , 2017). Having huge number of livestock population, the pastoral community in Ethiopia have been facing multiple challenges in their day to day life due to natural factors which need to be resolved through appropriate strategies. While, the traditional livelihood strategy of pastoralists has been constrained by decreasing productivity of rangelands to supply the required pasture and local conflicts for watering points due to competition for these vital resources (Gina, 2015) and increasing pressure on communal land by foreign agricultural investments and increasingly sealed regional and country borders. The large-scale irrigation schemes were implemented in lower Awash of the Afar region that transformed major parts of the pastoral dry season grazing areas into commercial farms, causing a substantial loss of communal pastures and increased conflict for resource among various land users (Rettberg, 2010).

Most of the study area pastoralists and agro-pastoralists have become increasingly involved in farming and non-farming/non-pastoral activities, but do not display a total detachment from traditional mobile herding. Still the households are still less likely to diversify their livelihoods, while semi-pastoral and agro-pastoral households keep livestock more as an additional insurance against failure in other livelihood activities such as farming. This indicates combining livestock production and farming has improved or at least constrained declines in livelihood outcomes. In

this regard, the human, natural and financial resource constraints coupled with leadership capacity and governance problems have diluted effects of development efforts designed to achieve multidimensional welfare in Afar region. The region and its administrative zones/woereda are repeatedly shocked by recurrent droughts and have recently experienced increasing. Due to the harsh agro-ecology, the adoption of irrigation farming, livelihood diversification, and suitable marketing strategies for livestock and crop products, could have particular importance to secure livelihoods in the region. Therefore, the vulnerable agro ecology and the livelihood pattern & mobility needs to the resiliency in human and natural induced shocks and the need to scale up successful achievements is very important to learn from the past shocks interventions with address policy, strategy and practice gaps and to improve pastoral livelihood. Aspire to observe the resilient to man-made and natural disasters; Improved and sustainable livelihood, Environment, and Institutions; where to be ensured for peaceful and inclusive pastoral development. Improving the livelihood standard and Income of mobile pastoralists through enhancing livestock production and with another livelihood diversification is the gap observed. It is crucial that, realizing improved and sustainable livelihoods through integrated development that is centered on the livestock potential, local knowledge and other reliable resources need to be studied that were not covered yet. Hence, it is needed to identify the major livelihood options and its determinate factors that challenged to maximizing the productivity of potential pastoralist. Moreover, the study addressed the effects of livelihood diversification on the vulnerability level of pastoral and agro-pastoral community to shocks and climate variability.

1.3 Objectives of the study

1.3.1 General objectives

The main objective of this study is to identify the determinants of livelihood diversification strategies and its implication to reduce vulnerability of pastoral and agro-pastoralists.

1.3.2 Specific objectives

In line with the general objective, this study is specifically intended to:

- Identify the common livelihood diversification strategies employed by pastoral and agro-pastoralists

- Explore the level of livelihood diversification status of pastoral and agro-pastoralists
- Examine the determinants of livelihood diversification pastoral and agro-pastoralists
- Analyse the effects of livelihood diversification on the vulnerability of pastoral and agro-pastoralists

1.3.3 Research questions

The study addressed the following key research questions:

- What are the common livelihood diversification strategies employed by pastoral and agro-pastoral households?
- What is the level of livelihood diversification status of pastoral and agro-pastoral households?
- What are the major determinant factors which affect the practice of livelihood diversification in pastoral and agro-pastoral community?
- Does livelihood diversification have impact to curve the problem of vulnerability at household level?
- What interventions the government and NGOs do to enhance livelihood diversification and cope vulnerability of a household or community?

1.4 Scope and Limitations of the Study

1.4.1 Scope of the study

This study is geographically delimited to Afambo Woreda Afar Regional State and it is conceptually limited to the study of four major themes of pastoral livelihood diversification that is (1) identification of major livelihood diversification strategies, (2) status of household livelihood diversification, (3) factors that determine household livelihood diversification and finally (4) effects of livelihood diversification on Vulnerability. All these issues are in line with the research gap outlined in the statement of the problem. The study is more interesting to include more kebeles from Afambo Woreda and beyond, however, for practical reasons such as budget and the similar nature of livelihoods in pastoral and agro-pastoral communities, it is limited to focus only two kebeles.

1.4.1 Limitation of the study

Studying factors that affect determinant of livelihood diversification and vulnerability in pastoralists and agro- pastoralists community require adequate data. Even though, there were access to the secondary data, the researcher was not found as compiled and limited access to the structured secondary data availability to support the cross-sectional survey at both the kebele and woreda levels such as household profiles, enterprises, and other livelihood information made it difficult to reconcile the primary data. In addition, due to the migratory nature of the pastoralists, data collection was challenging to complete timely and the enumerators had to travel on foot to reach the respondents and able to gather the required information. It was also observed some respondents were initially reluctant to participate and challenged for enumerators, however, the enumerators being familiar with the community's norms and language, they were able to raise awareness among the selected respondents. This familiarity helped to facilitate the data collection process.

It is important to note that livelihood diversification and vulnerability reduction among pastoral and agro-pastoral communities are influenced not only by household-level factors but also by a wide range of external factors, such as physical, environmental, and institutional rules and regulations. However, the study's time frame, budget, and scope did not allow for the inclusion of these variables, as doing so would have required a longitudinal study and forced the researcher to use the cross-sectional study to gather the major required data and strengthen with the available secondary data for this specific study.

1.5 Significance of the Study

The livelihood of most of the people in developing countries is highly dependent on agriculture and pastoralism is the key agricultural production system in the dry lands; but the carrying capacity of the sector is decreasing over time due to rate of increase in population and the corresponding reduction in farm size and shrinkage of rangelands. As a result, the participation of rural household members in a number of activities (both on and off-farms) is increasing. It is, therefore, crucial to closely examine effects of diversification to better understand on the situation and explore policy options to rationally address. It is also important to understand households' preferred livelihood diversification strategies and the extent to which these strategies are relevant to reducing pastoral and agro-pastoral vulnerability to shocks. Therefore,

this study addresses the conditions challenging to pastoralists & Agro-pastoralists on their livelihoods and how to respond to shocks.

It is also believed that the results of this study are important in providing valuable information that can contribute to more evidence-based decision making occurring across the study area and inform policy decisions regarding vulnerability reduction and coping strategies that may be extrapolated to other districts and zones of the region.

Moreover, understanding of the determinants of livelihood diversification and its effects on vulnerability can help government to prepare alternative livelihood development programs in the area that can effectively reduce vulnerability. Furthermore, the findings of the study used for policy makers, NGOs and others in devising follow up actions for livelihood development strategies and poverty reduction policies. Additionally, it paves the way and gives an insight to researchers and academicians who are interested to conduct detailed investigations of livelihoods diversification and vulnerability in other areas.

1.6 Organisation of the study

This study has five chapters. The first chapter presents the background of the study, a statement of the problem, objectives of the study, scope, limitations and the significance of the study. Chapter two covers a literature review and conceptual framework of the study. The third chapter focuses on research methodology, which includes a description of the study sites, research design, sampling and sampling method, method of data collection and analysis. The fourth chapter presents major findings with descriptive and inferential statistics on the socio-economic, demographics, policy and institutional variables, vulnerability and shocks that impend the pastoral and agro-pastoral livelihoods. This chapter presents major response strategies and constraints that determine the pastoral communities' ability to diversify their livelihoods. It focused on the roles of livelihood diversification and its implication to reduce vulnerability through enhancing the adaptive capacity of pastoral communities. Chapter five addresses the summery, concluding remarks and policy directions on the extents of pastoralists' livelihood diversification and its effects to reduced vulnerability shocks.

Chapter Two: Review of Related Literatures

2.1 Pastoral Livelihood System

Pastoral production systems are as those "in which at least 50% of the gross incomes from households (i.e. the value of market production and the projected value of existence production consumed by households) it comes from pastoralist or its from related activities, or else, anywhere more than 15% of household's food energy ingesting involves the milk or dairy products they produce. According to Morton (2010), pastoralists are people who depend on livestock or the sale of livestock products for most of their income and consumption, whose livestock is mainly grazed on communally-managed or open-access pastures, and who show at least some propensity, as households or individuals, to move seasonally with their livestock (Morton 2010). Pastoralist is also can be defined by a high dependence on livestock as income for economic and social welfare and the different types of strategic mobility is to get access water and pasture resources in areas of high rainfall variability.

The Pastoralist system has three major supports: (1) the pastoral family and other wider social institutions, (2) natural resources supporting the system and (3) the herd. Those characteristics are the typical elements of the pastoralist system. Pastoralist has two principal differences: the first one is Agro pastoralist and second one is nomadism. The term agro-pastoralist refers to the co- existence of agricultural and pastoral activities side by side at different scales. Agro-pastoralists are sedentary farmers who produce crops and raise livestock. Livestock are used for draught, savings and milk production (Alemayehu, 2004). Agro-pastoral can be described as the established pastoralists who cultivate enough areas to get feed to their families from their own crop production. Agro pastoralists grasp land rights and use their own or rented labor to cultivate land and grow clips (Tsegaye et al., 2013).

According to Amaha (2006), the dry lands of Ethiopia are dominated by rangeland-based livestock production systems known as pastoralism and agro-pastoralism (partly involved in opportunistic cropping) and represent a significant sector of the national agriculture in the country. The Ethiopian Ministry of Agriculture estimates that pastoralists own 73% of the nation's goats, 25% of the sheep, 20% of the cattle and the entire camel population. The

livestock sector contributes about 40% of agricultural Gross Domestic Product (GDP), or more than 20% of the total GDP.

2.2 Livelihood Diversification

2.2.1 Definition and Types of Livelihood Diversification

Livelihood diversification is defined as "the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living" (Ellis, 1998). Most studies report that livelihood diversification is beneficial for relieving pressure on the environment (De Sherbinin, et al., 2008; Hao et al., 2015), reducing livelihood risks and vulnerabilities (Liao & Fei, 2017; Zhang et al., 2019; Little et al., 2001), improving livelihood resilience and sustainability (Ifejika et al., 2014; Wan et al., 2016) and alleviating poverty (Hua, Yan et al., 2017; Dzanku, 2015). Exploring the characteristics and determinants of livelihood diversification are crucial issues in ecologically fragile regions to inform future appropriate policies and interventions for livelihood enhancement, ecological conservation and regional sustainable development.

The literature on livelihood diversification has focused on two general types of households: Farm households who live in sedentary rural societies and herder households who have traditionally relied on pastoralism. These two types of households are often discussed independently of one another because they are typically separated by larger geographical, ethnic and cultural divides (Baird & Leslie, 2013). The studies on the livelihood diversification of farm households have tended to examine crop diversification and engagement in non-agricultural activities (Martin & Lorenzen, 2016; McCord et al., 2015; Reardon et al., 2000; Asfaw et al., 2018; Paudel et al., 2017). Herders have been diversifying into sedentary agriculture and non-agricultural activities to cope with socio-environmental risks, reduce rangeland pressure and increase income (Liao & Fei, 2017; Little et al., 2001; McCabe et al., 2010; Headey et al., 2014).

Pastoral livelihood diversification can be defined as the pursuit of any non-pastoral income-earning activity in both urban and rural environments. This includes various forms of wholesale and retail trade (selling livestock, milk, hides and skins, honey, and artisan goods), rental property ownership and sales, waged employment (local and non-local, including working as a hired herder, farm worker, and migrant labourer), farming (subsistence and commercial), and the gathering and selling of wild products (gum arabic, fire wood, or medicinal plants) (Little, 2001).

2.2.2 Motives and determinates of Livelihood Diversification

Several motives prompt households and individuals to diversify assets, incomes, and activities. In terms of diversification motives, two broad perspectives have been distinguished: push (necessary) factors and pull (choice) factors (Barrett et al., 2001; Ellis, 2000). Although a number of studies have argued regarding these two motives (Martin & Lorenzen, 2016; Cinner et al., 2010), addressing this issue by considering them in isolation is insufficient. The causes of diversification are multi-faceted (Little et al., 2001), and push and pull factors can affect livelihood diversification together. The impact of individual characteristics, family characteristics, and location on livelihood diversification has been broadly discussed (Baird & Leslie, 2013).

It was found that for a vast majority of the rural population, livelihood diversification was distress driven (Saha & Bahal, 2012, Simtowe et al., (2016) considered many literatures on justifications for farm income diversification and grouped into four broad categories: (i) self-insurance against risk, (ii) an ex-post coping strategy, (iii) inability to specialize due to incomplete input markets and (iv) consumption diversification where there are incomplete output markets. This is consistent with Kassie (2016), who reported that most households avoid an extended period of dependency on only one or two sources of income as an ex-ante risk management strategy or as an ex-post risk-coping strategy. The reasons for livelihood diversification are varied, ranging from an attractive choice for accumulation purposes, enabled by asset and the diversity of those assets, to a distress induced insurance strategy brought on by crises (Martin & Lorenzen, 2016).

In developing countries, farm households allocate their labor to off-farm income diversification activities for the following reasons: to reduce income risk by diversifying ex ante; to maintain food security (income and consumption) in the face of low farm productivity and income shocks such as drought, by diversifying ex post, in the face of insurance market failure; and to earn cash income to finance farm investments, in the face of credit market failure (Kassie, 2017). Agricultural product processing and input requirements, which is determined by the agricultural product mix, create derived demand for nonfarm labor. Forces outside agriculture mainly in the cities and in the mining, sector also affect labor use in the rural nonfarm economy. Booms in the

mining and oil sectors draw labor from rural areas. In Nigeria, for instance, "Dutch disease" analysis illustrated this with respect to the oil boom in the early 1980s (Reardon, 1997).

It is often stated that "distress-pushed" diversification factors that push farmers into a variety of low-return activities, leading to more stable but lower household income generating activities (Lohmann & Liefner, 2009). In this light, diversification is seen as an involuntary reversion of the process of specialization, brought on by crises such that the multiplication of activities is an adaptation necessary to ensure survival (Cinner et al., 2010). On the other hand, progressive success and wealth, which in turn lead to increased access to resources, may lead to increased livelihood diversification as although they may have lower risk incentives than the poor, the non-poor may be more capable of financing this diversification if it is costly, have high entry barriers, and is initially risky (Reardon & Hopkins, 2006). From this point of view, diversification can be seen as a deliberate strategy adopted by proactive households with greater opportunities (Cinner et al., 2010; Martin & Lorenzen, 2016). These factors are negative factors that may force farm households to seek additional livelihood activities within or outside the farm. These factors tend to dominate in high-risk and low-potential agricultural environments, subject to drought, flooding and environmental degradation (Haggblade et al., 2007). The most common push factors are related to different forms of risk, such as seasonality and climatic uncertainty (Ellis, 2000). Others include land constraints driven by population pressure and fragmented land holdings, missing or incomplete factor markets, and market access problems due to poor infrastructure and high transaction costs (Dercon, 2002; Ellis, 1998).

On the other hand, pull factors are positive and these may attract farm households to pursue additional livelihood activities to improve their living standards. These factors provide incentives for farmers to expand their range of income activities outside farming by increasing the returns from nonfarm activities. Such factors tend to dominate in less risky and more dynamic agricultural environments (Haggblade et al., 2007). Alternatively, diversification resulting from a push or pull factors have been categorized by some scholars as either "survival-led" or "opportunity-led" respectively (Ellis, 2000). Survival-led diversification, which is driven by push factors, mainly occurs when poorer rural households engage in low-return nonfarm activities by necessity to ensure survival, to reduce vulnerability or to avoid falling deeper into poverty. They are pushed into low-return nonfarm activities because they have low endowments of assets such as land, capital, livestock and credit, making them less resistant to seasonal and other risk factors

(Ellis, 1998; Hirzel & Le Lay, 2008). Opportunity-led diversification is mainly driven by pull factors. It occurs when wealthier rural households engage in high-return nonfarm activities, with accumulation objectives, in order to increase household income by maximizing returns from their assets (Loison & Loison, 2016). Income diversification has been shown to be positively associated not only with wealth accumulation (Barrett, Bezuneh et al., 2001), but also with an increased ability to withstand exogenous shocks, at least in terms of partial consumption smoothing (Block & Webb, 2001; Dressler et al., 2016).

The final explanation for diversification patterns is the existence of economies of scope in production. Economies of scope exist when the same inputs generate greater per-unit profits when spread across multiple outputs than when dedicated to any one output. The concept differs from that of economies of scale, in which per unit profits are increasing as the amount of all inputs to production grows. Economies of scale tend to favor specialization. Most empirical studies of African agriculture find no significant economies of scale beyond a very small farm size, attributable in large part to the absence of sophisticated water control or mechanization (Bezuneh et al., 2001). Ellis and Freeman (2004) mentioned some of the benefits of livelihood diversification in the process of improving livelihood and reducing poverty. They argued that farm households diversify their livelihood because of asset-based and insurance-based diversification theories. Asset-based diversification theories argue that the degree and level of diversity in a farm household's income mix indicates the extent of diversity in the resources or assets it owns or has access to it. On the other hand, the insurance-based diversification theory argues that income failures and shocks dictate and push the farm household to diversify its activities. Ellis (2000) added that the reasons for livelihood diversification mainly emanates from necessity versus choice conditions. Inhabitants of marginal environments are portrayed in the burgeoning livelihoods literature as experts in the craft of survival under conditions of adversity (Davis, 2003; Ellis, 2000; Toulmin, 2009). Smallholder farmers use a variety of practices to adapt to climate variability and change. These practices include crop and livestock management, diversification of livelihood strategies and land use management (Phillipo et al., 2015). The growth of non-farm income sources if accessible in remote rural areas might reduce the need for landless dwellers to carry out extractive practices in local environments for their survival. This has been called the "substitution of employment for the environment" and has received quite a lot of attention in the policy literature (Lipton et al. 1991). In addition, livelihood diversification

is an effective way of solving the problems caused by poverty and environmental degradation. Therefore, livelihood diversification can be used as an efficient indicator to evaluate the success and sustainability of the rural community, which is, for instance, true in China (Liu & Liu, 2016).

Climatic dispositions can pose challenges in livelihood diversification. Areas that are associated with harsh climates may avert investors. Agro-ecology has a negative and significant correlation with the likelihood of choosing agriculture plus off farm plus nonfarm. This increase as we go from high lands to midland (Adugna and Wagayehu, 2012) reported the influence of agro-ecology and spatial variation as determinants of livelihood diversification. This might be due to differences in the quality and size of land, the amount and distribution of rainfall and population densities that influence between highlands and midlands. Agro-ecological factors show statistically significant association with the probability of diversification, and the probability was higher in midland and highland areas compared to the lowlands (Yishak G., et. al. 2014).

