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DETERMINANTS OF INCOME DIVERSIFICATION AND ITS EFFECT ON FOOD SECURITY OF SMALL HOLDER FARMERS IN THE CASE OF ASAYITA WOREDA, AFAR REGIONAL STATE

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ADVISOR: FENTAHUN TESAFA (ASSISTANT PROFESSOR)

JUNE 2018

BAHIR DAR, ETHIOPIA

DECLARATION

First, I declare that this thesis is prepared by my own effort with the guidance and close supervision of my advisor. I, the undersigned declare that the thesis entitled "**Determinants of income diversification and its effect on food security status in Asayita *Woreda*, Afar Ethiopia"** is entirely my original work and it has not been submitted any university for academic award. Besides, I have duly acknowledged and referenced all materials used in this work.

Name of the Student:

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Name of the Advisor:

Fentahun Tesafa (Assistant Professor)

Signature & date_____

ACKNOWLEDGEMENT

DEDICATION

I dedicate this thesis manuscript to my father **Adem Ali,** and my beloved mother **Kedija Hussen**, for nursing me with affection, unreserved assistance and for their dedicated encouragement in my academic carrier and life.

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ABBREVIATIONS AND ACRONYMS

AEU	Adult Equivalent Unit
CIA	Central Intelligence Agency
CSA	Central Statistical Agency
Das	Development Agents
EHNRI	Ethiopian Health and Nutrition Research Institute
ETB	Ethiopian Birr
ERHS	Ethiopia Rural Household Survey
FGD	Focus group discussion
FGT	Foster, Greer and Thorbeck
FRM	Fractional response model
GDP	Gross Domestic Product
GLM	General linear model
HCR	Head Count Ratio
HHI	Hirschman Herfindahl index
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
KCAL	Kilo Calorie
LPM	Linear Probability Model
MOARD	Ministry of Agriculture and Rural Development
NGOs	Non-Governmental Organizations
OFP	Off -farm Participation
OLS	Ordinary least square

PPS   Proportionate Probability Sampling

PSP   Poor safety net program

QMLE   Quasi-maximum likelihood method

RNF   Rural non –farm

SID   Simpsons Index of Diversity

St.Dev.   Standard Deviation

TLU   Tropical Livestock Unit

VIF   Variance Inflation Factor

WAO   Woreda Agricultural office

WB   World Bank

ABSTRACT

In Ethiopia 83 percent of small-holder farmers participated in farming activities and only 27 percent in non-farm economic enterprises.This paper examines the determinants of income diversification and its effect on food security in Asayita woreda Eastern part of Afar region. The study used two stages sampling in combination with stratified and simple random sampling procedures to select kebeles and households. The Simpson Index of Diversity(SID),Food Security Index(FSI), Fractional response model and Binary Logistic Regression model were employed to analyze the data collected from a sample of 153 rural households. While the Simpson index of diversity were used to measure the extent of income diversification and the food Security index is to measure the food security status. Income diversification level has positive and significant effect on food security status of the rural farming households in Asayita woreda. The level and type of income diversification depends on the accessibility and availability of different income sources. Similarly, food security depends on average Kcal per day consumed by all members of a household. The mean results of degree of income diversification revealed that Simpson Index of Diversity (SID = 0.24) by rural households in the study area. Further results of the head count index indicated that 60.1 % households were below the food insecurity line. The food insecurity gap and severity were 9.5 % and 2.6 % respectively. Based on fractional response model result educational status, credit utilization, distance from market, access to electric power, sex of the household head, annual household income, special skill and household size significantly affecting degree of income diversification. While the binary logistic regression model estimates indicate that distance from market, age, educational status, household size, farm size, livestock holding, credit utilization, remittance and annual household income have significantly influence on the probability of being food secure. Finally, this research indicates the important policy implications suggesting that programs, projects and/or any interventions designed targeting to engage people in other income generating activities would augment their income sources which are made to increase the food security status at household level in Asayita woreda.

Keywords: Income diversification; food security index; fractional response regression; logistic regression; Simpson index of diversity

1. INTRODUCTION

1.1 Background of the Study

Agriculture is the basic economic sector on which the country relies for its social and economic development. Its contribution to the gross domestic product (GDP), employment, and foreign exchange earnings of the country is about 35.8, 72.7 and 90 percent, respectively, makes it the incontestable sector in the country's development prospect (CIA, 2018). Despite its importance, the production and productivity of the sector still remains very low as of the traditional, subsistence and nature dependent nature of its production systems. As a result, Ethiopia fails to feed relatively large proportion of its population from domestic production. And more importantly, the population do not have the productive capacity to earn ability to commend its additional food requirements through commercial imports. The proportion of population undernourished was 64 percent in 1995 and improved progressively to 40 percent after 15 years in 2010 (FAO, 2013). However, the prevalence of undernourishment still remains as such a high level that effort for future improvement is required.