2.2.3 Modeling and Determinants of Livelihood Diversification

It is difficult to aggregate activities into a single measure that spans asset categories and it necessarily miss the income that accrues from non-productive capital (Barrett and Reardon, 2001). There are various indicators or indices used to measure livelihood diversification like number of income sources and their share, Simpson's index, Shannon index, Herfindel index, Ogive index, Entropy index, modified entropy index, composite entropy index (Dulruba and Roy, 2012). One definition of diversification is related to the number of income sources and the balance

among them. Hence, taking the number of income sources as a measure of diversification may be criticized on several grounds. First, a household with more economically active adults, all things being equal, more likely to have more income sources. This may reflect household labor supply decision as much as a desire for diversification. Second, it may be argued that there is discrepancy when comparing households receiving different shares of their income from similar activities (Biswarup and Ram, 2011). Since the definition of diversification relates the number of income sources and the balance among them, the Simpson index of diversity is widely used to measure the diversity. Joshi et al., (2003) used Simpson index to compare crop diversification in several South Asian countries. Aneani et al.,

(2011) also used Simpson index to analyze the extent and determinants of crop diversification in Ghana. Biswarup Saha and Bahal (2011) also adopted the Simpson index to measure livelihood diversity

Several studies have come up in Ethiopia and also at the international level that analyses factors affecting the decision and level of livelihood diversification. A study conducted by Geremew et al, (2017) employed the logit model to investigate the probability that a farm households participat in non-agricultural income diversification activities. Then, he applied the seemingly unrelated regression (SUR) model to a system of equations consisting of on-farm, off-farm and non-farm income equations.

On other hand the result of Baharu (2016) used Composite Entropy Index (C.E.I.) for dependent variable then multiple linear regression function for determinants. Moreover, the study conducted (Fikru, 2008) a case study of non-farm rural livelihood diversification on Ethiopia use both multiple linear regression for non-farm income as diversification and multinomial logistic regression for involvement on non-farm income as diversification. (Birhanu & Getachew, 2016) on their part applied Simpson index of diversification then Multinomial Logistic Regression Model. Moreover, Ibrahim et al. (2009) employed multiple linear regression models and identified that age and education of the household heads, extension visits, availability of tractor hiring, income from crop and road access to be the significant determinants of crop diversification in Nigeria. The multinomial logistic regression model (MLRM) result indicated that age, access to credit and regional location affected the crop diversification in Ghana (Aneani et al., 2011).

Several studies have analyses factors affecting the decision and level of crop diversification. Pitipunya (1995) used Logit model and identified the man-land ratio, education, trade experience and level of information as most important factors that influenced the cropping pattern, in Thailand. Moreover, Kimhi and Chiwele (2000), used Heckman-Two-Stage model and detected household demographics, the status of rural road construction, market access and the size of yield of maize are influenced Zambian maize diversification. Besides Rehima et.al (2013) employed Heckman two stage models to estimate the diversification decisions and the level of diversification separately on factors affecting farmers‟ crops diversification. In sum, the Heckman two stage models help to estimate separately the farmers‟ decisions and level of

diversification provides a better estimate by separating participation of farmers and level of participation with compared to any other model.

FAO and Tufts University (2019) has conducted a study on examining alternative livelihoods for improved resilience and transformation in Afar community by examining the gradual change over the past decades. The study has revealed very interesting finding that the main types livelihood diversification strategies at Woreda level are: (i) livestock-based activities (fodder commercialization, livestock trade, livestock product value addition); (ii) small-scale irrigation farming; (iii) fishing; (iv) natural resource production and handicrafts; (v) small-scale/retail trade; and (vi) wage employment including mining, tourism and commercial farming. However, it is noted that, the livelihood diversification strategies and factors associated with it are not the same in all communities across the region.

2.3 Vulnerability

2.3.1 Definition and elements of vulnerability

Vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, as well as climate variability and extremes; and is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2001). Vulnerability hence is the propensity or predisposition to be adversely affected, has been studied as a composite of adaptive capacity, sensitivity and exposure to hazards (Adger & Kelly, 1999; IPCC, 2001; Füssel, 2007; Yuga, et al., 2010). Adaptive capacity is the ability of people to cope with or adjust to the changing context and is explained by socio-economic indicators. Sensitivity is the ability of a system to be affected, and exposure is the incidences of events (Adger, 2006; Paavola, 2008). Vulnerability is thus comprised of risks or a chain of risky events that households confront in pursuit of their livelihoods, the sensitivity of livelihood to these risks, the response or options that households have for managing these risks and finally the outcomes that describe the loss in wellbeing (Turner, et al., 2003).

2.3.2 Approaches of Analyzing Vulnerability

There are various ways of analyzing vulnerability, namely, socio-economic, biophysical and an integrated approach, which unites both socio-economic and biophysical factors. The socio-

economic vulnerability assessment approach focuses on the socio-economic and political status of individuals or groups. Individuals in a community vary in terms of education, gender, wealth, health status, access to credit, access to information and technology, formal and informal (social) capital and political power, which are responsible for variations in vulnerability levels (Füssel, (Deressa et al., 2008). Consequently, vulnerability is a starting point or a state that exists within a system before it encounters a hazard event (Kelly and Adger, 2000). In this regard, vulnerability is shaped by society as a result of institutional and economic changes. The socio-economic approach focuses on identifying the adaptive capacity of individuals or communities based on their internal characteristics. One major limitation of this approach is that it focuses only on variations within society, but in reality, societies vary not only due to socio-political factors but also because of environmental or biophysical factors. The socio-economic approach does not account for the natural resource bases which have the potential to counteract the negative impacts of environmental shocks. For example, areas with easily accessible underground water can better cope with drought by utilizing this resource, compared to areas without it (Deressa et al., 2008).

The second commonly used approach is biophysical that attempts to assess the level of damage that a given environmental stress causes on both social and biological systems. It is sometimes known as an impact assessment. The emphasis is on the vulnerability or degradation of biophysical conditions. This is a dominant approach employed in studies of vulnerability to natural hazards and climate variability and change Füssel (2007) identified this approach as a risk-hazard approach. The biophysical approach, although very informative, also has a major limitation that assessment of biophysical factors is not a sufficient condition for understanding the complex dynamics of vulnerability. This approach also neglects both structural factors and human agency in producing vulnerability and in coping or adapting to it. The approach overemphasizes extreme events while neglecting root causes and everyday social processes that influence differential vulnerability. The third approach is the integrated vulnerability analysis, which combines both the socio-economic and biophysical factors. This approach includes all the internal state of vulnerability and the external situation. This analytical approach was applied by Madu (2012) in agro-ecological based household vulnerability analysis and by Deressa et al. (2008) in regionally based vulnerability analysis. This present study replicates an integrated vulnerability approach to develop vulnerability indices for each household as proposed by Madu

(2012) and adopted by Tesso et al., (2012) in Ethiopia. In this research, it is assumed that households with highly diversified livelihood have high adaptive capacity and there by low level of vulnerability to shock. The integrated assessment approach combines both socio-economic and biophysical approaches to determine vulnerability.

2.4 Conceptual Framework

The sustainable livelihoods framework or approach (SLA) developed by DFID (1999), OXFAM (2005), chambers & Conway (1992), Scoones (1998) and Ellis (2005) were the commonly accepted conceptual framework for to conduct livelihood-based studies. The framework illustrates how a household's capital assets – financial, physical, human, natural and social are the basis for their livelihood strategies and how different types of livelihood strategies can enhance positive livelihood outcomes such as better adaptive capacity. These strategies are impacted by the 'vulnerability context' in which people operate, and are also shaped by the policies, institutions and processes which form the external context. After all of the influences and access created by the above factors successful communities or individuals have better livelihood outcomes (Catley, 2008). The importance of access, or entitlement to assets, and the factors determining this, is generally dealt with by Sustainable Livelihood Framework (SLF`) models through analysis of Policies, Institutions and Processes (PIPs). . It can also be analyzed in the wider context within which livelihood strategies are pursued. Institutions, policies and legislation within the livelihood framework shape livelihoods. They operate at all levels and effectively determine access (to capital, to livelihood strategies and to decision-making bodies and sources of influence); the terms of exchange between different types of capital; and returns (economic and non-economic) to any given livelihood strategy (DFID, 2000).

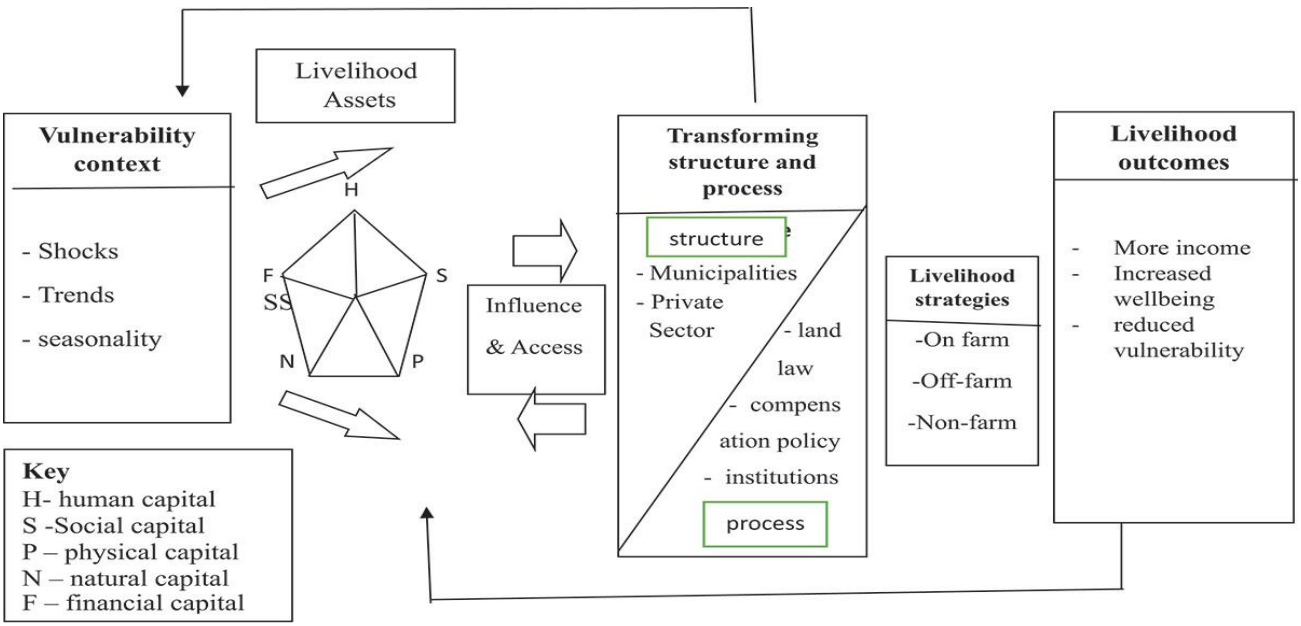


Figure 2.1: SLA Approach (Modified based on literature review, Scoones (1998), DFID (2000), Ellis (2005)

Vulnerability: The Vulnerability Context is the external environment which affects people's livelihoods due to either trends, shocks and or seasonality over which people have limited or no control (DFID, 2000). In this paper the vulnerability context is represented by climate change and variability. Climate change and variability is represented by gradual climate changes (precipitation and temperature), and extreme climatic events (prevalence of drought, flooding and storms).

Livelihood assets (Asset pentagon): The pentagon of capital assets serves as a visual presentation of information on assets. The pentagon grid can be used as a schematic demonstration of existing variations in regarding capital access. Because the availability of different assets changes constantly, the shape of the pentagon changes accordingly (Figure 2.1). If the triangle tip of a shape within the pentagon moves towards or away from the external line labelled H (Human capital), for instance, it is an indication of weaker emphasis given to this capital. However, if the internal shape forms a regular pentagon, it shows that a development intervention gives equal weighting to all forms of capital results shocks or vulnerability reduced (Scoones, 1998, Catley, 2008).

Human capital represents the skills, knowledge, and availability of labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood

objectives and at household level human capital is a factor of the amount and quality of labour available (DFID, 2000, Ellis, 2005).

Social capital refers to the resources people draw upon in pursuit of livelihood objectives. Social capital is developed through networks and connectedness; membership of more formalised groups (governed by mutually agreed or commonly accepted rules, norms and sanctions); and informal safety nets based upon relationships of trust, reciprocity and exchange (Scoones, 1998, DFID, 2000, Ellis, 2005).

Natural capital are endowments and resources of a region belonging to the biophysical realm, including forests, air, water, arable land, soil, genetic resources, and environmental services. Natural resources provide the requirements for a substantial resource base to support related economic activity and amenities for enhancing quality of life related to aesthetic appeal and proximity to the natural world (Scoones, 1998, DFID, 2000), Ellis, 2005).

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive; producer goods are the tools and equipment that people use to function more productively (Scoones, 1998, DFID, 2000, Ellis, 2005).

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. There are two main sources of financial capital: available stocks and regular flows of money. Current amount of household saving in the form of cash and jewellery, amount credit available to the households annually, annual amount of government support, and amount of money the household gets from remittance annually can be indicators (Scoones, 1998, DFID, 2000, Ellis, 2005).

Livelihood Strategies: Livelihood strategies are the combination of activities that people choose to undertake in order to achieve their livelihood goals. They include productive activities, investment strategies and reproductive choices. Livelihoods approaches try to understand the strategies pursued and the factors behind people's decisions; to reinforce the positive aspects of these strategies and mitigate against constraints. The choice of strategies is a dynamic process in which people combine activities to meet their changing needs. For example, in farming households, activities are not necessarily confined to agriculture but often include non-farm

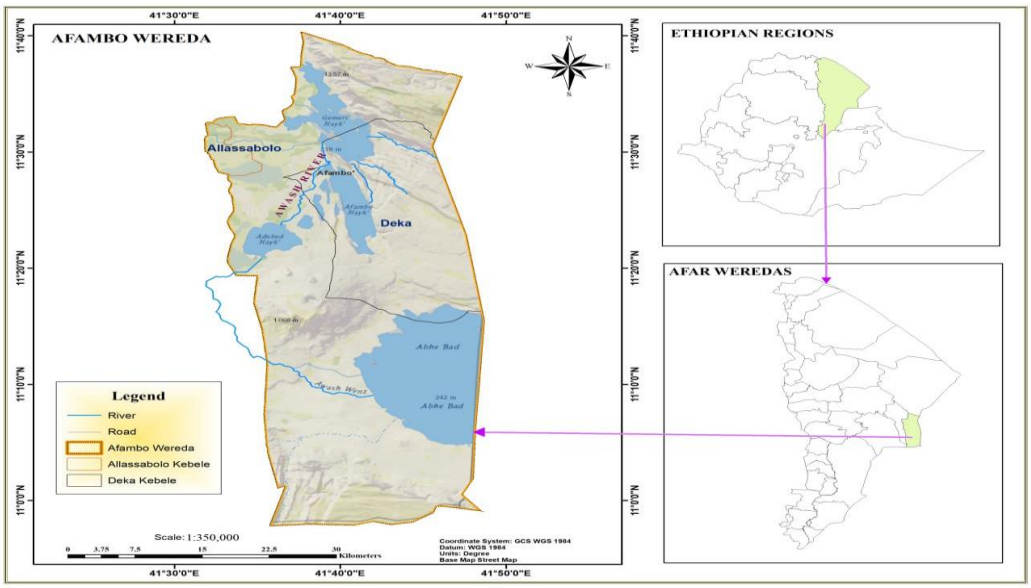
activities in order to diversify income and meet household needs. Migration, whether seasonal or permanent, is one common livelihood strategy. A major influence on people's choice of livelihood strategies is their access to assets and the policies, institutions and processes that affect their ability to use these assets to achieve positive livelihood outcomes.

Livelihood outcomes: The livelihoods approach is concerned with people. It seeks to gain an accurate and realistic understanding of people's strengths (assets or capital endowments) and how they endeavor to convert these into positive livelihood outcomes. Livelihood outcomes are achieved when households have secure ownership of, and access to assets, resources, stores, and income-generating activities to offset risks, ease shocks and meet contingencies. In the livelihood's framework identifies positive livelihood outcomes as: more income, increased wellbeing, reduced vulnerability, improved food security and more sustainable use of natural resource base.

Chapter Three: Research Methodology

3.1 Description of the study Area

Afambo is one of the woredas in the Afar Region of North-eastern Ethiopia. It is named after Lake Afambo, located at the border of this woreda with Asayita, near the international border with Djibouti. As part of the Administrative Zone 1, Afambo is bordered on the south by the Somali Region, on the west by Dubti, on the north by Asayita, and on the east by Djibouti. The largest town in this woreda is Afambo. The average elevation in this woreda is 404 meters above sea level the highest peak is Mount Dama Ali (1069 meters). The only perennial river is the Awash, which passes through Lake Afambo, and a chain of lakes south and east of it: Laitali, Gummare, Bario, and Lake Abbe. It is characterised by Arid climate agro-ecological zone with mean monthly temperature ranging from 38^0C to 42^0C and average annual rainfall ranging from 110-120mm.



Figures 3.1: Map of the study area

Based on the CSA projected data (2022), this woreda has a total population of 49,359 of these 29357 were male and 20,002 were female with settlement of an area 1,258.97 square kilometres. According to the Woreda pastoral and agricultural office (2023), the estimate arable lad was 8250 hectares of land. From these 7122 hectares of land was cultivated.

3.2 Research Design

In this study, a survey research based on cross-sectional research design was employed. Since this study required a data collected at a point in time, it involves only one contact with the study population and the researcher decides to use Cross-Sectional study design (Creswell, 2014, 2018). This study design enables to describe the situation at its existence along using both qualitative and quantitative approach. Cross-sectional study design, therefore, is deemed appropriate study the level and determinant factors of livelihood diversification.

3.3 Type and Source of Data

Both primary and secondary types of data were collected for this study. The primary data was collected from pastoral and agro-pastoral households, clan leaders, Woreda and kebele authorities and secondary data was obtained from Pastoral and Agricultural Office and Metrology agency.

3.4 Methods of Data Collection

The principal methods of data collection were household survey. For this purpose, structured questionnaire both open-ended and close-ended were developed to gather pertinent information from every household included in the study. The questionnaire was pre-tested for its consistency, logical flow, coding and length, and amended accordingly. Training was held to provide briefing for enumerators who understand and speak the local language (Afaraf) to facilitate successful data collection. In addition to household survey, focus group discussion (FGD) and key informant interviews (KI) was carried out with pastoralists and other government authorities to supplement the survey data. FGD and interview were conducted based on the principle of saturation point where the process repeated until no new information is obtained. Each FGD discussant having 6-8 carefully member was selected with inclusion of mix of inclusions of mix of participants from kebele leaders, Agricultural experts, Veterinarians, Youth, with mix of gender.

3.5 Sampling technique and sample size determination

Multistage sampling procedures were followed in designing the survey. At the first stage Afambo Woreda was selected purposively because of the presence of both crop and livestock

production as livelihood system and its accessibility. The Woreda has 8 kebeles among which four kebeles are agro-pastoral while the remaining four kebeles are pastoral. At the second stage, the Woreda is stratified in to two strata based on the two common pastoral livelihood systems namely (pastoral and agro pastoral livelihood), the third stage was selection of kebeles from the strata in which one kebele from each strata namely: Deka from pastoral livelihood zone and Alasambo from agro-pastoral livelihood zones. Due to the homogenous nature of the kebeles by livelihood type, the researcher strongly believes the two selected kebeles can be represent the Woreda. In the fourth stage respondents were selected from each kebeles using systematic random sampling techniques based on probability proportional to size (PPS). The lists of the household have been taken from the village administration which is used as sampling frame. A total of 351 households were included in the study as determined based on simplified formula by Yemane (1967) provided below, at 95% confidence level, 0.5 degree of variability and 5% level of precision as in the formula below:

$$n = \frac{N}{1+N\,(e)^2}$$

$$n = \frac{\mathbf{2841}}{1+\mathbf{2841}\,(0.05)^2} = \frac{2841}{8.1025} = 351$$

Where *N* designates total number of households in the Kebele, *n* is the required sample size and e is margin of error 5% (0.05).