Recognizing this fact it is essential for the smallholder farmers to involve in other income earning activities, besides attempting to improve production and productivity of agriculture. For instance, Dimova and Sen (2010) stated that participation and specialization of smallholder farmers in one particular activity is the exception and income diversification through participating in different activities is a custom. This is due to the fact that income diversification could help small-holders farmers to address the problem of risks and uncertainties, Ellis (1998); Dimova and Sen (2010) that their farming, which is nature dependent and rain-fed agriculture, usually encountered and also expected to create higher income (Amare Demissie and Belaineh Legesse, 2013). Being agriculture is nature dependent and the common jobs of small- holder farmers, it is usually characterized by different problems such as poor soil fertility, volatile rainfall, crop and livestock diseases, price shocks for crop and livestock products and other related conditions which guide to generating low income and gradually leads to food insecurity and poverty.

In Ethiopia, one of the main reasons for poverty and food insecurity of the extensive agriculture based small- holder farmers is their extremely low productivity (yield) of the smallholders (Canali and Slaviero,2010).The major producers of food in the country the fact that they use low-input, rain-fed and low-output farming systems (MOARD, 2010). Although the rural farm households in *Awsi* zone specifically in the study area (Asayita *woreda*) is highly dependent on the flood irrigation agricultural production systems, shortage of farm land resource and variability of the rain fall pattern, made the smallholder farmers unable to meet the annual food requirements of their families. As a result, they are obligated to engage in low return daily wage works, petty trading, services and handcraft activities to supplement their livelihoods and to cope up with the agricultural risks.

According to Bassie Yizengaw (2014), it is increasingly believed that diversification of income sources of households and widening of crops options by the farmers during cultivation have positive impact on the food security level of rural households. Evidences from various studies Agbola *et al.* (2008); Bereket Zerai and Zenebe Gebreegziabher (2011) also indicated that households having diversified sources of income have a positive implication on food security status of households through increasing their total monthly income earning. In general it is suggested that diversification of income sources has been put forward as one of the strategies that households employ to minimize their income variability and to ensure a minimum level of income diversification for improving poverty and food security status of the country at national and households level. Although the smallholders are involved in diverse livelihood activities, their participation in non-farm activities is influenced by complex and yet empirically unidentified factors. It is thus, important to identify the major factors influencing income diversification and its effect on food security status of rural farming households and thereby suggest possible intervention strategies for improving income diversification and its effect on food security status of smallholder farmers, considering the socio-economic and bio-physical circumstances of the study areas.

1.2 Statements of the Problem

In Ethiopia the pastoral (rural) economy is usually characterized as an agrarian economy in which large number of small holder farmers are generally in farming activities like crop production and livestock rearing with small number of them participate in non-farm business activities.Nagler and Naudé (2014) indicated that 83 percent of small-holder farmers in Ethiopia participated in farming activities and only 27 percent in non-farm economic enterprises. Majority of the population is however dependent on marginal non-farm income sources such as petty trade (WB, 2009). Besides, most of the Ethiopian rural people are poor and have access to one or less than one hectare of land IFAD (2011), low return from farming activities and their farm income is not enough for the whole year consumption Kilic *et al.* (2009) as well as varies considerably Beyan Ahmed (2016) exposed majority of rural households to chronic poverty. Due to this fact that in most countries farm households that are highly reliant on non- farm income can have good implications if they are thoroughly considered by agricultural research and extension systems of the country. As they are expected to reinvest their non- farm profit back into their farm production would improve farm productivity and household food security.

As agricultural production becomes low due to crop or livestock failures resulting from agro - climatic shocks and/or market failures, farm households utilize non- farm incomes to stabilize aggregate income flows and secure food access. In addition, they use non- farm income in the crucial hungry period between food stores running out and the next harvest season (Kilic *et al.* 2009). This implies that non-farm income cannot only be used as a mechanism to stabilize the household income but also reduces early harvest consumption or distress selling at early harvest time. Under scarce land and imperfect land market it also enables to create more job opportunity for some rural household members (mainly youths and women who are victims of this problem) and this contributes for the reduction of rural unemployment. In Ethiopia, where income from farm activities varies considerably, farm households usually engage in non farm income generating activities to supplement their agric ultural income (Beyan Ahmed, 2016). Hence, non-farm income is expected to enhance their production and productivity of farming.