Table 3.1: The target population and sample size

No,	Focus area	Target population (HH)	Proportion	Sample size (HH)
1	Pastoral Kebele (Deka)	1124	39.6	139
2	Agro-Pastoral Kebele (Alasabolo)	1717	60.4	212
	Total	**2841**	**100**	**351**

3.6 Method of Data Analysis

The survey data were analysed using descriptive and inferential (Econometrics analysis) methods. Descriptive statistics such as mean, proportion, percentage and frequencies were used to summarize the data with cross tabulation. Regarding econometric model, multinomial ordered logit model was applied to analyzed the determinants of household diversification status. The analysis of econometric model was included estimation of coefficient of the explanatory

variables that affected the level of livelihood diversification and estimation the marginal value of each explanatory variables to shows by how much degree influenced. The effect of diversification on vulnerability of the households was analysed using the principal component analysis (PCA). The livelihood Asset classified, and each asset components index calculated with mean value to compare the dominant components of the asset pentagons with graphical presentations following the explanation on the implication of reducing livelihood vulnerability. Furthermore, the level of livelihood diversification measured using the Simpson index diversity (SID). To analysis the data STATA version 14.1 software was used to process the statistical output of the research result.

3.7 Model specification

Both Probit and Logit analyses are well-established approaches in the literature for estimating dummy-dependent variables (Babalola & Aduba, 2014). However, when there are many observations at the extremes of the distribution, logit is preferred over probit, and the logit model is computationally easier to use than the other type. Because, the pobit model used for normally distributed computation and probit is more sensitive error terms with different probability assumptions, while the logit model used for likelihood ods ratio that can be used for ordered outcomes with suitable for ranked livelihood strategies. Therefore, in this study it is used a multiple logit model in this study. A model specification for livelihood diversification typically includes a dependent variable representing the level of livelihood diversification (often categorized as low, moderate, or high) and independent variables like household demographics, access to assets (land, capital, education), market access, exposure to shocks, government policies, and environmental factors, often analyzed using a multinomial logistic regression model to understand the probability of choosing different diversification strategies based on these factors. There are different methods of estimating household livelihood diversification, such as the Simpsons Index of Diversity (SID, Herfindahl, Gibbs, and Martin's indexes, however the Simpsons Index of Diversity (SID) is best to show the share of non-farm livelihood income in total household income (Khatun and Roy 2012).

3.7.1 Determinates of Livelihood Diversification

Choice of livelihood index depends on the specific objective and data structure. The most commonly preferred and used type of indexes were the Shannon Diversity Index (SHI'), Simpson diversity index (SID), Margalef's diversity index (MDI), Berger-Parker Dominance Index (BDI) and Pielou's Evenness Index (PEI). When measuring the determinants of livelihood diversification and vulnerability, a diversity index must reflect not only the number of different livelihood strategies employed by households but also the distribution of reliance on livelihood strategies. Some of the index measurement oversight and oversimplify the complexity of livelihood systems by focusing too much on dominance or richness without considering the broader distribution of strategies. In this regard the most commonly used diversification index in most literature was Shannon Diversity Index (SHI') and Simpson diversity index (SID). Accordingly, in this study Simpson index of diversity was considered as the most appropriate in terms of the nature of pastoralist and agro-pastoralist dominancy of livelihoods in context. The Simpson's Index tends to emphasize dominant strategies and minimize the value of significance of less frequent strategies. It is simple, robust and widely applicable index (Khatun and Roy 2012). Mathematically, It expressed as:

$$SID = 1 - \sum_{i=1}^{N} p_i^{\,2} \quad \ldots\ldots 1$$

Where P_i as the proportion of income coming from source *i*. The value of SID ranges from 0 to 1. The Simpson index of diversity is affected by the number of income sources and the proportion of income from each source (balance). The more uniformly distributed in the income from each source, the SDI approaches to 1 (Saha and Baha 2010). The diversification status of the households was classified based on the rating given by Sahal and Baha (2010) low (0 to 0.38), medium (0.39 to 0.63) and high (above 0.63). A similar finding has been reported by Agyeman et al. (2014) and they found that farming households in Western Ghana have SID index value of 0.33 that is below the average level. Factors affecting the adoption of diversification level of the farmers should be carefully examined to increase the diversification level. Rahman and Akter (2014) suggested that investment in the development of rural infrastructure including road connectivity, market access, irrigation facility, access to education and training skills, women empowerment can be a viable way to promote rural household

diversification level. In addition, Khatiwada et al. (2017) and Gebreyesus (2016) also asserted a similar opinion along with recommending, reconstructing, landholding policy and increasing access to credit.

The target variable of this study, livelihood diversification status, is an ordinal categorical variable. Multinomial ordered logistic regression model, which is suitable for modeling with an ordered categorical dependent variable were used to identify and analyze the determinants of households' diversification status. As the study indicated by Agyeman et al 2014 and Gebreyesus (2016) in Gana and Ethiopia, the level of livelihood diversification is classified in four categories: 1) non-diversified, 2) Low diversified, 3.Moderately diversified and 4) highly diversified. In this study, a household is considered as diversified livelihood, when it has involved in a number of incomes earning economic activities in addition to pastoralism. Both the number of income sources and the distribution of income between different sources (income balance) measured the level of diversification by using Simpson's Index of Diversity (SID). This also mathematically expressed by Gujarati, D.N 2004 and Green 2012 as follow.

$$y_1 * = x_i \beta + \varepsilon_i \quad \ldots\ldots 2$$

Where y_{i*}= the unobserved latent variable measures diversification status with four levels in increasing diversification level, coded as 1= non-diversified, 2. Low diversified, 3= moderately diversified and 4= highly diversified; x_i= vector of observed non-random explanatory variables assessing the attributes of diversification status; and ε_1= a random error term with mean 0 and variance 1. Hence, the pastoralist and agro-pastoralist participated in different livelihood strategies ordered as a polytomous response that takes value.

Y (1) if the household choice of livelihood strategy is on-farm alone activity such as Livestock and/or crop livelihood option considered as no diversified.

Y (2) if the household's choice of livelihood strategy is on-farm and non-farm with having two to three livelihood options such as livestock and/or crop plus small non-farm business is considered low diversified.

Y (3) if the household's choice of livelihood strategy is on-farm, non-farm and off-farm having four to six livelihood options such as Livestock/crop, small business, non-farm wage, agricultural wage, livestock trading, handcraft) is considered as medium diversified.

Y (4) if the household's choice of livelihood strategy is a combination of on-farm, non-farm, off-farm and other sources having seven and above livelihood options is considered as highly diversified (all combination of above plus income sources from remittance, public work/direct cash and support in kind/in finance) is considered as high diversified.

Mathematically, it is expressed y estimate as y* is as specified:

$$\left.\begin{array}{l} y_i = 1\ if\ y^* \leq \mu 1 \\ y_i = 2\ if\ \mu 1 < {y_i}^* \leq \mu 2 \\ yi = 3\ if\ \mu 2\ < y_i^*\ \leq \mu 3 \\ yi = 4\ if\ \mu 3\ < y_i^*\ \leq\ \ \mu 4 \end{array}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where μ_i's represent the thresholds or cut points to be projected (along with the parameter vector β). For the estimated cut-off points, μ follows the order $\mu_1 < \mu_2 < \mu_3 < \mu_4$. Taking the value of 4 if the household is highly diversified, 3 if the household is moderately diversified, 2 if the household diversified low and 1 if the household is non-diversified, the implied probabilities are obtained as:

$$\left.\begin{array}{l} Pr[y_i = 1|x_i] =]\Phi(-x_i\beta) \\ Pr[y_i = 2|x_i] = \Phi(\mu 1 - x_i\beta) - \Phi(\mu 2 - x_i\beta) \\ Pr[y_i = 3|x_i] = 1 - \Phi(\mu 2 - x_i\beta) \\ \Pr\ [yi = 4|xi] = 1 - \Phi(\mu 3 - x_i\beta) \end{array}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

The parameters of the model specified in equations 4 are estimated using the maximum likelihood method. However, there is lack of clarity in interpreting the coefficients of the model. For example, there are three categories of the diversification variables while the model has only one unknown threshold parameter (Greene, 2012). This necessitates for the partial change or marginal effect, which can reveal the effects of independent variables on the probability of three different levels of diversifications individually. A partial change in the predicted probability of the outcome *m*, for continuous variable, in the interval μ_{m-1} to μ*m* for a change in an explanatory variable x_k at the mean value is specified as Equation 5.

$$\frac{\delta pr(y={}^{m}/_{\bar{x}})}{\delta x} = \beta_k[f(\mu_{m-1} - \bar{x}\beta) - f(\mu_m - \bar{x}\beta)] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

On the other hand, the change in x_k the predicted probability for a discrete change in from initial value x_s to the end value (e.g. a change from x =0 to $x=1$) is given by Equation 6:

$$\frac{\Delta pr(y={}^{m}/_{\bar{x}})}{\Delta x_k} = p_r\left(y = {}^{m}/_{x}, x_k = x_E\right) - p_r\left(y = {}^{m}/_{x}, x_k = x_S\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Where $p_r\left(y = {}^{m}/_{x}, x_k\right)$ states the probability that $y = m$ given x, stating a value for x_k. Thus, when x_k changes from for x_S to for x_E, the predicted probability of outcome, m changes by $\frac{\Delta pr(y={}^{m}/_{\bar{x}})}{\Delta x_k}$, holding all variables at x.

The model involves categorical ordered dependent variable, diversification status, taking the value 1, 2, 3 and 4 where the status is non-diversified, Low diversified, moderately diversified, and highly diversified, respectively. The independent variables are listed in section (3.7.2).

3.7.2 Description of Variables for determinants of livelihood diversification

Independent variables: The independent variables of this study were sex of household head, age of household head, marital status of the household, family size, dependency ratio, education level of household head, livestock holding, size of farm land, market distance, access to training, access to information, access to veterinary services, membership of cooperative, frequency of extension visits, total household income, access to credit, livelihood support and exposure to shocks were the explanatory variables hypothesized as a factor to determine pastoralists and agro-pastoralists decision to participate in different livelihood diversification is explained as follows.

Sex of household: It often indicates that the "sex of the household head" (whether the household is headed by a male or female) is a significant factor influencing livelihood diversification, with male-headed households generally showing a higher tendency to diversify their livelihoods compared to female-headed households, often due to factors like access to resources and social norms that can limit women's participation in certain economic activities; this means that the gender of the household head can play a crucial role in determining the level of livelihood diversification a household undertakes (Ambachew, 2016).

Age of household: as the age of household head increased, the farmer will be getting older and could not be capable of diversifying and more likely to concentrate on-farm activities for their

subsistence. According to Asfir (2016), age affects livelihood diversification negatively since old farmers were well established, more experienced in agricultural production, more resistant to new ideas and information hence less likely to diversify their livelihood.

Household size: due to the presence of large families to practice multiple activities as a household laborer to diversify their livelihood strategies. Family size is expected to have positive effect on livelihood diversification strategies (Melese et al, 2018).

Dependency ratio: It determines the participation of individuals in the labor market, the expenditure and investment in the social sector. The existence of a large number of children below 15 ages and above 65 ages of the households could affect livelihood negatively. Children may necessitate greater income to support their basic needs and elders also need greater labor than contributing directly to the productive role (Desalegn, 2016).

Marital status: The martial status of household heads expected to have the combined income sources and support each other's and most of the time, the female headed households had a better engagement in non-farm activities selling of local drink and cooked food. While male household head have observed to choose Agriculture and off-farm activity diversification to fulfill basic need of the house. Hence, the combined effects of livelihood show that marriage has a positive effect on livelihood diversification strategies (Sintayehu, and Belayneh, 2017).

Education level: education level influenced positively the household's livelihood diversification, since they may have better skilled (Asenake, 2010). Households those having primary education, secondary education, and other education diversify their income greater than as compared to household head those households without any level of education (Yishak et al., 2014).This is probably because school education increases the human capital levels and provides the necessary skills which enable the entry into more non-farm wage labor or self-employment and increasing the productivity of agricultural sector which will be invested in any other income generating activities (Tariku, 2019).

Membership to cooperatives: it represents whether household head is members to cooperatives or not. Being members in the informal associations, such as indigenous cooperation groups, enforcing widely agreed standards of behavior, and uniting people with bonds of community solidarity and mutual assistance (Yishak et al. 2014). This variable was expected to be positively

related to livelihood diversification and means for obtaining different employment opportunities (Asfir, 2016).

Access to training: Its dummy variable taking value 1 if the household participated in training and otherwise zero. The exposure to different GO and NGOs training program and orientation helps the pastoral household to have better understanding about non pastoral activities (Wassie and Fikadu, 2015). Pastoralists' and agro-pastoralists participation in organized orientation programs is significantly associated with private land enclosures for dry land farming, and for the double purpose of cereal cultivation and fodder production (Geremew et al,2017).

Land size: land size is the basic asset for the majority of rural livelihoods. Farm households having more farm land size were forced to follow agricultural intensification rather than diversification (Yizengaw et al, 2015). Farm land size is hypothesized negatively impact on livelihood diversification strategies.

Access to credit: access of credit is one of the important institutional factors that have a positive effect on livelihood diversification. Hence, providing credit for resource poor farmers will enhance livelihood diversification (Adugna and Wagayehu, 2012).

Numbers of livestock (in Tropical livestock units): this is one of the determinant factors and a negative effect on livelihood diversification. Hence farmers with a large number of livestock in tropical livestock units were less likely to diversify livelihood than those who own small number of TLUs due to better opportunity to earn more income from livestock production (Asfir, 2016). However, as cited by Adugna and Wagayehu (2012), indicated that, having more livestock will make households to diversified more and generate more incomes due to the fact that, it provides more options to have alternative livelihood options.

Access to Information: Access to Information is having Mobile, Radio and other means of information sources to any agricultural and non-agricultural activities will lead to increase to aware for their productive asset on pastoral and agro-pastoral activities (Adugna and Wagayehu, 2012).

Total annual income: Affects household livelihood diversification positively. Therefore, households having large cash income were more likely to diversify livelihood into non/off-farm activity (Wondim, 2018) and also indicated a study by Yizengaw et al. (2015).

Consumption expenditure: it is a continuous explanatory variable and hypothesized with a negative impact. As the consumption pattern of households increase, the income spend for investment will be less and household will face challenges to diversify their livelihoods.

Market distance: market distance negatively affected households' income diversification activity. As market distance increase from home, farmer's non/off-farm income diversification will be discouraged (Yenesew, and Fekadu, 2015). Households having near market possibility to selling out their labor to the nearest market maximize their income and to smooth their annual consumption during the slack crop production period, promote rural-urban linkage and develop the entrepreneurial skill of farm households to diversify their livelihood (Weldegebrial, 2018).

Livelihood Support: Livelihood support is a dummy variable expected to have a positive impact on the livelihood diversification. Support by government, non-government and local institutions will provide strength for pastoralists and agro-pastoralists (Wassie and Fikadu, 2015).

Number of available livelihoods: It is a discrete variable which hypothesized as a positive impact in which the livelihood diversification opportunity creates and motivate households to engage other than primary livelihood incomes. The major available livelihood strategies categorized and leveled as: 1) Primary livelihood (Livestock & Farming), 2) Off-farm which include livestock & crop trade, pack animal renting, 3) Non-farm livelihood activity including petty trading, labor employment, sales of fire wood & self-employment and 4) Other livelihood activities such as Public work cash for work and food for work.

Frequency of Extension service visit: Access to enough extension services endows them with different information, knowledge, and skill about confrontation and prospects of diversified livelihood strategies (Adugna and Wagayehu, 2012). It has a positive impact on livelihood strategies. Because the extension services are an important source of information on pastoral and agro-pastoral main livelihood practices.

Exposure to Shocks: Another variable is the shock (the natural incidence) that comprises Drought, livestock disease out breaks, illness and flooding during the household's productive season (Mengistu, 2016). It hypothesized with a negative impact on income diversification (Ferede, 2023). Exposure to shocks makes the households more vulnerable to lose their existing livelihoods and will be less adaptation to alternative activities (Ayalew and Tesfaye, 2012).

Distance to Veterinary Services: It is a continuous variable which measured in walking hours from the residence of the households and hypothesized to have negative impact in livelihood diversification because of it takes the time of the households who engage in other livelihoods rather than waste their productive time to access for livestock health services (Zigale, 2016).