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However, it is not well known whether there exists variability in the level of income diversification among rural farm households in the study areas. Besides, some rural households in the study area allocate their working time between farms and non-farm activities to have secure income (consumption) for their family members while others engaged in farming only. Yet, it is not clear why some households engage only in farm activities while others engage in both farm and non-farm income generating activities. Afar region has been heavily dependent on external food aid and food insecure region (Indris Siraje and Adam Bekele, 2013). However the status of food security and the associated factors which determine food security and livelihood vulnerability are not well recognized in the study area, imposing difficulty in responding to solving the current problems among the pastoralists of the Asayita *woreda.*

Non-farm employment provides additional income that enables farmers to spend more on their basic needs including food, education, closing and health care. This implies that non-farm employment has a significant role in maintaining household food security (Bereket Zerai and Zenebe Gebreegziabher, 2011; Oyewole, 2012; Bassie Yizengaw, 2014). Policy makers and others did not look at the way in which the rural income diversification is integrated with employment generation and other food security status improvement strategies due to lack of empirical evidences that help understand well. Even though the *woreda* is the initial capital city of the Afar region which has better access to infrastructure like asphalt road, its economic activities are mostly based on farming like flood irrigation, livestock rearing where income diversification has not yet widely practiced. This shows that there is a gap in rural households to diversify their income sources assisting to smooth their consumption all round the year in the study area. Thus, this study was proposed aiming to answer why some households engaged only in farming while others engaged in both farm and non-farm activities and to identify the major factors that determine income diversification strategies and its effect on food security status of rural households in the study area.

1.3 Objectives of the Study

1.3.1 General objective

The general objective of the study is to analyze the socio- economic determinants of income diversification and its effect on food security status of small holder farmers in Asayita *woreda* of Afar region.

1.3.2 Specific objectives

➢ To estimate the degree of income diversification among rural farm households
➢ To identify the major factors affecting degree of income diversification of smallholder farmers
➢ To measure the food security status of households
➢ To analyse factors affecting food security status of smallholder farmers and
➢ To analyze the effect of income diversification on food security of rural households

1.4 Research Questions

The output of this research answers the following basic research questions.

➢ What is the levels of income diversification among the farm households?
➢ What are the major factors which determine degree income diversification?
➢ What is the food security status of the respondents?
➢ What are the major factors which determine food security status and
➢ What is the effect of income diversification on food security status among smallholder farmers?

1.5 Significance of the Study

Non-farm activities provide not only alternative sources of income and employment for small holder farmers but also stimulate agricultural production. Knowledge of the nature and effects of the non- farm activities provide clues to promote the rural economy. Thus this study, by identifying the major factors which are determining income diversification strategies and its effect on food security status, hopes to provide necessary analytical insights for targeting the rural non-farm sectors in the study area. To sum up, the importance of doing the study on determinants of income diversification and its effect on food security status among small holder farmers in Asayita *woreda* of Afar region has three major benefits. First, the findings of this study were great role in understanding factors that determine income

diversification strategies and its effect on food security. Second, the study is expect to be indispensable for stakeholders such as farmers, extension agents, extension administrators, subject matter specialists, planners, policy makers, and other related government agencies, NGOs, and private sectors that have their own stakes and being engaged in the enhancement of rural income. Third, the result of the study was serve as a good basis for the coming researchers who have a strong desire to conduct a study on this or related topics in Afar region, Asayita *woreda* or elsewhere.

1.6 Scope and Limitations of the Study

Geographically, this study focused on only to Asaita *woreda,* Afar regional national State. Conceptually, the coverage of the study was limited to the factors responsible for income diversification and its effect on food security status among small holder farmers in the study area. Although there are a number of factors that could influence income diversification of rural households, this study focused only on certain variables; like economic, demographic, institutional and geographical variables which mainly affect income diversification and food security status, because the above listed variables are the most important factors that affect income diversification and food security status of rural households. This study faced a number of scarcities such as financial resource, human resource, and transportation service. Due to this fact the study was conducted only on three kebeles out of the total 13 kebeles found in the woreda and only a sample of 153 farm households were taken as units of observations from the large rural population found in the study *woreda.*

1.7 Organization of the Thesis

The report of this study was organized into five chapters. It begins with the introduction part, which focuses mainly on background, problem statement and justification, objectives, and significance of the study, scope, research question and its limitation. Chapter two is dealt with review of theoretical and empirical literature which is pertinent to concern of the study. Chapter three describes research methodology which includes a brief description of how and who collect household survey and secondary data, procedures, econometrics model and techniques of estimation method. Results and discussions were presented in chapter four. Conclusion, recommendation and suggestion for further study area were presented in the final chapter of this study.