Table 3.2: Description of explanatory variables

S.N	Variables Description	Code	Variables Characters		Expected sign
1	Sex	SEX	Dummy	1. Female 2. Male	-/+
2	Age	AGE	Continuous	Number of Years	-/+
3	Marital Status	MAS	Categorical	1=single 2=married 3=divorced 4=widowed	+
4	Family Size	FSZ	Continuous	Number of family members	+/-
5	Dependency ratio	DER	Continuous	Number of dependents and total family size ratio	-
6	Level of education	LED	Continuous	Level of Education	+
7	Membership	MBS	Dummy	0.No, 1. Yes	+
8	Land Size	LAS	Continuous	Cultivated land in Hectare	-
9	Livelihood Support	LVS	Dummy	0.No, 1. Yes	+
10	Access to training	ACT	Dummy	0.No, 1. Yes	+
11	Access to credit	ACC	Dummy	0.No, 1. Yes	+
12	Access to Information	ACIF	Dummy	0.No, 1. Yes	+
13	Annual Income	AIM	Continuous	Income per year/ETB	+/-
14	Consumption expenditure	CEP	Continuous	Consumption expenditure/year/ETB	-
15	Total Livestock Unit	TLU	Continuous	Tropical Livestock Unit	-
16	Number of livelihood options	NLV	Discrete	1. Livestock and crop 2. Off-farm 3. Non-Farm 4. Others (Remittance//direct support)	+
17	Distance to Market	DTM	Continuous	Walk-in hours	-
18	Frequency of Extension service visit	EXS	Continuous	Frequency of visits/Month	+
19	Exposure to Shocks	ETS	Dummy	0.No, 1. Yes	-
20	Access to Veterinary services	ACVS	Continuous	Walk-in hours	-

3.7.3 Effects of livelihood diversification on Vulnerability

In this study, vulnerability assessment index developed by the IPCC (2012) used to employ for the estimation of household vulnerability. This index is in line with and based on the integrated approach to vulnerability assessment. The index is specified in below:

Vulnerability = (Adaptive capacity) − (Sensitivity +Exposure) ……..…….……7

When the adaptive capacity of the household exceeds that of its sensitivity and exposure, the household becomes less vulnerable to any shock and the reverse is also true otherwise. Each set (adaptive capacity, sensitivity and exposure) is composed of different variables. In this study exposure is common to all households since the biophysical environment where the respondent dwell is spatially similar. Sensitivity analysis represents by shock related impacts such as, shortage of food, loss of water and pasture resources and conflicts faced by those households. When it comes to adaptive capacity, it represents by household's access and possession of the five types of capitals in the sustainable livelihood framework (Human capital (H), natural capital (N), social capital (S), physical capital (P) and financial capital (F). Based on this, it is mathematically specified as:

$$V_i = (A_1X_{1J} + A_2X_{2J} + \cdots + A_{2n}X_{nJ}) - (A_{n+1}Y_{1J} + A_{n+2}Y_{2J} + \cdots + A_{n+n}X_{nJ}) \text{……..8}$$

Where V_i is the vulnerability index, while X_s are elements of adaptive capacity, and Y_s are elements of exposure and sensitivity. The values of X and Y are obtained by normalization using their mean and standard errors. If $X_{IJ} = \left(X_{IJ} - X_{1*}\right)/S_{1*}$ where X_{1j*} is the mean of X_{1j} across the different households, and S_1* is its standard deviation. X_1 is the principal component result of factors. In this regard, the first principal component of a set of variables is the linear index of all the variables that captures the largest amount of information common to all the variables. The whole matrix of variables of adaptive capacity (X_{ij}) and variables of exposure and sensitivity (Y_{ij}) appears as follows:

$$X_{ij}\Big/Y_{ij} = \begin{pmatrix} (X_{11} + X_{12} + \cdots + X_{2n}) - (Y_{11} + Y_{12} + \cdots + Y_{2n}) \\ (X_{m1} + X_{m2} + \cdots + X_{mn}) - (Y_{m1} + Y_{m2} + \cdots + Y_{mn}) \end{pmatrix} \text{……9}$$

In Equation 10, the A's is the first component score of each variable computed using principal component analysis (PCA) in STATA. Finally, the vulnerability index of each household is obtained using Equation 10 as follows:

$$V_i = \begin{pmatrix} A_1 \\ A_{12} \\ \vdots \\ A_{n+n} \end{pmatrix} \times \begin{pmatrix} (X_{11} + X_{12} + \cdots + X_{2n}) - (Y_{11} + Y_{12} + \cdots + Y_{2n}) \\ (X_{m1} + X_{m2} + \cdots + X_{mn}) - (Y_{m1} + Y_{m2} + \cdots + Y_{mn}) \end{pmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots 10$$

In calculating the direction of relationship in vulnerability indicators, a negative value assigned to both exposure and sensitivity. The justification is that households which are highly exposed to climate shocks are more sensitive to damage, assuming constant adaptive capacity. The implication is that a higher net value indicates lesser vulnerability and vice versa. However, in creating the indices, the scale of analysis is important. In this study, the households are classified into four categories based on the value of their vulnerability index, which puts households into Very high, high, Moderate and low vulnerable categories. However, the index computed is not based on the thresholds or presents an absolute value. It is a relative measure, representing the households' own perception of how they have been coping in the past compared to other households.

According to the recent study by Sekhri, et al. (2020), the level of livelihood vulnerability is categorized with ordinal scale as (1) Very highly vulnerable ($0.6 \leq \text{LVI} \leq 1$) which implies households for whom the difference between adaptive capacity and sensitivity/exposure is significantly negative; (2) highly vulnerable ($0.2 \leq \text{LVI} < 0.6$), which means that households for whom the difference between adaptive capacity and sensitivity/exposure is between 0.2 and 0.06; (3) Moderately vulnerable ($-0.2 \leq \text{LVI} < 0.2$) which means that the difference between adaptive capacity and exposure/sensitivity is between -0.2 and 0.2. The last cut-off LVI indicator is low vulnerability ranging from ($-1 \leq \text{LVI} < -0.2$).

Mathematically, following Greene (1997), the reduced form of the ordinal logit model is given as:

$$Y_j^* = X_j^I \beta + U_{Ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots 11$$

where *Y* is the level of vulnerability and involves ordered outcome, that is, $Y = 1$ is given to households that have a high level of vulnerability as observed by the negative value of adaptive capacity minus sensitivity/exposure; $Y = 2$ is given to households having adaptive capacity nearly equal to their sensitivity/exposure; and $Y = 3$ is given to households having their adaptive capacity exceeding their sensitivity and exposure. Y^* is the given state of vulnerability.

$$\left.\begin{array}{l} Y = 1\ if Y^* \leq \mu 2 \\ Y = 2\ if\ \mu 2 < Y^* \leq \mu 3 \\ Y = 3\ if \mu 3 < Y^* \end{array}\right] \ldots\ldots 12$$

Given the cumulative normal function$\Phi(\beta' x)$, the probabilities can be shown, thus,

$$\left.\begin{array}{l} Pr[y = 1\ or\ highly\ vulnerable] = \Phi(-\beta' x) \\ Pr[y = 2\ or\ neutral\ level\ of\ vulnerable] = \Phi(\mu 2 - \beta' x) - \Phi(\mu 3 - \beta' x) \\ Pr[y = 3\ or\ less\ vulnerable = 1 - \Phi(\mu 3 - \beta' x)] \end{array}\right] \ldots\ldots 13$$

Chapter Four: Result and Discussion

4.1 Result and discussion of descriptive statistics

This section focused by describing the participation of households in livelihood activities followed by presenting the livelihood clusters used by Pastoral and Agro-pastoral households before analyzing the Level, determinants, challenges and effects of livelihood diversification. The first section described the demographic characteristics of households along with its pastoral and agro-pastoral livelihood asset characteristics. The second section analysis deals with Livelihood strategy and Income composition of pastoral and Agro-pastoralists. The third section of this focussed the level of livelihood diversification status. Section four examines the determinants of livelihood diversification. The fifth section shows analysis of the livelihood diversification implication to the vulnerability of pastoral and Agro-pastoralists. The six section presents challenges of livelihood diversification. The final section analysed the adaption/coping strategies to reduce vulnerability from shocks and stress.

4.1.1 Demographic and Socio-economic characteristics

Sex of household head: Most survey respondents (both pastoralist and agro-pastoralists) were male which accounts 51.08 percent pastoralist and 51.42 percent agro-pastoralist, whereas 48.92 and 48.58 percent were female pastoralist and agro-pastoralist respectively. As indicated on table 4.1, the findings of the study show 29.5% male households and 25.18% female households were moderately diversified their livelihoods with having four to six livelihood options in pastoralists, while 30.66% of male and 25.45% of female agro-pastoralists were moderately diversified with four to six livelihood options. Only 10.07 and 7.91 percent of male and female pastoralists were highly diversified their livelihood respectively with seven and above livelihood options, while 9.4 of male and 10.08 of female agro-pastoralists were highly diversified with same livelihood options. This implies that, moderately diversified women tend to move into petty trade, hand craft from local material, selling of livestock products, selling of charcoal and firewood as livelihood income sources, in addition to primary livelihood economic activities (livestock and crop). Conversely, men frequently engage in livestock trading, rent pack animals, and self-employment, employed in construction work, take advantage of comparatively more waged employment than women. However, in this study being male and female have almost similar livelihood

diversification participation as shown in table 4.1 of below as female has almost similar contribution to the livelihood diversification with male.

Marital Status: The results of the survey indicates; married households were 76.26 for pastoralist and 81.60 percent of for agro-pastoralist respectively. Only 16.55 and 15.09 percent of them were unmarried respectively. According to perceived response of the respondents being married has a probability of creating more livelihood opportunities and sustainable life settlement and supported by also religions. This is evidenced and shown in table 4.1 below as 41.0 of married pastoralists and 44.8 of married agro-pastoralists were moderately diversified their livelihoods, whereas 15.1 pastoralists and 16.9 agro pastoralists married pastoralists were highly diversified. It is true that, being married households have more diversified than unmarried, widowed and divorced households. The implication is having shared responsibility and division of labor contributed for more livelihood choices and access to resources.

Table 4 1: Sex and Martial Status of Respondents

Categorical Variables	Level of Diversification (Pastoralist)						Level of Diversification (Agro-Pastoralist)				
	Total	High	Moderately	Low	No		Total share	High	Moderately	Low	No
Sex: 1. Male	51.13	14 (10.07)	41 (29.5)	13 (9.35)	3 (2.16)		51.49	20 (9.4)	65(30.66)	22 (10.4)	2(0.94)
2. Female	48.87	11 (7.91)	35(25.18)	18 (12.9)	4 (2.88)		48.51	23 (10.8)	54(25.47)	24(11.3)	2(0.94)
Marital Status											
Married	76.26	21(15.1)	57(41.0)	24(17.2)	4(2.88)		81.6	36(16.9)	95(44.81)	37(17.4)	4(1.89)
Unmarried	16.55	2(1.44)	14(10.0)	5(3.6)	2(1.44)		15.09	6(2.83)	16(7.55)	7(3.3)	0
Widowed	4.32	1(0.72)	2(1.44)	1(0.72)	0		2.83	1(0.47)	6(2.83)	0	0
Divorced	2.88	21(15.1)	57(41.0)	24(17.2)	4(2.88)		0.47	0	2(0.94)	2(0.94)	0

Sources: Survey result (2024)

Being membership: As the survey result shows being membership is one the contributed factor to livelihood opportunities on pastoral and agro-pastoralists. Accordingly, 51.80 of pastoralists and 51.42 of agro-pastoralism have members of cooperatives for their livelihood activities. As described in table 4.2 of below, from being membership households' 28.78 pastoralists and 24.53 agro-pastoralist were moderately diversified and 9.35 of pastoralist and 12.30 of agro-pastoralists were highly diversified. Hence memberships have positive contribution to livelihood options. It is also confirmed with the perceived response of KII as:

"Ato Ahemed Mohammed, one of the agro-pastoralists said that "being memberships in local community and as a member of cooperatives benefited to have real-time market information, obtained initial capital, share experiences in livestock and agricultural practices, support

each other's to reduce the negative effects of shock in addition to strength social bond to engage in alternative livelihood options" (KII,2024).

Access to Training: Provided training services for different livelihood options have positive contribution. It implies that increased training access to household heads increases the likelihood of engaging in different livelihood activities. The exposure to different Government and Non-government training program supported the pastoralists and agro-pastoralists households to have better understanding in livelihood options in addition to primary economic activities. In the study area, while there is low level of training (32.37 % pastoralist and 27.83% agro-pastoralists), held by local government and Non-government institutions, those who took training have better livelihood engagement and options which implies provision of training contributed and develop awareness for pastoralists and agro-pastoralists who participated in livelihood support training.

Access to information: Information is vital for their livelihood activities on market, agricultural and livestock production, processing, health and others daily lives. The survey study indicated 52.51 of pastoralists and 54.72 of agro-pastoralists have access to information using radio and mobile channels. From these, 28.78 % pastoralists and 28.30 % agro-pastoralist were moderately diversified their livelihood incomes. This implies households having more shared information related to livelihood options, marketing channel, current local economic situation and supporting technology have better opportunity to participate in different livelihood options which has association with the level of diversification. The more likelihood of the agro-pastoralists indicated that, they have more cooperation and local group formation that contribute in crop production, irrigation water uses association, improved seed and joint use pest management practices.

"According to the FGD discussant perceived information, having communication technologies such as mobile, radio and person to person shared information support them to access better information which benefit the community by having equally distributed market and other livelihood information and share for families, friends, and neighborhoods" (FGD discussion,2024).

Table 4.2: Descriptive statics of membership, training and access to information

Categorical Variables	Level of Diversification (Pastoralist)					Level of Diversification (Agro-Pastoralist)				
		High	Medium	Low	No		High	Medium	Low	No
Membership: Yes	51.80	13 (9.35)	40 (28.78)	14 (10.1)	5 (3.6)	51.42	26 (12.3)	52(24.53)	28 (13.2)	3(1.42)
No	48.20	12 (8.63)	36 (25.9)	17 (12.2)	2 (1.44)	48.58	17 (8.01)	67 (31.6)	18 (8.5)	1 (0.47)
Access to training: Yes	32.37	9 (6.47)	22(15.83)	12 (8.6)	2 (1.44)	27.83	14 (6.6)	37 (17.45)	7 (3.3)	1 (0.47)
No	67.63	16 (11.52)	54 (38.85)	19 (13.7)	5 (3.6)	72.17	29 (13.7)	82 (38.68)	39 (18.4)	3 (1.42)
Access to Information: Yes	52.51	12 (8.63)	40 (28.78)	16 (11.5)	5 (3.6)	54.72	30 (14.2)	60 (28.3)	24 (11.3)	2 (0.94)
No	47.49	13 (9.35)	36 (25.9)	15 (10.8)	2 (1.44)	45.28	13 (6.13)	59 (27.83)	22 (10.4)	2 (0.94)

Sources: Survey result (2024), * significant at 5% level

Access and amount of Credit: Access to credit facility and the amount of credit received increases the probability of Pastoralists and agro-pastoralists being expended to invest in their livelihood activities. Even though three-fourth of the sampled households were not participated in credit scheme, those who took credit in formal and informal institutions had better chance of livelihood diversification as responded by selected FGD discussant and KII of participants who explained as "having more credit access to households' leads to increase the level of their livelihoods". However, only 26.63 pastoralists and 28.77 agro-pastoralists were taking credit from relatives, friends and neighborhoods with average credit amount of 2345.32ETB and 1733.491ETB respectively.

"One of the respondent's W/zo Fatuma Ali stated that, "As a matter of faith, a Muslim cannot lend money to, or receive money from someone and expect to benefit interest (known as riba) is not allowed. To make money from money is forbidden. Wealth can only be generated through legitimate trade and investment in assets. Money must be used in a productive way".

Hence, keeping in mind the Muslim participants needs, the study aimed to find the best alternative with having credit access to us should be interest free.

Livelihood Support: The Livelihood Support Program (LSP) evolved from the belief that could have a greater impact on reducing vulnerability, poverty and livelihood insecurity, if its wealth of talent and experience were integrated into a more flexible and demand-responsive team approach. Immediate access to livelihoods supports and economic inclusion contributes in vital ways to

stabilization, and ensures livelihood security, improve resilience building and self-reliance for forcibly impacted pastoralist and agro-pastoralists. This study shows that, 64.76 percent of pastoralists and 59.43 percent of agro-pastoralists had livelihood support from government, non-government and local community institutions. However, the contribution of the provision of support aimed to have the households being moderately diversified in their livelihoods indicated 35.25 percent of pastoralists and 32.08 percent of agro-pastoralist and contributed 11.51 percent of pastoralists and 12.74 percent of agro-pastoralists were high level of diversification. This implies that, being agro-pastoralist have better livelihood support as they are engaged in crop production that demands input provision, irrigation support, and extension services than pastoralists.

The livelihood support includes grassroots actions with communities facilitated by GOs and NGOs in pastoral development programs and outreach in the case of the collective livestock production and product marketing, livestock health service facilities and pasture developments with livestock and agricultural extension services, input provision, direct cash support, cash for work, as well as the work of development-oriented local initiatives appreciated for the contribution of livelihood diversification.

Access to clean Water: Water development enables the provision of a vital resource to sustain humans, animals and plants in Ethiopia's arid areas. Pastoralism is the dominant form of livelihood in such areas. Water development in the Ethiopian pastoral dry lands of pastoralist and agro-pastoralist has always been a priority for humanitarian, development agencies and for governments. However, over the last decades, scientists have become an increasing concerned about the numerous adverse unforeseen effects of access to clean water policies. Owing to this, this study also shows only 46.75 pastoralists and 48.58 agro-pastoralist have access to clean water including with chemical treatment for drinking water and household consumptions. This result also supported by the qualitative theme expressed as:

"The majority of members of FGD discussant and KII, explained that the sources of water for their livelihood is from "Awash River" and off course, pastoralists understand the dynamics of rangelands and use water as a means to manage pasture. In the wet season, both water and pasture are abundant and easily available. As the rainy season subsides and water becomes scarce, livestock are moved to dry season grazing areas where water sources are more reliable, but forage is finite. This finite stock of forage must last until the next rains, requiring strict

management of water to limit the number of livestock allowed to graze" (FGD and KII Survey, 2024).

Table 4.3: Descriptive statics of access to credit, livelihood support and access to water

Categorical Variables	Level of Diversification (Pastoralist)					Level of Diversification (Agro-Pastoralist)				
	Perc	High	Medium	Low	No	Perc	High	Medium	Low	No
Access to credit: Yes	26.63	8 (5.76)	21 (15.11)	5 (3.6)	3 (2.16)	28.77	19 (8.96)	32 (15.09)	10 (4.72)	0
No	73.38	17 (12.23)	55 (39.57)	26 (18.7)	4 (2.88)	71.23	24 (11.32)	87 (41.04)	36 (17.0)	4 (1.89)
Livelihood Support: Yes	64.76	16 (11.51)	49 (35.25)	20 (14.4)	5 (3.6)	59.43	27 (12.74)	68 (32.08)	29 (13.7)	2 (0.94)
No	35.24	9 (6.47)	27 (19.42)	11 (7.91)	2 (1.44)	40.57	16 (7.55)	51 (24.06)	17 (8.02)	2 (0.94)
Access to Clean Water: Yes	46.75	10 (7.19)	34 (24.46)	17(12.23)	4 (2.88)	48.58	22 (10.38)	55 (25.94)	23 (10.8)	3 (1.42)
No	54.24	15 (10.79)	42 (30.22)	14 (10.07)	3 (3.16)	51.42	21 (9.91)	64 (30.19)	23 (10.9)	1 (0.47)

Sources: Survey result (2024)

4.1.2 Demographic and Socio-economic characteristics (Quantitative variables)

This section focused the quantitative Statistical description of (Discrete and continuous variables) which can take countable and an uncountable set of values in the survey study. The mean value, standard deviation, minimum and maximum value along with reference to pastoral and agro-pastoral livelihood diversification status are statistically described.

Age of Household heads: Age structure of both pastoralists and agro-pastoralists plays a fundamental role in household decision choice in the use of alternative livelihood choices. The mean age of the total sample households was found 40.42 years with standard deviation of 11.75 ranging from 23 to 82 years (Table 4.4). As study indicated that, the mean age of pastoralists is 38.10 years, while the mean age of Agro-pastoralists is 41.93 years with 7.69 and 13.59 standard deviation respectively. The majority of the study participants were within the productive age groups and only few of them were beyond age of 65. This implies households within the range of productive age and having more life experience take an opportunity to engage in different economics activities and increase their livelihood options.

Number of dependents and total family size ratio: The mean of households' family size was 5.20 pastoralists and 4.89 for agro-pastoralists respectively. The overall mean of the family size

was 5.01 with deviation 0.97 which is similar to the national average household size. From these, the mean of dependency ratio ranging from 0 to 14 years age and greater than the age of 65 years was 0.39 and 0.42 for pastoralist and agro-pastoralists. This implies, the households having more dependent family with less opportunity to participate in more livelihood options.

> *"From the focus group discussion perceived response, having large household size is an opportunity to participate in various livelihood diversification activities due to the availability of more labor in the households. Moreover, those who had no children and old in age were found to be economically low since they do not have enough labor to involve in various activities and increase sources of livelihood activities. Therefore, large households' size was found to be one of the push factors for the households of pastoral and agro-pastoral in surrounding area to involve in diversification activities".*

Cultivated land Size: The result of the survey study shown that, agro-pastoralists has an average of 0.97 hectares of land with a deviation of 0.25 hectares ranging from minimum of 0.75hacrates and maximum of 1.50 hectares. Nearly, the majority of agro-pastoralists have more irrigable lands than non-irrigable lands. Because of the location is nearby Awash River. The variation of land size among villages can be attributed to different factors, which include availability of land which is suitable for farming and community size of the areas.

Tropical Livestock Unit: Livestock holding is found to have a significant contribution being diversifying their livelihood away from pure pastoralism. Households who can get the required amount of food from livestock may not engage in another income generating activities unless their objective is to increase their asset holding while households with a smaller number of livestock try to diversify their income portfolio. The study shows that, the mean value of pastoralists livestock holding was 15.11 units while the agro-pastoralists was 10.58 units with a standard deviation of 12.03 and 6.76 units respectively. This implies, pastoralists have more units of livestock than agro-pastoralists which was considered as their primary livelihood.

Table 4.4: Descriptive statics of Age, Family size, dependency ration, Land size, Livestock unit

Pastoralists					**Agro-Pastoralists**			
Continuous Variables	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Age	38.10	7.69	23.00	60.00	41.93	13.59	23.00	82.00
Family Size	5.20	0.85	2.00	6.00	4.89	1.02	2.00	6.00

Dependency Ratio	0.39	0.18	0.00	0.75		0.42	0.21	0.00	0.80
Land Size	0.00	0.00	0.00	0.00		0.97	0.25	0.75	1.50
Total Livestock Unit	15.11	12.03	0.18	62.03		10.58	6.76	0.30	27.87

Sources: Survey result (2024)

Livelihood Sources: Although pastoralists have undergone tremendous livelihood transitions, livestock have always been the main medium of livelihood sources by which pastoral households rely on ecosystem services and the main source of income. Crop production, livestock and livestock trading, renting pack animals and handicrafts are natural resource-based livelihoods, while the others petty trading and self-employed are non-natural resource-based. Wage labor, salaried jobs, skill non-farm jobs, and remittance involves temporary out-migration by the male members of the households.

The findings elucidate in table 4.5 presented the livelihood choices among pastoralists and agro-pastoralists living in Afambo woreda of Afar region. Although pastoralism traditionally has been the major economic activity for pastoral whose households specializing in livestock have lower incomes than those who practice farming or combine livestock and crop farming. Thus, the mean value of the number of livelihood options for pastoralists was 4.85 while agro-pastoralists was 5.76 respectively. This implies 48 percent of pastoralists have nearly 5 livelihood options and 58 percent of agro-pastoralists have nearly 6 livelihood options with better income sources.

Total Annual Income: The total annual income of the households has also been positively and significantly associated with engaging the combination of different livelihood activities. The mean income value of the pastoralists was 42,495ETB, while the mean income value of Agro-pastoralist was 52,868 ETB with nearly standard deviation of 13,711 ETB and 13,274 ETB respectively. This implies that, the mean income of agro-pastoralists has better than the mean income of pastoralists because, the agro-pastoralists have additional crop income sources and the number of participants is higher. The minimum annual income of pastoralist was 12,500 ETB and the maximum income was 65,500 ETB and the minimum income of agro-pastoralists was 13,700 ETB, While the maximum was 70,800 ETB. It shows that both pastoralist and agro-pastoralist with more annual cash income is more likely to diversify their livelihood of activities. It is noted that households with having participated in different livelihood options by combining on Farm+off-farm + off-farm and other direct support activities increase the level of income.

Consumption and health expenditure: From the total incomes the mean of consumption expenditure for pastoralists was 32598 ETB, similarly the mean of consumption expenditure for agro-pastoralist was 32338 ETB. This implies majority of the study participants spend their annual income for household consumption resulted less likely to reinvest for their livelihoods. In the meantime, they spent an average of 6983 and 5320 ETB for health expenditure.

Estimated livestock and crop lose: Both pastoralists and agro-pastoralist were losing an average of 14,889 and 12,717 ETB from livestock death due to drought and diseases. While, agro-pastoralists also faced an average of 4,533 ETB lose from crop production due to drought and pest infestations. This implies there was climate shocks and variability that impact livelihood of the households and challenging to depend only with primary livelihood income sources and an implication to seek households to other livelihood options.

Food Deficiency ratio/Year: The most indicative variables for less livelihood options and vulnerability of both pastoralist and agro-pastoralists was food shortage faced during the last one year. As indicated in table 4.5, households within the study area, the mean value of pastoralists with face food shortage was 6.7 months and for agro-pastoralists 6.42 months per year with ranging from 1 months to10 months. This implies households suffer food shortage almost more than half of the year and the livelihood diversification is not a choice rather than means of continued existence.

Table 4.5: Descriptive statics of Livelihood sources, income and consumption expenditure

	Pastoralists					Agro-Pastoralists			
Continuous Variables	**Mean**	**Std. Dev.**	**Min**	**Max**		**Mean**	**Std. Dev.**	**Min**	**Max**
Number of Livelihood Sources	4.85	1.45	1.00	8.00		5.76	1.34	1.00	8.00
Livelihood Proportion (ratio)	0.48	0.14	0.10	0.80		0.58	0.13	0.10	0.80
Annual Income (ETB)	42495	13711	12500	65500		52868	13274	13700	70800
Amount of Credit (ETB)	2345	3359	0.00	15000		1733	2595	0.00	15000
Consumption Expenditure (ETB)	32598	18094	10000	55000		32338	19171	10000	55000
Health Expenditure (ETB)	6983	7167	0.00	40000		5320	5997	0.00	40000
Estimated Livestock Loss (ETB)	14889	1632	11663	18115		12717	1241	10271	15163
Estimated Crop Loss (ETB)	0.00	0.00	0.00	0.00		4533	262	4017	5049
Food Deficient ratio/Year	6.70	2.58	1.00	10.00		6.42	2.90	1.00	10.00

Sources: Survey result (2024)

Distance to Market: Distance to markets decreased the probability of a household diversifying livelihood activities. The more the market have distance from their livelihood activities/residing area, the less to engaged in different activities as no chance a vailed the output to the market.

Reversely, the relationship could indicate that market access exposes households to other livelihood strategies. The study result shows the average distance in waking hours was 3.38 hours with standard deviation of 1.28 hours for pastoralists while 3.49 hours with standard deviation of 1.24 hours for Agro-pastoralists. This implies pastoralist and agro-pastoralists were travel long hours to access market to sell and buy their livestock, crop and other livelihood outputs. Hence creating market value chain, being membership for cooperative unions, government and non-governmental support for the provision and creating an opportunity to access marketing channel motivated the households to more participated in different livelihood options.

Distance to Animal Health Services: Animal health services: is crucial for pastoralists whose livelihood depend of livestock production. As indicated on survey result pastoralists and agro-pastoralists have access to animal health services with a mean walking hour of 0.44 & 0.37 with a standard deviation of 0.59 & 0.53 respectively. In the household interview schedule, both pastoralists and agro-pastoralists were asked about the market and animal health services contribution to livelihood diversification while they practiced. Accordingly, respondent replied that distance to good market; animal health access influences their cattle population productivity and other livelihood activities.

Extension Service Visit (frequency): According to the survey result, the average monthly frequency of access to Extension services was 1.5 times for pastoral and 1.67 times for agro-pastoralists per month. This implies there is low level of support by extension agents and less professional support resulted less likelihood to get livestock and crop production support in addition to have less support to engage households to participate on other livelihood income sources than primary livelihood options.

Distance to all weather-Road (hours): Access to road is one of the basic infrastructure facilities to facilitate livelihood options. The mean value of access to road in walk-in hours is 0.70 hours for pastoralist and 0.96 hours for agro-pastoralists with deviation of 1.06 and 1.26 respectively for each pastoral and agro-pastoral households. Road is one of the basic infrastructures that support the community to transport their livestock and agricultural products to the nearest market and reduced time wastage and energy to walk more distance with personal carriage to sell. Hence, the result shows low level of access to main roads by pastoralist and agro-pastoralists. It is believed to be that for each household not expected to access road, however at least the construction of main roads to the woreda and zonal town considered the majority of settled communities in the

surrounding study area which creating an opportunity of residing pastoralists and agro-pastoralist with access facilities for their livelihood trading activities.

According to the discussion from FGD, "access for basic services and infrastructures were their issue and frequent request for the local government while pastoral development program run and different NGO intervention introduced, however the focused for the last consecutive years were provision of humanitarian aid and provision of emergency reliefs support in the area due to recurrent drought, northern conflict impacts and the need for rehabilitation the existing damages".

Table 4.6: Descriptive statics of access for basic services and infrastructures

Pastoralists						Agro-Pastoralists			
Continuous Variables	**Mean**	**Std. Dev.**	**Min**	**Max**		**Mean**	**Std. Dev.**	**Min**	**Max**
Distance to Market (hours)	3.38	1.28	0.30	5.30		3.49	1.24	0.30	5.30
Distance from School (hours)	0.72	0.88	0.01	4.30		0.88	1.05	0.01	4.30
Distance to Health Services (hours)	0.38	0.58	0.01	2.00		0.39	0.61	0.01	2.00
Distance to Road (hours)	0.70	1.06	0.01	4.30		0.96	1.26	0.01	4.30
Distance to Veterinary Services (hours)	0.44	0.59	0.01	2.00		0.37	0.53	0.01	2.00
Extension Service Visit (frequency)	1.50	1.57	0.00	4.00		1.67	1.42	0.00	4.00

Sources: Survey result (2024)

4.2 Livelihood strategy and Income Composition

Livelihood strategies are the combination of activities that people undertake to survive and fulfill their livelihood requirements. In the study area, there are four types of livelihood diversification strategies that pastoralist and agro-pastoralists have adopted to achieve their livelihood outcome. Figure 4.1 presents the sources of livelihood activities adopted by the pastoral and agro-pastoral households to generate their annual income flow. In the district, the largest proportions of the livelihood sources solely engaged was in livestock production which accounts 52%. This implies majority of the household's income sources was sales of the primary agriculture livelihood activities, even though the contribution of crop production alone was low level (only 7.9%). The second most dominate livelihood support was receiving remittance which accounts with 11.1% of contribution whereas sales of fire wood and charcoal 8.3%, petty trading, casual labor and livestock trading almost equally contributed with 4.4%. The remaining livelihood sources were contributed less than 2.7%.

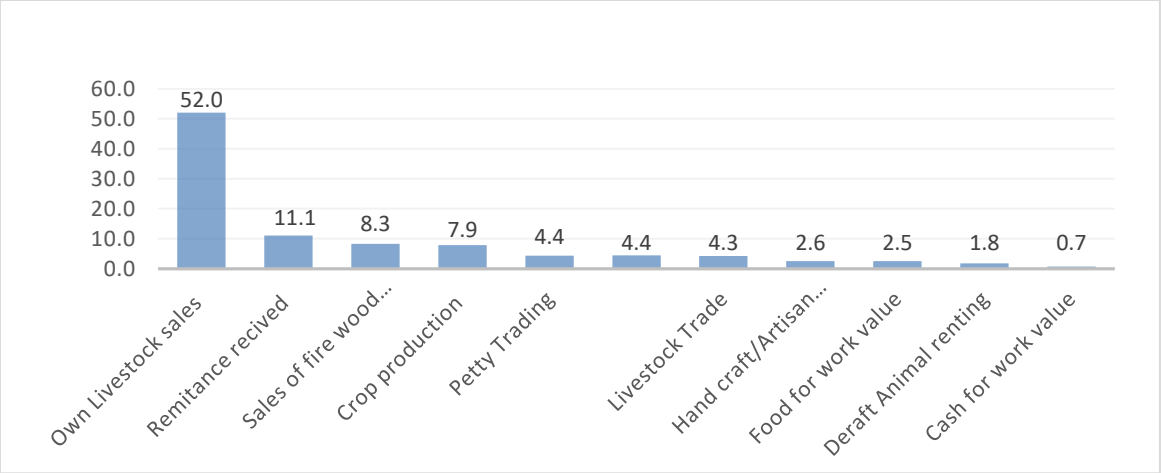


Figure 4 1. Figure 4.1 Sources of Livelihoods incomes

Coming to the results of the livelihood classification along with income sources and shares, the study shows the major dominate income sources of pastoralists and agro-pastoralist were sales of own livestock, livestock products and crop sales with annual income share of 56.03%. The mean income shares for livestock sales was 23,383 ETB for pastoralist while the mean income share of livestock and crop sales for agro-pastoralist was 29,899 ETB. This implies agro-pastoralists had better income sources than pastoralists due to the additional crop sales income. The second highest livelihood income sources are Non-farm incomes which covers 19.23% which generated from sales of fire wood and charcoal, petty trading and off-farm employment with a total mean income of 9,675 ETB for pastoralists and 9,180 ETB for Agro-pastoralists. The third livelihood income sources contributed 12.99% of share which generated from social SafetyNet (food for work and cash for work) and remittances with mean income of 3,691 ETB for pastoralists and 8,066 ETB for Agro-pastoralists. The fourth livelihood income sources were off-farm activities contributed 11.76% from total income with mean income of 5,747 ETB for pastoralists and 5,723 ETB for Agro-pastoralists. Summing-up, the study result indicated, the dominant livelihood options and income sources was the primary livelihood economic activities which cover more than half of the annual income share contribution. The total mean income of agro-pastoral households is higher than the mean income of pastoral households, because agro-pastoralists have additional livelihood options with crop production and diversification having a possibility of producing 2 to 3 times per annum using irrigation which has contribution to increase income share across the group.

Table 4.7: Share of Annual Income from Various Livelihood Economic Activities

Pastoralist					Agro-pastoralist			Total Income Share	
Sources of income	**Income (ETB)**	**% share**	**Mean**		**Income (ETB)**	**% share**	**Mean**	**Total Income share**	**Total % share**
On farm Income (Livestock +Crop)	**3,250,200**	**55.02**	**23,383**		**6,338,600**	**56.55**	**29,899**	**9,588,800**	**56.03**
Own Livestock sales	3,250,200	55.02	23,383		5,081,300	45.34	23,968	8,331,500	
Crop production sales	-	-	-		1,257,300	11.22	5,931	1,257,300	
Off-farm Income	**798,780**	**13.52**	**5,747**		**1,213,370**	**10.83**	**5,723**	**2,012,150**	**11.76**
Draft Animal renting	547,780	**9.27**	3,941		771,800	6.89	3,641	1,319,580	
Livestock Trade	251,000	4.25	1,806		441,570	3.94	2,083	692,570	
Non-farm Income	**1,344,876**	**22.77**	**9,675**		**1,946,190**	**17.36**	**9,180**	**3,291,066**	**19.23**
Sales of fire wood and charcoal	202,800	3.43	1,459		200,850	1.79	947	403,650	
Petty Trading	124,496	2.11	895.65		288,600	2.57	1,361	413,096	
Casual non-farm labor Employment	668,500	11.32	4809.4		1,100,400	9.82	5,191	1,768,900	
Self-employment	349,080	5.91	2511.4		356,340	3.18	1,681	705,420	
Other Incomes from Support	**513,000**	**8.68**	**3,691**		**1,709,905**	**15.26**	**8,066**	**2,222,905**	**12.99**
Remittance received	289,500	4.90	2082.7		393,000	3.51	1,854	682,500	
Food for work value	83,500	1.41	600.72		1,173,800	10.47	5,537	1,257,300	
Cash for work value	140,000	2.37	1,007		143,105	1.28	675	283,105	
Total Income	**5,906,856**	**100**	**42,495**		**11,208,065**	**100**	**52,868**	**17,114,921**	**100**

Sources: Survey result (2024)

4.3 Level of livelihood diversification status

The Simpson index of diversity computed to investigate the degree of livelihood diversification among the pastoralists and agro-pastoralists is shown in Table 4.8 which demonstrates the estimated results. The majority of pastoral and agro-pastoral households fall in the Medium level of diversification which cover 55.56 percent. The overall mean value of (0.579) diversity index also indicated a medium level of diversification across all households. This implies that, pastoralist and agro-pastoralist have four to six livelihood options to diversify their income sources with participated farm and off-farm activities. The high level of diversification index 19.37 % infers participated seven and more livelihood options to diversify households' income sources. The likelihood ratio indicated that there is a probability of 2.93 percent that households tend to move from lower level of diversification to the next level of diversification as referred the cut point of each category.

Table 4.8: Level of livelihood diversification

Level of Diversification	Agro-Pastoralist		Pastoralist		Total share	
	Count	Percentage	Count	Percentage	Count	Percentage
No diversified (<0.26)	4	1.89	7	5.04	11	3.13
Low diversified (0.26-0.49)	46	21.7	31	22.3	77	21.94
Moderate diversified (0.50-0.69)	119	56.13	76	54.68	195	55.56
High diversified (≥0.70)	43	20.28	25	17.99	68	19.37
Mean of SID	**0.579**					

Sources: Survey result (2024)

4.4 Determinants of livelihood diversification: Econometric Model Results

4.4.1 **Multicollinearity and degree of association**

As specified in the methodology part of this research, multinomial ordered logistic regression model was used to identify factors affecting livelihood diversification strategies in the study area. Under this section important variables such as demographic, socio-economic, institutional, infrastructure access and exposure to shocks characteristic which were hypothesized to influence the households' decision to participate into different livelihood diversification strategies are considered. The analysis was made by using; STATA 14.1 version. The hypothesized explanatory variables were tested for the existence of Independence of irrelevant alternative (IIA) and Multicollinearity.

Before conducting econometric analysis, it is vital to look into the problem of multicollinearity among the continuous explanatory variables and verify the degree of associations among dummy explanatory variables which otherwise, the parameter estimate would seriously be affected by the existence of multicollinearity among variables. To this end, the variance inflation factor (VIF) and contingency coefficients were used to test the degree of multicollinearity among the continuous variables and to check the degree of association among the discrete variables. The values of VIF for continuous variables were found to be small (i.e. VIF values less than 10). As a rule of thumb, if the VIF of a variable exceeds 10, that variable is said to be highly collinear (Gujarati, 2004). Based on the VIF result, in this study the mean value of the VIF is 1.41 with a maximum VIF value of 1.89 and minimum values of 1.06 which showed that there is no problem of multicollinearity among the variables in this study.

Table 4.9: Variance Inflation Factors

Continuous Variables	VIF	1/VIF
Family Size	1.89	0.531
Annual Income	1.60	0.628
Distance to Veterinary Services	1.57	0.638
Consumption Expenditure	1.57	0.637
Dependency ration	1.54	0.651
Distance to Market	1.38	0.725
Age	1.37	0.73
Land Size	1.28	0.780
Extension visit	1.22	0.817
Number of livelihood options	1.22	0.822
Tropical Livestock Units	1.14	0.878
Level of Education	1.06	0.940
Mean VIF	**1.41**	**0.732**

Source: Results of the econometrics estimation

Also, according to (Gujarati, 2004), contingency coefficient is a chi-square-based measure of association where a value 0.75 or above indicates a stronger relationship between explanatory variables. Accordingly, the results of the computation revealed that the maximum value of contingency coefficient was 0.45 indicating no serious problem of association among categorical explanatory variables.