2. REVIEW OF LITERATURES

This chapter in general discusses some theoretical concepts and empirical evidences about the socio-economic determinants of income diversification and its effect on food security, including definitions and concepts of income, income diversification and food security, classification of household income sources, approaches and measurement of income diversification, and determinants of income diversification and household food security. The first part of this chapter presents the theoretical review focusing on concepts and principles of income diversification and food security and the next part presents the empirical evidences on both income diversification and food security aspects.

2.1 Concepts and Definitions Applied in Income Diversification and Food Security Analysis

2.1.1 Definitions of income and income diversification

According to Collins Essential English Dictionary (2006), income is defined as the total amount of money earned from work or obtained from other sources over a given period of time. There have been various ways to define diversification. It is defined as increasing the small holder farmers or household income sources rather than farming activities like crop production and livestock rearing (Hengsdijk *et al.,* 2007) And similarly Brugère *et al.* (2008) define diversification as the procedures for small holder farmers or households to create different set of income generating activities rather than farming for survival and in order to get better living standards. Additionally, income diversification is the process by which households widen their income base by adopting new economic activities. When we say income diversification is a process if small holder farmers participate in income diversification activities their level of production is changed from subsistence to provide some amounts of product to the market (participate in commercial activities) and try to diversify from only agricultural activity to non-farm activities.

In the most successful cases, income diversification creates increment in the small holder farmer income and they try to invest in other non agricultural activities. In contrast, income diversification may occur as a survival response to several shocks and stresses. For instance when members of poor farming households are forced to migrate in search of wage labour or sell assets because their crops fail or they face a sudden need for extra income. This situation refers to push factors (Samson Eshetu *et al.,* 2010). According to Haggblade *et al.* (2010), outside non- farm activities like shopkeeping, hand craft, petty trading, and services

providing activities, food processing and preparation for sale activities etc, business enterprise are included in rural non-farm enterprise. Regardless of sectoral or functional classification which can be either wage employment or self employment all activities left from one's own property are included under non - farm activities (Beyan Ahmed, 2016). Non-farm income includes both off-farm wage labour and non-farm self-employment (Reardon, 1997).

2.1.2 Food security and its dimensions

According to Olayemi (1996), food is a basic necessity of life and its importance at the household level is obvious since it is a basic means of sustenance. According to Okunmadewa (2001), the concern for food security and nutritional well being in an economy is predicated by role of human element in economic development. This shows why at national level food is one of political and economic significant concept especially in issues relating and ensuring peace and stability among the populace. Food security exists when food is available to everyone at all times, they have means of access, and that it is nutritionally adequate in terms of quantity, quality and variety also that it is acceptable, within the given culture (FAO, 2013). This implied food must be available to the people to an extent that will meet some acceptable level of nutritional standards in terms calorie, protein and minerals which the body needs; the possession of means by the people to acquire it and consistency in its supply at all times.

At National level, food security exists when all people at all times have the physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for active and healthy life. But according to Ingawa (2002) food security at household level indicates physical and economic access to food and also it is adequate in terms of quantity, quality, safety and cultural accessibility to meet each person's need. According to FAO (2003), in the world about two billion people face lack of food security intermittently due to varying degree of poverty, while up to 852 million men, women and children are in chronic hanger due to extreme poverty. In conventional usage, people usually link food security only with accessibility. But more formally it comprises various dimensions.

Jrad *et al.* (2010) for example elaborated food security based on four dimensions as food availability, accessibility, utilization and stability.

Food availability: It indicates the physical presence of food which may come from own production, purchases from internal market or import from external market. Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade by including food aid. As a result of this food production is not the same as food availability. Food availability is the net amount remaining after production, stocks and imports have been summed and exports deducted for each item included in the food balance sheet (i.e. production minus exports plus imports). Adequacy is assessed through comparison of availability with the estimated consumption requirement for each food item in the country.

Food access: It indicates the ability to obtain sufficient food of guaranteed quality and quantity to meet nutritional requirements of all household members. To be food is accessible it should be at right place at the right time and people should have economic freedom and also have purchasing power to buy adequate food. According to Kuwornu *et al.* (2011), food access is determined by physical and financial resources, as well as by social and political factors. Availability and access include several components: quantity (i.e., enough food and energy), quality (i.e., foods that provide all essential nutrients), safety (i.e., food that is free of contaminants and does not pose health risks) and cultural acceptability and preferences (i.e., foods that people like and that fit into traditional or preferred diets).