Table 4.10: Contingency coefficient

Dummy Variables	Sex of Household Head	Marital Status	Membership	Access to Training	Access to Credit	Access to information	Exposure to Shocks
Sex of Household Head	1.00						
Marital Status	0.21	1.00					
Membership	0.31	0.25	1.00				
Access to Training	0.44	0.26	0.35	1.00			
Access to Credit	0.23	0.19	0.36	0.36	1.00		
Access to information	0.22	0.15	0.44	0.34	0.44	1.00	
Exposure to Shocks	0.12	0.22	0.32	0.45	0.22	0.34	1.00

Source: Results of the econometrics Estimation

4.4.2 Testing Goodness-of- fit

The goodness-of-fit determines the accuracy of the model prediction approximates to the observed data. Wald Chi- square test shows the overall goodness of fit of the model at 1% probability level. Wald Chi-square test shows that at least one of the predictors' regression coefficients is not equal to zero. From the results in the Table 4.11, a Wald chi2 statistic of 85.45 with a Chi-square distribution of (Prob>chi2) = 0.0016 is significant at less than 1% probability level shows at least one of the explanatory variables in the model has significant effect on household's livelihood

diversification strategies and that the explanatory variables jointly influence household's livelihood diversification strategies.

Table 4.11: Goodness-of-fit estimation

Wald Chi-square test	Chi-square distribution of (Prob>chi^2)	Prob > chi^2
85.45	**0.0016**	**0.0000**

Source: Results of the econometrics Estimation

4.4.3 Determinants of livelihood diversification

The multinomial ordered logistic regression model was used to analyze the relationship between independent variable and response variable. Among 18 hypothesized explanatory variables, 7 variables were found to be positively significant on livelihood diversification strategies and 4 of the variables were negatively significant on the livelihood diversification of households. The degree of each significant explanatory variables described as follows:

Age: Age of household head has positively and significantly influenced the probability of participation in non-farm livelihood strategy at 5% level of significance. This positive result implies that household heads with age increased implement non-farm income livelihood strategy more than young aged household heads due to the fact that the mean age of the survey result shows 40.41 years (mean of 38.10 for pastoral and mean of 41.93 year for agro-pastoral) indicated majority of the households were in productive age groups. Hence an increase age resulted to diversify more than the youngest group of age. This result is also similar with the findings of previous studies by Asfir (2016) on the study of livelihood diversification shows an increase age with reference to productive age groups led to have more experience and exposure to participated in more livelihood options.

Family Size: Family size of household heads has positive and statistically significant effect on the probability of participation on farming, non-farm, petty trade and off farm livelihood strategies at 5%, significance level. This result indicates that large families are more likely to practice on multiple farming activities due to the fact that rectify the shortage of labor to undertake different activates at a time. This result is also consistent with the findings of Melese et al (2018) in their study on the determinants

Dependency ratio: The results of the study shows that, the dependency ratio of households has negatively and statically significance with 5% probability because the average dependency ratio of the survey was 0.41 implies that at least one family life is depend of the other productive family in the households or as indicated in the marginal value of the study a unit dependency ratio has decreasing the diversification level of households by 18.7% probability. This also supported by a study by Desalegn (2016) an increase the unproductive family size in household level decreased the probability of participation of non-farm activities.

Level of education: Educational level of household heads has positively and statistically influenced the probability of participation in livelihood diversification strategies at 5% statistical significance level. The result could be justified due to the fact that educated household heads gain the required skills and knowledge that enables them to involve in non-farm income activates and various business activities. As the study show that the majority of the households were attended primary education even though there were few households attending high school. As studied by Asenake (2010) and Yishak et al. (2014), households those having primary education, secondary education, and other education diversify their income greater than as compared to household head those households without any level of education. This is probably because school education increases the human capital levels and provides the necessary skills which enable the entry into more remunerative labor markets especially for non-farm.

Land/farm Size: Households having more farm size has negatively affected the probability of non-farm, off-farm and other livelihood strategies at 5% significance level. Because of household heads has positively and significantly influenced the probability of agricultural framing than other livelihood strategy at 5 % significance level whereas it the positive relationship of farm land size with likelihood of agricultural farming livelihood strategy implies that farmers who have large farm size are spending more time on the farm cultivations and producing agricultural outputs compared with those who have small area of land. On the other hand, non-farm and petty trade livelihood strategies are not demanding land size. The study by Yizengaw et al (2015) indicated similar result as farm households having more farm land size were forced to follow agricultural intensification rather than diversification. Hence, farm land size has negatively impact on livelihood diversification strategies for agro-pastoralists.

Access to training: Training has positively and significantly impacted the probability of livelihood diversification due to awareness creation, skill up their knowledge and have informed

decision to pastoralist and agro-pastoralist livelihood activities. As the study show the result indicated there is approximately a 10% probability to livelihood extent implies households took training has more participated in nonfarm and off farm activities than who were not taken. As studied by Wassie and Fikadu (2015), exposure to different government and non-government training program helps to have better understanding about non-pastoral activities that pastoralists' and agro-pastoralists participation. Other study by Geremew et al (2017) indicated same result as households were took training have more opportunity to diversify their livelihoods.

Annual Income: The income level of pastoralists and agro-pastoralists expected with positive significant contribution to households' livelihood strategies. This variable found to have a positive and significant influence on household's choice of on-farm and non-farm combination livelihood diversification strategies with 7.3 % probability level. From the model estimate and other things were constant, the marginal effect reveals that the probability of a household using other than primary sources of livelihoods (non-farm and off-farm combination) activities increased by 8.3%. This is because households with large total income can easily meet their consumption as well as other family requirements and beyond that they go for demand pull livelihood outcomes (such as accumulation of assets, more income). Thus, they can easily overcome financial constraints to engage in alternative non/off-farm activities. This finding is in line with the finding of Yizengaw et al. (2015) and Wondim, (2018), stated that level of income affects household's livelihood diversification positively. Therefore, households having large cash income were more likely to diversify livelihood into non/off-farm.

Distance to Market: The market distance has negatively and significantly affected households' livelihood diversification. As the market distance increase from home, pastoralists and agro-pastoralists were not intended to be being participated for non/off-farm livelihood diversification due to distance to market discouraged to sell the outputs of their activities. This indicated in the study shows a decreased by 6.7% livelihoods due to far from market location and same result show the marginal impacts of the distance to market in the study area indicated a 1-hour increase in walking to market leads a decreased by 7.6% livelihood diversification. Similarly, studied by Yenesew, and Fekadu, (2015) and Weldegebrial (2018), indicated that households having near market possibility to selling out their labor to the nearest market maximize their income and to smooth their annual consumption during the slack crop production period, promote rural-urban linkage and develop the entrepreneurial skill of farm households to diversify their livelihoods.

Livelihood Support: Households' having support from Government institutions, non-government and local institutions have a positive contribution to the livelihood diversification by 5.64%, because pastoralists and agro-pastoralists with different support such as capacity building, coaching, took awareness training, financial and material support have strength to diversify their livelihoods. The marginal impact of the livelihoods also showed that households having support by different stakeholders were increased a probability of getting livelihood diversification by 6.4%. This result also supported with similar study by Wassie and Fikadu (2015).

Consumption Expenditure: Consumption expenditure has negatively and significantly impacted the livelihoods diversification in the study area with decrement of 6.2% probability at 1% significant level, implies that households' having more consumption expenditure have less livelihood diversification strategies. Because less investment in non-farm and off-farm activities due to finical shortage resulted less probability reinvestment. This implies majority of the study participants spend their annual income for household consumption resulted less likely to reinvest for their livelihoods. The results of the marginal effects showed a unit consumption of the income received will leads to 0.7% decrease to participate in non-and off-farm activities.

Exposure to shocks: The incidence of shock has positively and significantly impact on livelihood diversification in pastoral and agro-pastoral areas. Because, the frequency of shocks resulted decreased the pastoralists and agro-pastoralists income from primary sources were found to increase the rate/extent of livelihood diversification in the study area with a probability of 1%. Apparently, this finding agrees against with a-priori expectations/hypothesis because increase in the frequency of shocks and stressors, as well as increase in households' livelihood insecurity situation should induce more participation in livelihood diversification as buffers against all forms of shocks significant at 5% level.

To sum-up, similar study by Agyeman et al. (2014) found that Western Ghana's farming households have also examined the range of diversification which implies that the level of livelihood diversification depend of the determinate factors to the cut point of level being low, medium and high. Other study by Rahman and Akter (2014) stated that investing Investments in infrastructure, including road connectivity, market access, irrigation facilities, education, and women empowerment can promote diversification in Pastoral and Agro-pastoral areas. Furthermore, Khatiwada et al. (2017) and Gebreyesus (2016) shared a similar perspective while advocating for landholding policy change and expanded financial access.

Table 4.12: Major determinants of livelihood diversification (explanatory variables)

Livelihood diversification (index)	Coefficient (β)	Std.Err.	z-value	P>z	Average marginal effect (β)	Std.Err.	z-value	P>z
Sex	0.019	0.234	0.080	0.935	0.002	0.026	0.080	0.935
Age	**0.016**	**0.013**	**1.200**	**0.031**	**0.018**	**0.001**	**1.200**	**0.030**
Marital Status	0.150	0.234	0.640	0.521	0.017	0.026	0.640	0.521
Family Size	**0.321**	**0.142**	**2.250**	**0.024**	**0.036**	**0.016**	**2.270**	**0.024**
Dependency ratio	**-1.651**	**0.753**	**-2.190**	**0.028**	**-0.187**	0.084	-2.220	0.027
Level of education	**0.221**	**0.126**	**1.750**	**0.045**	**0.025**	**0.014**	**1.790**	**0.044**
Membership	-0.131	0.230	-0.570	0.570	-0.015	0.026	-0.570	0.569
Land Size	**-0.912**	**0.256**	**-3.570**	**0.000**	**-0.103**	**0.029**	**-3.610**	**0.000**
Access to training	**0.090**	**0.048**	**0.200**	**0.041**	**0.010**	**0.051**	**0.200**	**0.041**
Access to credit	0.177	0.514	0.340	0.731	0.020	0.058	0.340	0.731
Access to Information	0.018	0.230	0.080	0.939	0.002	0.026	0.080	0.939
Annual Income	**0.073**	**0.0115**	**4.380**	**0.000**	**0.083**	**0.012**	**4.040**	**0.000**
Total Livestock Unit	-0.008	0.012	-0.630	0.529	-0.001	0.001	-0.630	0.531
Exposure to Shocks	**0.091**	**0.247**	**0.370**	**0.012**	**0.010**	**0.028**	**0.370**	**0.011**
Distance to Market	**-0.067**	**0.092**	**-0.730**	**0.037**	**-0.076**	**0.010**	**-0.123**	**0.036**
Frequency of Extension service visit	-0.007	0.076	-0.100	0.922	-0.001	0.009	-0.100	0.922
Livelihood Support	**0.564**	**0.093**	**6.040**	**0.000**	**0.064**	**0.011**	**5.750**	**0.000**
Consumption Expenditure	**-0.062**	**0.093**	**-6.690**	**0.000**	**-0.007**	**0.097**	**-7.180**	**0.000**
/cut1	-0.684	1.200	-	-	-0.684	1.200	-	-
/cut2	2.106	1.183	-	-	2.106	1.183	-	-
/cut3	5.661	1.217	-	-	5.661	1.217	-	-

Survey result, 2024

Cut point 1: This indicates the results of the ordered logistic regression which shows the level of livelihood diversification (SID score) between 0.26-0.49 indices. This implies there is a unit reduction with 0.684 from cut point 2. This result shows pastoralist and agro-pastoralists only participated on farm and few off-farm livelihoods options.

Cut point 2: This indicted the results of the ordered logistic regression which shows moderate level of livelihood diversification (SID score) between 0.50-0.69 indices. This implies there is a unit of 2.0106 increase when moving from cut point 1 and decrease same unit from cut point 3. This result implies pastoralists and agro-pastoralists participated with on farm, off-farm and few non-farm activities have beter livelihood than those who only engaged on farm (crop + livestock) and few off-farms.

Cut point 3: This indicates the high level of diversified with greater than 0.70 indices which shows 3.555 unit increased from cut point 2, while increased by 6.345 units from moving from cut

point 1. This mean, pastoralists and agro-pastoralists participated on farm, off-farm, non-farm and public works that considered as livelihood options and are considered in better livelihood diversification position.

4.5 The implication of Livelihood Diversification on the Extent of Vulnerability

4.5.1 Temperature and Rainfall Variability as exposure to vulnerability

This section examining the welfare of pastoralists by using elements of the sustainable livelihoods' framework facilitates identification of the causes and dynamics of climate variability among pastoralists. As indicated in the livelihood's framework of figure in chapter two of figure (2.1), the welfare of pastoralists in the dynamic context of risks, seasonal and long-term trends which affect assets and livelihood strategies and determine the level of vulnerability. The exposure, sensitivity, and adaptive capacity indices were separately calculated resulting in the two-livelihood zone's vulnerability index.

In the study area, exposure to drought, climate change mainly high temperature and low rainfall with erratic condition implies the climate variability that impact households' livelihood diversification mainly due to increase in temperature and lower rainfall with erratic nature annually. This tend to the pastoral and agro-pastoral households tend to vulnerable to drought and shocks with reducing their productivity and asset building capability. Figure 4.2 illustrates the spatial and temporal variability and trend of minimum, maximum, and annual mean temperature from 2000-2023. It shows the annual temperature trend variation. Accordingly, the t-max in the study area increased slightly from year to year with mean maximum temperature value of 38.22 °C. The annual total mean temperature also same increased slightly from year with having the mean value of 30.73°C. The annual mean temperature minimum was 23.25°C which has also slightly increase from year to year. The annual T-max and T-min slightly increased by 1.17^{o}C deviation in each year.

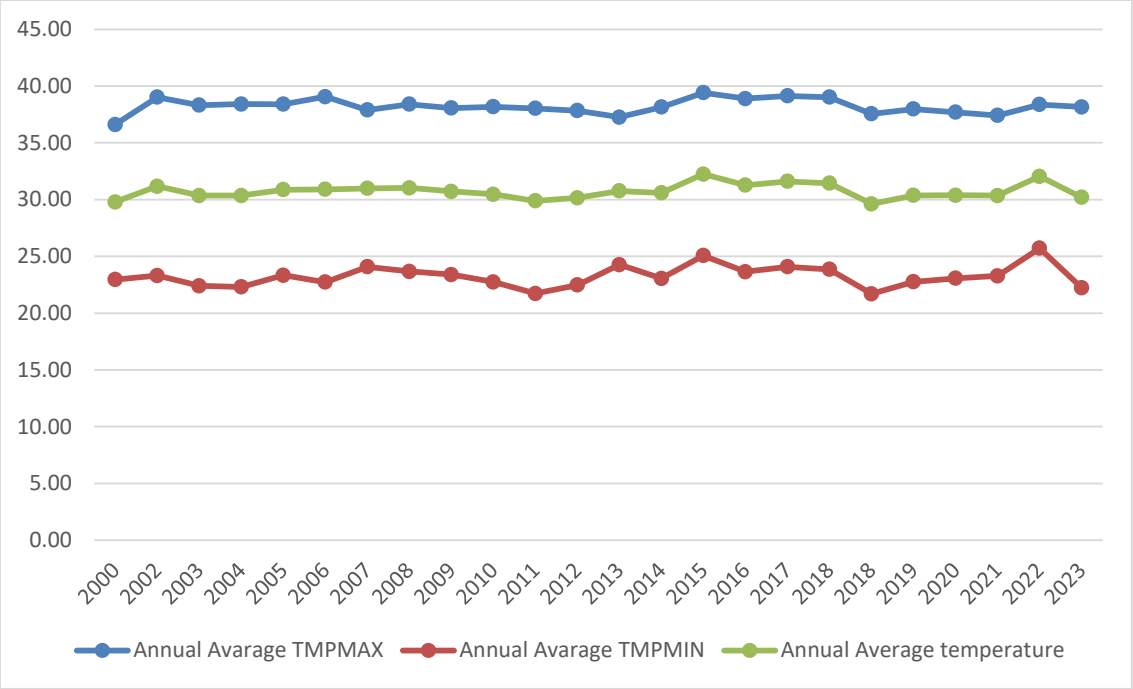


Figure 4.2:The seasonal and annual variability of temperature in Afambo woreda (2000-2023)

This dynamic temperature change against the mean value would lead to the occurrence of precipitation change and variability in the study area. Figure 4.3 also depicts that the Afambo wereda experienced great variation and distribution and changes of rainfall, R-max and R-min. It shows an annual rainfall significantly increased by 4.75mm/year. The minimum and maximum rainfall amount of the wereda were 0.00 mm recorded in 2017 implies no rainfall for 12 months during this year and 21.94mm recorded in 2014 respectively. The mean rainfall of the last 24years was 10.91mm. This implies there is low amount of annual rainfall received naturally and challenging to livestock pasture development and crop production. The magnitude of the rainfall shows fluctuation and decreased from year to year from 2000 to 2023.

Pastoralists live in arid and semi-arid areas that experience different livelihood shocks due to changes in environmental, social and economic circumstances. Pastoralists are highly vulnerable to repetitive livelihood shocks due to shortage of precipitation which devastate their livestock and livestock products. Household participants perceived that, there is a decline of rainfall as the main indicator of climate change and variability in both livelihood zones.

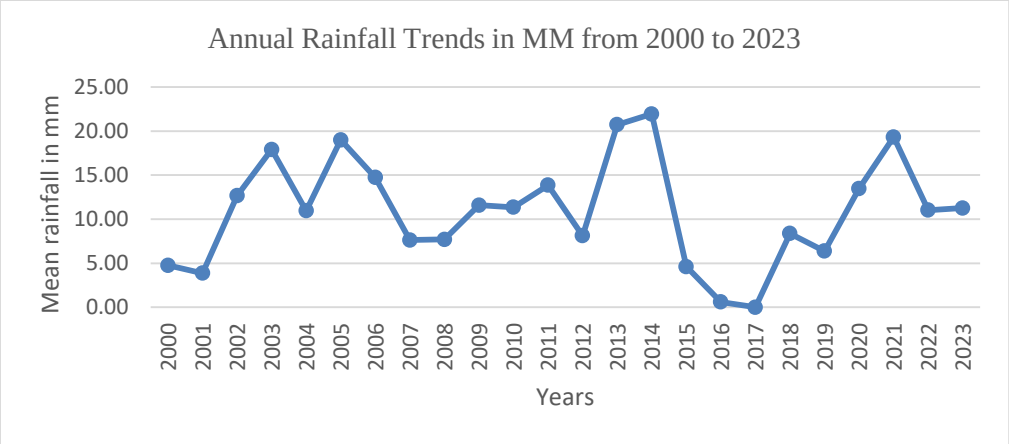


Figure 4.3: The seasonal and annual variability of rainfall in Afambo woreda (2000-2023)

"The impact of climate extreme's and other human and natural induced hazard exposures had been impacting the pastoral and agro-pastoral livelihoods in serval times and same also recovery livelihood strategies had been experienced to respond the shocks". (Key informant Interview,2024),

As depicted in table 4.13 of the study result, the major impact of climate shocks was decline pastures contributed 0.94 & 0.93 severity index. This implies lack of feed and water during the dry season and drought is the main constraint affecting livestock production in the area. Shortage of rain and the frequently recurring drought in the area is a major cause for reduced forage production and quality. Shortage of feed and water and the harsh climatic condition of the area seriously affect the health and productivity of animals. The second shocks were livestock death contributed 0.86 and 0.85 severity index. This implies that, the prolonged dry season and drought are the causes for high mortality rate. The third was disease outbreak which accounts 0.85 & 0.84 severity index. The second and third causes indicated that, Diseases such PPR, Pasteurellosis, Sheep & goat pox, CCPP, CBPP, Anthrax; Parasites such as ticks and manage mites; predators and poisonous plants such as gaaddalla also have a significant effect on the health and productivity of animals. The fourth was crop failure for agro-pastoralists and elder illness for pastoralists (0.60), the fifth was climate impacts on human capital with adverse effects of elders, children, disabled and women (pregnant, illness) contributed ranging from 0.49, 0.35 and 0.14 severity index respectively.

Table 4.13: The Impacts of climate extremes in pastoral and Agro-pastoral livelihoods with severity index

Impacts of climatic extremes (low rainfall, high rainfall and high temperature)	**Pastoralists**	**Agro-pastoralists**	**Severity ranks**
Decline pastures	0.94	0.93	1

Livestock death	0.86	0.85	2
Disease outbreaks	0.85	0.84	3
Crop failures	0.00	0.65	4
Elders (illness)	0.60* (4^{th})	0.59	5
Children (illness)	0.49	0.47	6
Disabled	0.35	0.36	7
Women (pregnant, illness)	0.21	0.14	8

Sources: Survey result, 2024

The result in table 4.14 showed that, shortage of rain and the frequently recurring drought in the area was a major cause for reduced forage production and quality which contributed 0.93 and 0.90 severity index. This implies shortage of feed and water and the harsh climatic condition of the area seriously affect the health and productivity of animals. Invasive species (0.86 & 0.84), and loss of water access/non-irrigable pasture (0.65 & 0.68) were the second and third causes of pasture declines contributed for pastoral and agro-pastoral livelihood zones. The fourth major cause of pasture decline was push encroachment is exacerbating the problem of feed shortage contributed 0.42 & 0.45 severity index for pastoral and agro-pastoral households respectively. Encroachment of the rangeland by some invasive plant species such as Prosopis juliflora reduces accessibility of forage leading to reduction of effective grazing areas. Demarcation of regional boundaries and ethnic conflicts also hinder movement of the pastoralists in search feed and water thereby hampering the indigenous coping mechanisms impacted with a severity index of 0.36 & 0.38 with the two livelihood zones respectively. Change in land tenure from communal to privatization and expansion of cropping and land grabbing for cultivation and private enclosure were the others causing shrinkage of grazing areas and loss of key resources for dry season and drought period grazing contributed from 0.20 to 0.09 severity index.

Table 4.14: Causes of Pasture decline in pastoral and Agro-pastoral livelihoods

Causes of Pasture Declines	**Severity index**		
	Pastoralist	**Agro-Pastoralist**	**Severity ranks**
Recurring drought	0.93	0.90	1
Invasive species	0.86	0.84	2
Loss of water access/non-irrigable pasture/	0.65	0.68	3
Encroachment of agricultural frontiers	0.42	0.45	4
Conflict with neighboring groups	0.36	0.38	5
Change in land tenure from communal to privatization	0.20	0.19	6
Expansion of large-scale irrigated farms	0.10	0.09	7

Sources: Survey result, 2024

Table 4.15 shows the consequence of decline in pasture resulted primarily to confine livestock close to villages with severity index of 0.94 and 0.96 for pastoral and agro-pastoral households. The second consequence was livestock death contributed 0.72 and 0.68, while the third was moved livestock to distant place accounts 0.67 and 0.66 severity index respectively. The forth severity consequence was decreased livestock production with a severity index of 0.65 and 0.64. The last consequence was households tend to shrift to non-agricultural activities with 0.62 and 0.63 for pastoral and agro-pastoral households' respectively.

Table 4.15: Consequence of pasture decline/lose to pastoral and Agro-pastoral livelihoods

What happened to your household when you lost your grazing land in your area?			
Impacts of Grazing Land lose/declines	**Pastoralist**	**Agro-Pastoralist**	**Severity ranks**
Confine livestock close to villages	0.94	0.96	1
Livestock Death	0.72	0.68	2
Moved livestock to distant place	0.67	0.66	3
Decreased livestock production/milk, meat, eggs /	0.65	0.64	4
Tend to shift to non-agricultural activities	0.62	0.63	5

Sources: Survey result, 2024

4.5.2 Livestock Production Trends and Climate Variability

In pastoral and agropastoral systems, livestock is a key asset for poor people, fulfilling multiple economic, social and risk management functions. The impact of climate change is expected to heighten the vulnerability of livestock systems and reinforce existing factors that are affecting livestock production systems (IFAD, 2007, 2010). For pastoral and agro-pastoral communities, losing livestock assets could trigger a collapse into chronic poverty and have a lasting effect on livelihoods. The impact of climate change can heighten the vulnerability of livestock systems and exacerbate existing stress upon them, such as drought that affects livestock production. Hence, sustainability of livestock production in the face of climatic variation calls for adaptation measures to prevent its adverse effect on livestock production (Grace etal.,2016). This section examined the relationship between climate variability and livestock production and the lessons that can be drawn for achieving sustainable livestock production in pastoral and agro-pastoral of Afambo Wereda. The study employed six years recent trend data on livestock production given by the mean index of the aggregate livestock production over the period of 2018 to 2024.

The livestock production trends show decreasing from year to year. The average livestock number of 2018/19 was (71,043) which is higher than the overall average number of livestock across the year. The average number of livestock in 2019/20 was (69,911) which was higher than the following four consecutive years but less than the preceding year. The average number of livestock in the year 2020/21 was (69,350) which was higher than the next three years average but lower than the preceding two years. In the 2021/22 the average number of livestock was (68,837) which was higher than the next two years average but lower than the preceding three years average. The 2022/23 average number of livestock was (67,922), while in 2023/24, it was (66,437).

In section 4.5.1 of previous analysis explored some of the key issues linking to examine the effects of climate variability on the welfare of pastoralists by using elements of the sustainable livelihoods framework implies that, the physical asset (livestock) impacted by climate shocks and stress. Because, the recurrent drought in the study area impacted a decline in pasture resulted livestock death and pastoralists tend to sell their livestock with no options. However, the vulnerability of livestock to climate variability varies across species based on their adaptive mechanism (Fereja, 2016).

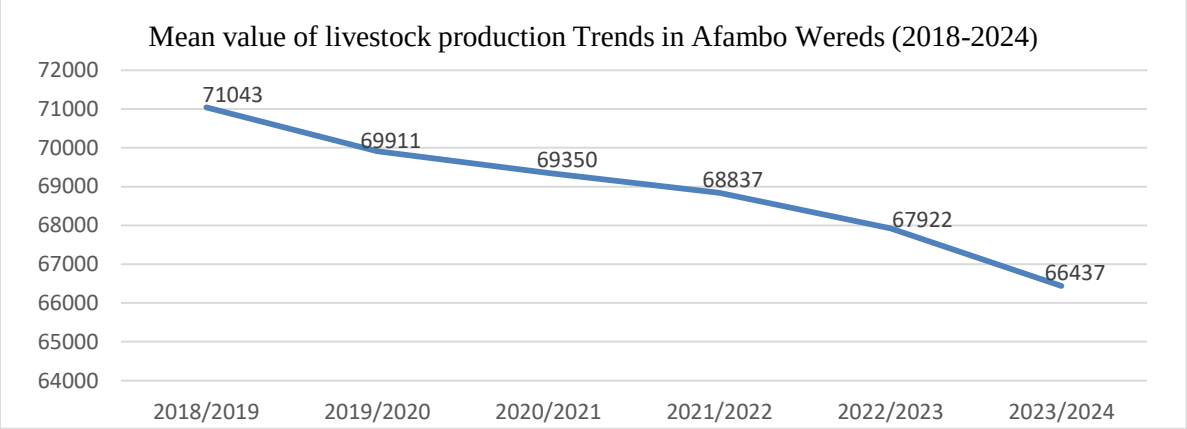


Figure 4.4: mean value of number of livestock production trends

Regarding to livestock production trends by livestock types, a significantly higher number of cattle and sheep death were recorded due to climate variability, while the death of goat and camel were eventually low. Loss of animals is associated with drought and the cumulative impacts of rainfall and surface temperature variability. The climate variability alters plants' growth potential, deterioration of livestock feed resources and livestock's physiological response. Increasing patterns of temperature and decreasing rainfall trends in drought prone area as phenomenon, pastoral and agro-pastoral communities who rely on natural resources for livestock production rigorously feel its adverse effects. This also supported by Wako, Tadesse, and Angassa (2017) as stated in their

study, “climate variability alters the niche of forage species and may modify animal feed resources” and also the changes in grassland composition lead to inadequate grassland serving capacity and the areas left with browse feed resources (Fereja,2016).

> *From the FDG discussant and KII summery, “The livestock death rate is now increasing than before because of drought caused by a decline in rainfall (amount, intensity and duration), limited grazing feed resources caused by bush encroachments, land degradation (loss of pasture land productivity), new emerging livestock diseases and heat stresses”.*

*As shown in table 4.16, the mean number of cattle for the last six years was (*97,746) with standard deviation of 3,469.40 having (-2,122) mean variance in each year which was high in reduction of cattle per year. The mean of the number of sheep production trends was (10,8001) which was the higher reduction observed next to cattle production with a standard deviation of (2,433) and having (-1,172) reduction per year. The mean of goat production was (15,4419), which shows high mean value as compared to other livestock production trends across the years with low deviation (2,150.67) and variance (-851) indicated slower reduction than cattle and sheep. The mean of the number of Camel was 44,031 and same slow reduction with standard deviation of (1,797.38) and reduction by mean variance of (-953) per year. The other livestock production type was the mean of the number donkey which was (9,171) and shows lower standard deviation (317.2) and mean variance (-195). The last was poultry (chicken production) with mean number of (133) and shows positive mean variance of (81.3) only the last three years, as there was no poultry production between 2018/19 to 2020/21 as per the given data. The overall mean of the livestock number was (68,917) with over all standard deviation of (1,719.71) and overall reduction of (-868) per year which was lower reduction.

Table 4.16: Livestock Production Trends and Climate Variability

Livestock Type	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	Raw Total	Raw Mean	Mean Variance	Stdev
Cattle	101,311	101,309	99,129	96,996	94,909	92,821	586,475	97,746	**-2,122**	**3469.40**
Sheep	111,168	108,775	108,773	108,771	106,430	104,088	648,005	108,001	**-1,172**	**2433.00**
Goat	157,819	154,422	154,420	154,418	154,416	151,018	926,513	154,419	**-851**	**2150.67**
Camel	46,463	45,463	44,485	43,528	42,591	41,653	264,183	44,031	**-953**	**1797.38**
Donkey	9,498	9,496	9,292	9,110	8,914	8,717	55,027	9,171	**-195**	**317.20**
Chicken	0	0	0	200	271	325	796	133	**81.3**	**150.64**
Column Total	**426,259**	**419,465**	**416,099**	**413,023**	**407,531**	**398,622**	**2,480,999**	**413,500**	**-868**	**1719.71**
Column Mean	**71043**	**69911**	**69350**	**68837**	**67922**	**66437**	**413500**	**68,917**		
Variance	**-**	**-6794**	**-3366**	**-3076**	**-5492**	**-8909**	**-**	**-5,527**	**-**	
Stdev	**62,442.5**	**61,275.7**	**61,176.0**	**61,042.0**	**60,650.9**	**59,303.1**	**60,981.70**			

Sources: Wereda Agricultural and Pastoral Development Office, 2024

In addition to the trend analysis, the survey respondents declared that the main drivers for livestock decline in the study area is drought and drought-driven impacts. In general, the ranking of livestock declines drivers in Deka and Alasabolo study locations showed that drought received high ranking. Respondents of the study area believed that diseases and shortage of grazing feed resources associated with drought incidence. Drought condition attributed to the shortage of available feed resources, leading to poor in body condition, which in turn diminish body immune system and make the animal easily exposed to the disease. The primary climate stresses in dryland areas are drought, inadequate water, heat and inadequate feed resources, which lowers pasture growth and livestock exposed them to new pathogens and vectors. The result of the current study agreed with the finding of (Boru et al., 2014) who reported drought and land fragmentation, herd livestock death and declining cattle population in eastern Guji zone.

4.5.3 Estimation of vulnerability index

The vulnerability of pastoralists and agro-pastoralists to current risks and shocks was assessed using LVI. The LVI was assumed as a function of adaptive capacity, sensitivity, and exposure (IPCC ,2012). In this study, the weights for the indicators of exposure are all positive as hypothesized shown in the trend. This implies that while mean annual temperature trends with a weight index of 0.307 and the mean of annual rainfall trends with a weight index of 0.11 contribute negatively to vulnerability index. However, as indicated the mean value of the weights of the 24 yearly temperature trend contributes more compared to the 24 yearly mean rainfall trend (referred figure 4.2 and 4.3 of section 4.5.1).

Table 4.17: Components of vulnerability with mean values

Sensitivity Index	Exposure Index (Mean Rainfall and Mean Tem)		Adaptive capacity Index	Vulnerability
Mean Weight index	R-mean weight Index	T-Mean Weight Index	Mean	Mean
0.30	0.11	0.31	0.29	-0.43

Sources: Own computation, 2024

The components of sensitivity were extracted from five variables that were assumed as sensitivity indicators. These were total livestock death, total crop loses, loss of access to water, loss of grazing lands/forages, Household member associated with climate-induced shocks, average food

insufficient months and others. The components had the direction of influenced by shocks and stress with a total effects of mean value weight of 0.30 indexes.

The adaptive capacity index represents the average of the individual sub-component (determinant) values while the determinant values are the average of the normalized indicator values (Denbel *et al*, 2024). The components of were obtained from the loading (weights) extracted from the livelihood assets that have significant contribution to adaptive capacity. These were the human capital support to livelihood diversification such as provision of training, skill and efforts to livelihood support, financial capital such as remittance, income from livestock and crops, credit access and amount, social capital cooperatives, community support and kinship, natural capital availability of water, availability of pasture, physical capital such as livestock and crop land. These livelihood assents measure the overall adaptive capacity index of the pastoral and agro-pastoral households in the Afambo Wereda. The mean value weight index for the adaptive capacity main elements was 0.29 while the mean weight index of livelihood sensitivity elements was 0.30 while the mean index of exposure with respect to annual mean rainfall for the last 24 years was 0.11, while the mean weight of exposure with respect to Annual temperature (T-mean for the last 24 years) was 0.31. The livelihood vulnerability index with respect to sensitivity, adaptive capacity and total exposure was -0.43. The result is similar with a study by Cinner et al. (2013) focused evaluating social and ecological vulnerability and Ponsian et al. (2016) which was focused Vulnerability of agro-pastoral farmers to climate risks in northern and central Tanzania. In figure 4.5 of the spider diagram showed that, the major components of vulnerability Index with respect to exposure, sensitivity and adaptive capacity indexes.

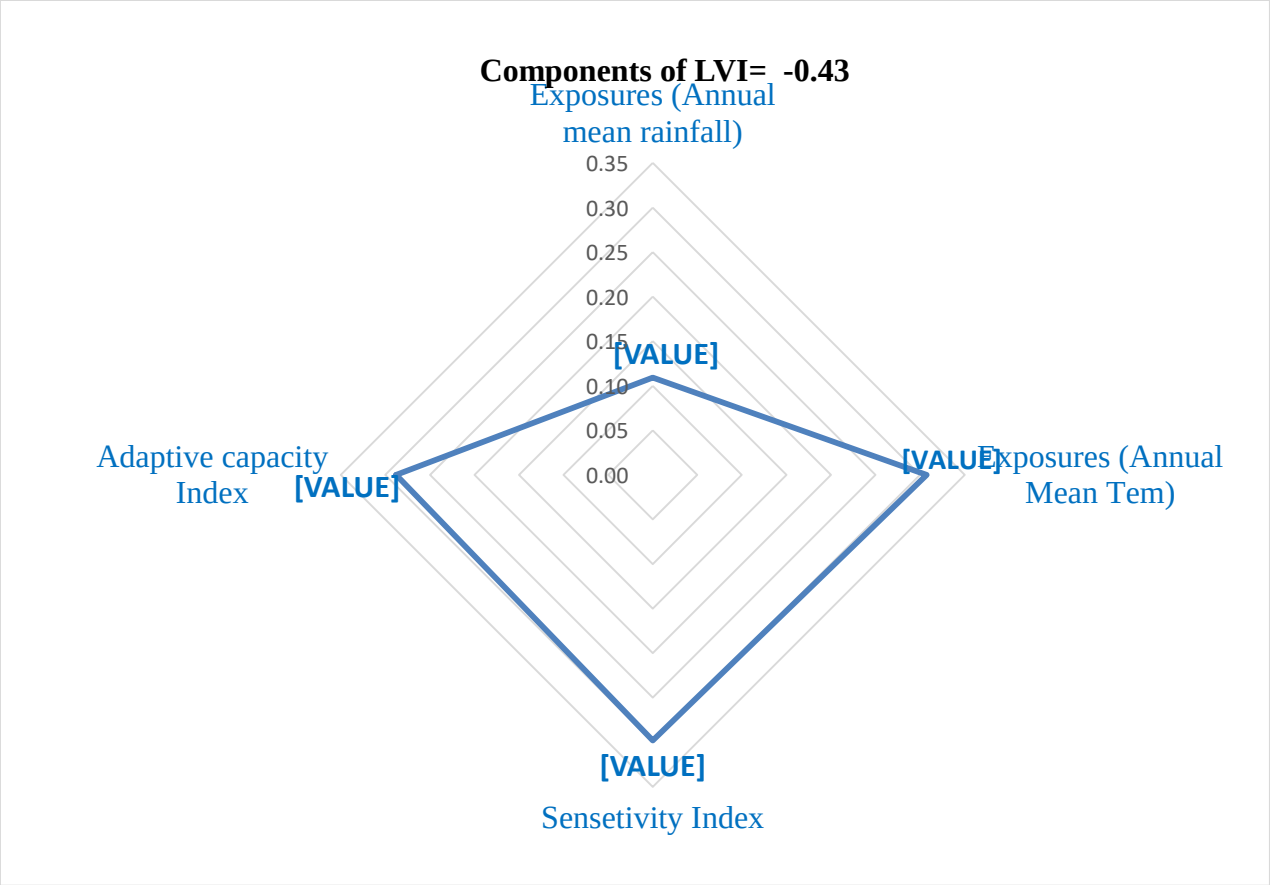


Figure 4.5: Spider diagram of the major components of Vulnerability Index

4.5.4 Extent of Livelihood Vulnerability Index

In this section effects of livelihood diversification nexus extent of livelihood vulnerability helps to identify the pastoral and agro-pastoral that are most at risk and the sources of their vulnerability. This is essential in determining the most important adaptation interventions that are tailored to the specific needs of those pastoral and agro-pastoral households. The LVI along with the vulnerability index have been employed to measure the extent of livestock and crop resources-dependent households' vulnerability to climate variability and change in the Afambo Woreda of Afar region. Pastoral and Agro-pastoral households living in the in the study experience different levels of vulnerability to shocks and stress such as climate variability and change with having different adaptive capacities. As indicated in table 4.18 of below, the study show that the majority of the pastoral and agro-pastoral households fall high and moderate level of Livelihood vulnerability which account 61% of the pastoral and 62% of agro-pastoral in moderate livelihood vulnerability index, while 29% for pastoral and 26% agro-pastoral households were high vulnerability (which is moderately high). Few of them were in low and very high vulnerability ranges. This implies that, those who diversified more livelihoods and have option to engage in

multiple income sources have less likely to be vulnerable, while those who were less opportunity to access in choice of livelihood options had highly vulnerable.