Food utilization: It refers to intake and absorption of adequate and quality food for safeguarding of good health. This means proper biological use of food, requiring a diet that contains sufficient energy and essential nutrients, as well as ways of food storage, processing, basic nutrition and child care and illness management (USAID, 2008; Jrad *et al.,* 2010). At households level food utilization depends on the services they have for food storage and processing, their awareness and practices in relation to food preparation, how food is shared within the household (whether according to the needs of individual members) and the state of health of each individual (which may be impaired by disease, poor hygiene, sanitation and health care).

Food stability: It refers to the availability of secure access to enough food currently as well as in the future or at different points in time. This recognizes that people's food security situation may change. Generally, stability in food security may be determined by livelihood characteristics, production patterns, political stability, livelihood resilience and type of shocks and hazards. Stability is a cross-cutting dimension that refers to food being available, accessible and utilization being adequate at all times, so that people do not have to worry about the risk of being food insecure during certain seasons or due to external events (Jef L.*et al.,* 2015).

2.2 Classification of Household Income Sources and Reasons for Income Diversifications

Instead of participating or concentrating on agriculture with its potential gains from specialization(produce one product or services efficiently) small holder farmer or households have different motives for diversifying their income sources by participating to non/off farm activities. According to Barrett *et al.* (2001a), small holder farmers diversification to non-farm activities could be induced by diminishing or time-varying returns on agricultural labour or on land, market failures etc. According to Ellis (1998), the occurrence of different labour market, the seasonal use of labour, household-risk minimization strategies and coping behaviour, access or availability of credit market (credit market imperfection) and household savings and investment strategies are the reason why small holder farmers try to diversify their income sources. Non-farm income can thus help in overcoming credit market imperfection and insurance problems. Even if income sources have been classified in various ways following income classification proposed by Bassie Yizengaw (2014) in world development report, in Ethiopia context they classified income generating activities as agricultural (like crop production and livestock rearing) and non- farm (petty trade ,remittance etc) are the major sources of income for small holder farmers.

Agricultural activities are further divided into agricultural crops and livestock while off-farm activities are sub-divided into agricultural wage employment, non-agricultural wage employment, non-farm self-employment, and other non-labour income (remittance, transfer) generating activities. Here the income of agricultural wage employment and non-agricultural wage employment can be grouped as wage income. In Ethiopia, even if agriculture is the dominant sector where many farm households make living, rural non-farm activities also play significant role in employment creation, income generation and enhancing farm production

activities (Beyan Ahmed, 2016). For poor farm household, participating on non-farm/off farm income diversification activities are important. This is because poor farm house household faces lack of liquidity and poor access to credit are the most constraints to increase farming productivity among farm house hold in developing countries. Apart from getting income from non-farm activities that can be used to purchase best agricultural inputs like(seed, fertilizer, chemicals) and employ labour forces for agricultural production, non -farm income has been used as collateral to get agricultural loans given the inadequacy of land, in certain settings (Hertz, 2009).

According to Davis *et al.* (2009), the ability of households to act on these incentives depends on a set of capacity variables. On the micro level, these variables include the vector of assets such as physical, social, human, and organizational capital, and liquidity from sources such as cash cropping. At small level, these variables contain access to local assets such as hard infrastructure (roads) and soft infrastructure (financial services). The access to credit and financial markets proofs to play a crucial role. However, high return from non-farm activities has certain requisites to enter these activities. These requirements include among others education, skills and investments. Participation in these lucrative non-farm activities is thus conditioned by the possibility to overcome the required entry barriers. Non-farm activity requires substantial investments; liquidity constraints will hamper households with restricted assets to enter these activities. Households to overcome these entry barriers depends on their capacity variables collateral requirements, market imperfections and differences in repayment capacity make credit constraints more severe for poor households than for rich households. The empirical investigation about classification of income generating activities indicates farm and non –farm sources are the major one. Because of this, this study consider both farm income (crop and livestock production) and non- farm (formal wage, self employment, non formal wage, remittance and rent) income sources.

2.3 Approaches of Diversification Analysis

Asset, activity and income based concepts are different important approaches for diversification analysis. How an object is select for diversification analysis is explained in moderately full way. Any factors that directly or indirectly generate cash in the form of money or dollar or in-kind returns are asset. Assets can be chosen as an object of diversification analysis to describe and study diversification. Using asset approach for describe and study diversification has its own two disadvantages. First, individual cannot

assign productive asset in to the specific activities instead of being used across activities. As a result it is difficult to sum up assets in a single activity. Second, because of insufficient development of asset market in developing countries measuring the real value of asset is difficult. The alternative activity based approach is used to describe and analysis the concept of diversification it has its own limitations. From those limitations using activity approach does not include unearned type of income, this lead to an imperfect level understanding of the relationship between diversification and poverty reduction and also it is difficult to identify which asset is assigned to which specific activities (Barrett *et al.,* 2001a).

However, researchers purposively ignore unearned income sources and define diversification as participation in income-generating activities; activity diversification can be adopted as a suitable measure. Thus time allocated to, or income earned from each activity may be used to analyze diversification. Unfortunately, another weak point is that reported employment share of non-farm activities is believed to be understated (Lanjouw and Feder, 2001). Because non-farm activities are widely recognized to provide supplementary work during slack periods of the agricultural cycle, real working time allocated to those activities is often unintentionally added to the total account of agricultural employment the primary source of income of farmers. This, thus, causes an underestimate of the actual proportion of labour time that is devoted to non-farm activities (Barrett *et al.,* 2001b).

Because of certain limitation or weakness of asset and activity based approach for the concept of diversification income based approach has often been used in practical work. By means of income based approach we may propose numerous advantages. First, under the case of diversification the major purposes are maximization and smooth the flow of income, or both for small holder farmers this can be a usual candidate (Ellis, 2000; Barrett *et al.,* 2001a). Second, by allocating either productive or non productive resources (assets) in to some activities the end outcome is income. Because of higher progress of commodities market than asset markets it is simple to change income payment to kind way of payment (Barrett *et al.,* 2001b). Third, to define the concept of poverty line by relating with absolute poverty line and small holder farmers (household) wealth income is more or less an important idea. Due to the above listed reasons it gives the impression that explaining the concept of diversification in terms of income may be appropriate method and also some practical studies used income approach. Because of this and other reasons, this study use income based approach for investigation of the concept of diversification.

2.4 Linkages between Agriculture, Non-Farm Activities and Food Security

An important economic question concerns, whether the rising income from agricultural production drives the growth of rural non-farm activities, or whether the increasing income from non-farm activities contribute the agricultural activities.

Evans and Ngau (1991) argued that income from non -farm activities for small holder farmers serves as insurance against agricultural risks, enables households to adopt new production technologies and to increase productivity activities induces agricultural growth through improved investment opportunities. Similarly, Reardon *et al.* (1994) indicated that the decision of whether or not to invest non-farm income for small holder farmers is affected by two set of variables. The first concerns the character of the existing capital market, when we look the nature of capital market if the performance of credit market is poor; the non-farm income becomes a substitute for borrowed capital for investment activities. The second issues it depends on the characteristics of such income, such as its timing and nature in comparison to the needs of agricultural production, and also on small holder's internal dynamics and in terms also of distribution and the control of funds.

For small holder farmer participating in to different income generating activities may also have long-term negative effect on food security, because poor farmers who engage in non-farm activities and generate non-farm income do so in order to survive or for stay alive not to improve the sustainability of their livelihoods or to invest in improved agricultural production activities. They see diversification more as an involuntary coping strategy than a strategic choice related to wealth accumulation. Poor households and low-potential areas often lack access to poverty-alleviating better-paying non-farm employment, and poor people are therefore involved in unstable, low-wage, low-productivity and low-growth non-farm activities. Thus, the evidence concerning the long-term impact of non-farm income on poverty is inconclusive. However, the short-term effects on food security are clearer rural non- farm income enables households to purchase food during a poor harvest and also serves as a source of saving and of accumulation of assets usable for food during difficult times (Gordon and Craig, 2001). On the other hand, when food security is assured people have potential to demand services and goods produced by the rural non -farm sector.

2.5 Empirical Evidences on Determinants of Income Diversification and its Effect on Food security

2.5.1 Determinants of household income diversification

Among small holder farmers the income diversification level and types depends on the availability and accessibility of various income sources and the type of risk and uncertainties small holder farmers are responding to which may in turn depend on household's markets like (labour and product market), human and social capital, and recurring policy changes. Some practical studies illustrate the strong factor which influences income diversification strategies are educational attainment (education level of household head) and infrastructure access for production and marketing activities (Barrett *et al.,* 2001a; 2001b). Rural households earn their living from farm activities. However, farming alone does not provide sufficient income for sustenance among rural dwellers (Oluwatayo, 2009).