Table 4.18: Extent of Livelihood Vulnerability Index (LVI)

Level of Livelihood Vulnerability (LVI)	**Pastoral Households**		**Agro-pastoral Households**		**Severity Rank**
	Frequency	**Proportion**	**Frequency**	**Proportion**	
Very High ($0.6 \leq LVI \leq 1$)	3	0.02	2	0.01	4
High ($0.2 \leq LVI < 0.6$)	41	0.29	55	0.26	2
Moderate ($-0.2 \leq LVI < 0.2$)	85	0.61	132	0.62	1
Low ($-1 \leq LVI < -0.2$)	10	0.07	23	0.11	3

Survey result (2024)

The vulnerability index revealed that agro-pastoral households were less vulnerable than pastoral in Afambolo Wereda. However, their vulnerability was contributed to by exposure to climate risks, sensitivity (internal and external disturbances), and the households' adaptive capacity. The Sensitivity and adaptive capacity of households were found to have a direct policy implication since they can be controlled by humans.

The livelihood strategies component measures income diversity and consists of the percent of households who are entirely reliant on Livestock production, crop production (agricultural activities), off-farm and Non-farm activities in addition to livelihood support and direct cash received in the form of remittance. The availability of adaptive capacity assets is essential that enable the ability of human systems to adjust the impact of climate variability and extreme events. The adaptive capacity component of the study is composed of fifteen variables that fall in to the different asset forms of human, social, financial, physical, and natural for Pastoral and agro-pastoral livelihood zone. The first major sub-component of adaptive capacity was the social capital. This includes being cooperative with community members, kinship and family-oriented business engagement, received support from extended families and social works among the pastoral and agro-pastoral livelihoods resulted an aggregate adaptive capacity of 0.29 contribution. The study also indicated that, there was variation of social capital capacity that observed among the two-livelihood zone. The second major sub-component of adaptive capacity in the study area was the physical capital such as own livestock, productive cultivated lands, infrastructure, producer goods include the availability of technology components (farm inputs such as fertilizers, improved seeds, and extension services) and farm equipment (plowing instruments and farm animals). The infrastructure is the travel time access including access to road, school, and health service. These sub-components of the adaptive capacity were contributed 0.22. The third sub-component of the adaptive capacity was the financial capital.

The study revealed that, the financial capital includes the livestock per capita owned (in TLU), diversity of income sources (sales of crop, livestock, firewood, and charcoal), food for work, cash for work, agricultural labor, remittances, paid employment in Towns (causal labor), and institutional access to saving and credit services which contributes 0.18 index. The fourth sub-components were the Natural capital which includes the availability of pasture lands, availability of water and farmland size, perceived farmland degradation, and soil productivity/fertility across the two livelihood zones. The Natural capital adaptive capacity contribution was 0.18. The fifth sub-component of adaptive capacity was the human capital which includes six indicators: level of educational, age of household head, dependence ratio, family size, skill (training), and sex of household heads (being male and female). These indicators exhibited variation of human capital among the pastoral and agro-pastoral livelihood zones. The aggregate human capital contribution was 0.11 which is low adaptive capacity level.

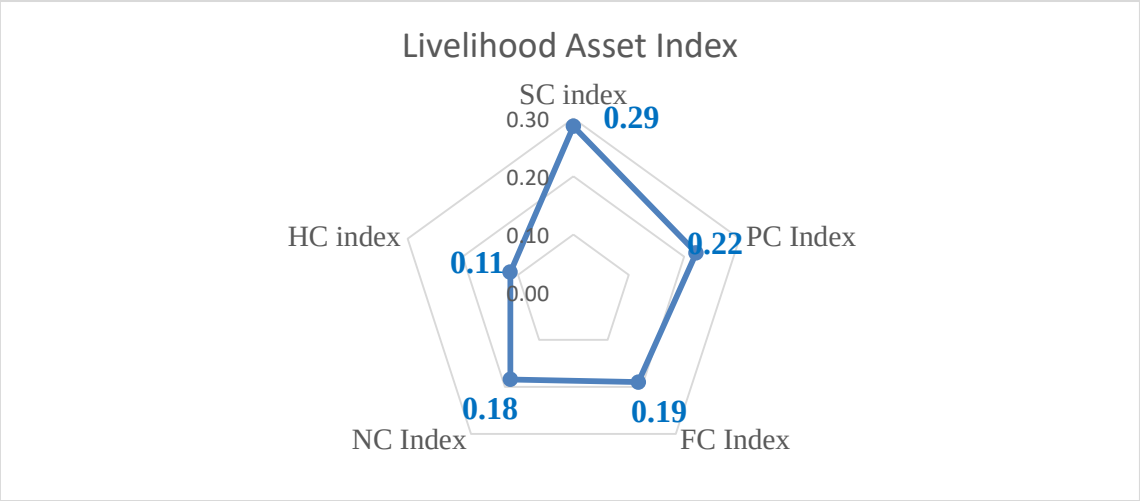


Table 4.6: Spider diagram of the major components of Livelihood Index

4.6 Challenges of pastoral and Agro-pastoral livelihood diversification strategies

Livelihood diversification is an important survival strategy for the rural households in the developing countries. However, there are several constraints to successful livelihood diversification. Identification of constraints for pastoral and agro-pastoral area is crucial for development interventions. As indicated in table 4.19 of this study result was justified and identified some of the socio-economic, technological, institutional and policy constraints to livelihood diversification. These constraints have been found to vary across livelihoods areas as well as across livelihood groups. The major constraints to livelihood diversification in pastoral and agro-pastoralists were: Livestock Disease outbreak, Lack of business awareness, Lack of

veterinary service, Lack of technical skill, lack of good market opportunity and Lack of credit access with severity rank of 1 to 5. Lack of initial capital, Lack of agricultural input, Resource demand Conflict, Decrement in pasture, Loss of communal grazing lands by state and private farms were the other livelihood challenges with a severity index of 6 to 11.

Table 4 19: Challenges of livelihood diversification

Challenges of livelihood diversification	Pastoral			Agro-Pastoral		
	Count	Index value	Severity Rank	Count	Index value	Severity Rank
Expansion of private Agriculture	7	0.05	10	0	0.00	11
Lack of business awareness	125	0.81	2	131	0.64	2
Lack of veterinary service	117	0.75	3	120	0.59	3
Livestock Disease outbreak	126	0.81	2	161	0.79	1
Lack of initial capital	99	0.64	6	94	0.46	6
Decrement in pasture	109	0.71		59	0.29	
Resource demand Conflict	55	0.35	8	64	0.31	8
Lack of agricultural input	0	0.00	11	74	0.36	7
Lack of technical skill	112	0.72	4	106	0.52	4
Lack of credit access	109	0.70	6	96	0.47	5
Lack of good market	131	0.85	1	107	0.52	4

Sources: Survey result (2024)

"Through the interview with the woreda livelihood development officer, the study found that there are diverse challenges affecting diversification of then livelihood among pastoralists and agro-Pastoralists in the study kebele. He stated; Challenges arising from lack of capital base, drought that ravages even the little gathered plantations and livestock are outstanding challenges to the livelihood of the people in this region. Moreover, other secondary challenges are public issues such as social amenities including; access to veterinary services, schools, health centers and cooperative unions. Scarce and/or infective social amenities imply costly services to the resident, hence transferring the little resources into paying up for these services (Woreda Livelihood Development Officer)".

4.7 Pastoralist Livelihood Strategies to cope with vulnerabilities and shocks

It is not drought as such that makes pastoralists vulnerable, but the growing inability of pastoralists to cope with it. Factors that constrain pastoral drought response mechanisms, especially the mobility of people and animals, are the main reason for this. Even if all above risks (in section 4.5.1), faced by pastoralists/agro-pastoralist are suitably managed, in the longer term their wellbeing would decline as a consequence of growing human and livestock populations on limited

and often degraded drylands leading to increasing imbalances between the demand for and supply of land and water. Therefore, while individual impoverished pastoral/agro-pastoral households can be helped to regain a viable and sustainable livelihood in pastoral areas, this is no longer true for the pastoral/agro-pastoral population as a whole. Complementary policies and strategies with the objective to reduce the imbalance between humans, livestock and the environment therefore need to be put in place.

The policies and strategies to facilitate the engagement of pastoral people in alternative income generating activities should start from two angles. On the one hand investment opportunities for pastoral people need to be identified followed by the creation of access to credit and training in order to enable pastoral people to pursue the investment opportunity. On the other hand, public sector investment in labor intensive infrastructure provision could create employment opportunities for pastoral people, while incentives schemes to train and hire ethnic minorities including pastoral people might be established for the private sector.

Table 4.20 outlines the main strategies that pastoralists have adopted over time to cope with vulnerabilities and shocks. It also attempts to show that pastoral communities are more vulnerable in the face of increasing hazards partly associated with drought, but increasingly a result of the combined effects of shocks in other livelihood assets indicated in above discussion (section 4.5.1).

The main coping strategies were herd combination with other non and off farm activities which accounts (0.95 & 0.96) index, pasture survey and migration with herd splitting were the second strategy with (0.93 & 0.92) index, the third major strategy was sales of livestock with index of (0.63 & 0.58), the fourth was changing the composition of herds (0.56 & 0.55) and the fifth was leaving livestock under the care of bond-friend/kin respectively (0.47 & 0.49) for pastoral and agro-pastoral households respectively.

As indicated in the survey result livelihood diversification is also a key element of resilience and strengthens the capacity of households to deal with future shocks and stresses. Hence seeking relief assistance/food aid and direct cash/, Minimize consumption, reduce meals and expenses, borrowed from relatives/others and household splitting (sending children to relatives) were the worst adaptive capacity and coping mechanisms to survive the shocks, while diversify income sources/selling of charcoal and firewood and labor migration to towns were the other means of livelihood coping strategies that households used to escape from stress. Off course, livelihood

strategies are not equally vulnerable to the different risks associated with specific shocks and stresses, suggesting that diversification into multiple livelihood activities, each with different risk profiles, will provide the most effective buffer against future unpredictability.

Table 4 20: Main pastoralist strategies to cope with vulnerabilities and shocks (with multiple response options)

Main pastoralist strategies to cope with vulnerabilities and shocks	**Coping strategy Index**		
	Pastoralists	**Agro-pastoralists**	**Ranks**
Combining herding with non-pastoral activities (trading, cultivation)	0.95	0.96	1
Pasture survey and migration with herd splitting	0.93	0.92	2
Livestock sales/Destocking	0.63	0.58	3
Changing the composition of herds	0.56	0.55	4
Leaving livestock under the care of bond-friend/kin	0.47	0.49	5
Seeking relief assistance/feed aid/food aid and direct cash for both food and feed	0.45	0.46	6
Minimize consumption, reduce meals and expenses	0.44	0.43	7
Diversify income sources/sold charcoal and firewood/	0.42	0.42	8
Borrowed from relatives and others	0.40	0.39	9
Labor migration to towns	0.37	0.38	10
Household splitting (sending children to relatives)	0.33	0.35	11

Sources: Survey result, 2024

Chapter Five: Conclusion and Recommendation

5.1 Conclusion

This study identifies the major livelihood strategy, determinants of livelihood diversification, and the analysis the principal components of livelihood diversification to reduce vulnerability in Afambo Woreda of Afar region. The findings of the result showed, livestock production is the main livelihood income source of the pastoralist and agro-pastoralists in the study area. Agricultural Crop production is also an important means of economic diversification followed by other non-agricultural livelihood activities such as livestock and petty trading, draft animal renting, selling of hand craft, temporary wage, self-employment, selling of fire wood and charcoal, participation of public works (food for work and cash for work) and remittance. The Simpson index of diversity was used to compute the degree of livelihood diversification among pastoral and agro-pastoral households', which demonstrates the estimated results. The findings of the result presented pastoral and agro-pastoral households have moderately livelihood diversified portfolio, yet they diversified away from farming over time which cover 55.56 percent. On the contrary, only 19.37 per cent of them have a high level of diversified income source. Overall, the mean value of the diversity index is 0.579 indicating moderately level of diversification. The econometric analysis demonstrated that education of household head, family size, years of experience in age, level of income (as used for initial capital) were increased the number of non-farm activities, access to training, provision of livelihood support, and exposure to shocks enhanced livelihood diversification which contributed significantly at 5% level. While, consumption expenditure, distance to market, land size and dependency ratio were negatively significant at 5% level. The total mean income of agro-pastoral households is higher than the mean income of pastoral households, because of agro-pastoralists have additional annual crop sales income and have an opportunity to work being as a member, used inputs as a share and easy of information flow for market value chain and increased their income share contribution within the group.

The majority of households' livelihood vulnerability ranges highly vulnerable and moderately vulnerable. Major indicators of vulnerability to shocks and stress include a decline of the pasture lands, death of livestock, reduction of water availability, losses of crop production, food insecurity months and outbreaks of human and livestock diseases. The study used a linear combination among the three components of vulnerability (exposure, sensitivity, and adaptive capacity. The

vulnerability index revealed that agro-pastoral households were less vulnerable than pastoral in Afambolo Wereda. However, household's vulnerability depends on, the exposure to climate risks, sensitivity (internal and external disturbances), and the households' adaptive capacity. The Sensitivity and adaptive capacity of households were found to have a direct policy implication since they can be controlled by government and non-governmental interventions in coordination with local adaptive capacity. The availability of adaptive capacity assets is essential that enable the ability of human systems to adjust the impact of climate variability and extreme events. The adaptive capacity component of the study is composed of the elements of the five Asset pentagons variables that fall in to the different asset forms of human, social, financial, physical, and natural for Pastoral and agro-pastoral livelihood zone.

The major constraints to livelihood diversification in pastoral and agro-pastoralists were: Livestock Disease outbreak, Lack of business awareness, Lack of veterinary service, Lack of technical skill, lack of good market opportunity and Lack of credit access with severity rank of 1 to 5. Lack of initial capital, Lack of agricultural input, Resource demand Conflict, Decrement in pasture, Loss of communal grazing lands by state and private farms were the other livelihood challenges with a severity index of 6 to 11. The main coping strategies were herd combination with other non and off farm activities, pasture survey and migration with herd splitting, sales of livestock, changing the composition of herds and leaving livestock under the care of bond-friend/kin respectively.

5.2 Recommendation

The crucial policy question is whether it would pay off to invest in pastoral development, or whether it would be more appropriate to design exit-strategies for pastoralists/agro-pastoralists allowing them to abandon livestock keeping. Both of the above options should be pursued in parallel. On the one hand, the increasing pastoral/agro-pastoral populations on decreasing rangelands requires that policy-makers should develop and implement exit and/or diversification strategies for pastoral people. There are, however, also good economic reasons for investing in pastoral areas. Hence, the below recommendation is forwarded based on the findings of this research.

- The dominant income shares of employed livelihood strategies by Agro-Pastoralists are livestock and crop production. The pastoral and Agricultural development office should work

to support the households to specialize and diversify the existing main livelihood strategies including drought resistant livestock and improved variety of crops to enhance productivity & reduce vulnerability

- The income shares of other livelihood options including draft animal renting, livestock trade, petty trading, casual labor and self-employment covers almost one fourth of the total income for pastoralists and Agro-pastoralists which have significant contribution to reduce vulnerability. Therefore, the Woreda Enterprise and Pastoral development offices should establish strong coordination to improve the income share of these livelihood options through provision of technical support, business and skill trainings, provision of initial working capital and market opportunities.
- The provision of extension service for crop production is very limited in the study area and pastoral and Agricultural development office should employ extension agents to enhance the frequency and quality of extension service for agro-pastoralists
- Design and implement interest-free credit schemes tailored to the needs of pastoral and Agro-pastoral Muslim communities and promote investment in livelihood diversification activities such as small-scale trade, handicrafts, and non-livestock-related enterprises, reducing dependency on vulnerable pastoral resources.
- Establish and strengthen community-based financial institutions or cooperatives that offer interest-free loans, allowing pastoralists to collectively manage and access funds based on mutual trust and community values.
- Woreda trade, Enterprise and pastoral development offices should establish market value chain for input supply as well as product sell through value addition to improve the income share of the available livelihood sources including on-farm, off-farm and non-farm activities.
- Pastoral development and distastes prevention management office should establish strong coordination and work strengthening of early warning system to reduce loss of livestock and crops anticipating occurrence of shocks.
- Woreda sector office including administration, pastoral development, water development office, Health office, Enterprise office should strengthen their coordination to enhance the adaptive capacity and reduce vulnerability of pastoral and Agro- pastoralists
- The above indicated sectors and involving NGOs should work to establish anticipatory actions to reduce sensitivity and exposure of livelihood assets to drought, livestock diseases and other climatic shocks

- Access to information is one of the most important elements for livelihood diversification to have shared information for market value chain, product price, input price and local livelihood economic activities. Hence, provision of relevant information to pastoral and agro-pastoral households by the woreda enterprise and pastoral development office who is responsible to support agricultural and non-agricultural livelihood diversification economics activities.

In general, the level of livelihood diversification of pastoral and agro-pastoral households depend on the knowledge and understanding to use the available livelihood choices and opportunity with the combination of the asset pentagons. Furthermore, households with low levels of human, financial, social and physical capital are found to have less capacity to meet the challenges of the livelihood vulnerability. Households' local adaptation strategies for resilience help them in implementing non-agricultural livelihood activities. However, a low level of household vulnerability does not mean that they are resilient to shocks and stress. The households' vulnerability may provide government and other relevant agencies with critical information for proper understanding of the local context in policy interventions. A good and well-balanced attitude might restrain households from adapting resilience measures. Therefore, vulnerability and resilience are discrete entities and livelihood adaptive capacity is the means to curve vulnerability in combination with other factors.

Furthermore, future research should be conducted on livelihood return thresholds to determine whether a certain level of remuneration associated with a type of livelihood is necessary to make a difference in adapting to and recovering from shocks.

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Annexes

Annex I: Survey Questionnaire

Annex II: Secondary Row data

A. Temperature variability data
B. Rainfall variability data
C. Livestock production trend

Annexes II: Pictures of FGD discussant, KII and HH survey