According to Adugna Eneyew (2012), in southern Ethiopia livelihood strategies include livestock keeping, crop cultivation, remittance and hand craft and in Kenya consist of gifts, petty business and formal employment (Wanyama *et al.,* 2010). Olale *et al.* (2010) report greater likelihood of men diversifying than their female counter parts. Most studies in the area of off farm/non-farm income indicated that, farm characteristics of the household are considered as main factors determining the decision of participation in off/non-farm activities. For example, using data on 200 households selected from 40 villages of Southeast Nigeria, Ibekwe *et al.* (2010) examined factors determining non-farm income. They found that increases in the size of farm land increases farmers' willingness to operate in farm activities than participating in non- farm activities. This may further show the fact that small-sized farmers are driven out of farm activities in the study areas. Similarly, Bedemo *et al.* (2013) studied factors determining the decisions to participate in to non- farm work in western Ethiopia. According to them access to credit and size of farm land are major determinants of decisions to participate in non- farm activities. Various explanations for diversification behaviours can be found in the economic literature to explain both incentives and disincentives for rural households to combine traditional crops with new crops, Norman (1974), agricultural crops with animal husbandry or forestry activities Kurosaki (1997) agricultural activities with off-farm activities such as migration and tourism (Murphy, 1999; Barrett *et al.,* 2001a).

To secure their livelihood structure, if environmental and economical situations are changing smallholder farmers have an incentive to participate in non-farm activities and get non-farm income. On the other hand, factors like barriers to enter non-farm activities and risk aversion behaviour of households can also hold them back from participating in non-farm activities. The motives are usually divided into two categories: "pull factors" and "push factors" (Barrett *et al.,* 2001a). According to Norman (1974); Hart, (1994); Jalan and Ravallion (1998); Davis and Pearce (2001), for small holder farmers pull factors for income diversification are benefits from complementarities between activities, new income opportunities created by market development, improvement of infrastructure and diversification for asset accumulation respectively.

However, for small holder farmers Push factors include ex-ante risk management for both works of Alderman and Paxson (1992); Hoogeveen (2001). But for Carter (1997) push factor for smallholder household are ex-post risk coping strategies, contrary for Omamo (1998) high transaction costs is the push factor of smallholder farmers that enforce to participating in different income generating activities. Liquidity constraints and credit market failure for Reardon *et al.* (1994), and the seasonality of agricultural production activity Sahn (1989) are the factor which push households participate towards non-farm activities. In addition to this, according to Xia and Simmons (2004) the important factor to encourage households to reallocate their productive resources to higher-return activities is market development. Whereas agricultural seasonality, frequent climatic hazards, poor resource endowments; and poor access to financial institution like credit institution may all push rural households to undertake a wider range of activities in order to secure their livelihood. Household livelihood strategies are jointly determined by these two sets of factors.

According to Carter (1997); Reardon *et al.* (2002), risks play a key role in the activity diversification process. Since they strongly influence rural production, income and welfare, risks are major "push" factors that encourage households to turn to a more diversified portfolio of activities. Both farm and non-farm income generating activities can be used as efficient mechanisms for small holder farmers to reduce income risks and uncertainties (Ellis, 1998; Hoogeveen, 2001). However, in a rapidly changing and volatile environment, uncertainty may also make agricultural households more reluctant to engage in new activities. This is particularly the case for poor households who typically have a higher absolute risk aversion (Rosenzweig and Binswanger, 1993). Education and training produce a labour force

that is skilled.

According to Oluwatayo (2009), for small holder farmer household heads with formal education, married, engaged in farming as primary occupation and those living far away from headquarters of state or local government are less diversified than those with no formal education, single/divorced/widowed, non-farming households and those living very close to the state or local government headquarters. The implication of this is that respondents with formal education (especially those educated up to tertiary level) are engaged in better and well-paid salaried jobs than those with no formal education hence they have lower likelihood of combining two or more jobs (multiple job holding). This is because education enhances the potential of respondents and makes them access available opportunities with little or no stress.

The study conducted by Yishak Gecho (2017) on rural farm households income diversification in the case of Wolayita, his survey result also shows that out of the total sample households (300), about 246 households (82%) pursued agriculture as a primary income source. About 51 respondents (17.3%) reported that agriculture was their second alternative giving first priority to either non-farm or off-farm activities while only three respondents (1%) put agriculture in the third place. On the other hand, 37 respondents (12.3%) reported that non-farm activity was their primary income source. By applying Binary logit model to investigate factors influencing the households' participation in income diversification eight variables were significant with respect to income diversification with less than 10 percent of the probability level. These variables include sex, education, oxen ownership, tropical livestock, farm size, distance to market, participation in local leadership and annual farm income.

Ibekwe *et al.* (2010) works on determinants of farm and non –farm income among farm households in south east Nigeria noted that the age of household head was significant and negatively correlated with farm income. This may be due to the fact that the older the farmer is less productive than young farmers. This equally has implication for farm productivity. Land is an important resource in agricultural production. In the same way, Readon *et al.* (1998) the small size of farm holdings has been one of the factors that are driving small holder farmers out of farm business and has been regarded by many authors as one of the push factors. Family size is an important factor for livelihood diversification. They found that farm household size was significant and correlated with farm income diversification. This

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may be due to the fact that increase in farm household size means increase in family labour this has implication for availability of labour during peak periods of farm activities. Individuals own asset base helps both directly and indirectly in livelihood diversification. Asset offers a store of wealth as well as provides an opportunity to invest in alternative enterprises.

Amare Demissie and Belaineh Legesse (2013), analyzed the determinants of income diversification among small households farmers in the case of Fedis district, Eastern Hararghe zone, Ethiopia by using tobit regression model participation in to non farm income generating activities influenced by human capital related variables are (gender, age of household head, number of economically active family members, education level of household head and presence of children attending school), livelihood assets, livelihood diversifying strategy and infrastructure related variable (proximity to market). The result indicates that the above factors need to be considered by policy makers in the planning of agricultural and non agricultural initiatives in this study area.

In the same way, Bekelu Teshome and Abdi Khalil Edris (2013), conducted a research on determinants and patterns of income diversification among smallholder farmers in Akaki district, Ethiopia two stage random sampling with proportionate probability sampling (PPS) was used to collect cross-sectional data from 155 farm households using structured questionnaire. The data were also supported with documents from agricultural and rural development office and farmers cooperatives in the study area. The tobit model was used to analyze the factors determining the income diversification. From the descriptive statistics, sales of homemade farm employment and drinks, and non-farm employment were found to be the most important sources of off-farm income in the study area. The results from tobit model indicate that, family size; number of extension visit per year and education level has a positive significant effect over income diversification. On the other hand, age of the household head; land size and average distance from market have negative and significant influence on the household's decision towards diversification. The empirical investigation about determinants of income diversification indicates that farmers' level of income diversification and participation in income diversification is influenced by various factors. Generally socio-economic characteristics of the households are considered in this study as factors which influence the level or degree of income diversification in Asayita woreda.

2.5.2 Status and determinants food security of households

According to African Development Bank (2014), report Ethiopia is one of the most food-insecure and famine affected countries. A large portion of the country's population has been affected by chronic and transitory food insecurity. The situation of chronically food insecure people is becoming more and more severe. Food security situation in Ethiopia is highly linked to recurring food shortage and famine in the country, which are associated to recurrent drought. According to FAO (2013), more than 41 percent of the Ethiopian population lives below the poverty line and above 31 million people are undernourished. Food insecurity is a reality for hundreds of millions of people around the world, with the most affected countries being those in East Africa. In Ethiopia, the problem of food insecurity is exacerbating around pastoral areas due to the influence of a number of socio-economic and environmental factors.

According to Sanusi *et al.* (2006), the basic factors influencing the food security status of small holder farmers or households are the socio-economic characteristics and resources of individual households. In addition to this Indris Siraje and Adam Bekele (2013) on the work of assessment of food insecurity and coping mechanisms among pastoral households of Afar national regional state in the case of Chifra woreda, Ethiopia. By using calorie intake approach, 65.8% of sample respondents were food insecure, while 34.2% were food secure. On the other hand, analysis of the logistic regression model resulted in eight statistically significant variables affecting the food security status of the sampled households in the district. Family size, age of household head, dependency ratio, livestock disease incidence were causing food insecurity whereas sex of household head, herd size, income from livestock production and non-farm income were working against food insecurity. Their finding recommends that appropriate policy measures be taken towards limiting dependent population size through integrated and accessible health and education services, improving the contribution of the pastoralist women through trainings that could help remove cultural barriers and supporting the livestock sector through proper forage development as well as extended veterinary service and disease control programs. Finally, considering the fact that non-farm income of the sample households significantly affected households' food, pastoral households' insecurity in the district should be assisted to diversify their sources of income so that they may be able to cope with the prevailing problem and meet at least their minimum food requirement particularly during the drought season.

The study conducted by Fekadu Beyene and Mequanent Muche (2010) in the study on determinants of food security among rural households of central Ethiopia using binary logistic regression model identified that age of household head, educational level of household head, off-farm/ non-farm income, use of chemical fertilizer, size of cultivated land, livestock ownership, oxen ownership and soil and water conservation practices were found to be significant in determining household food security. According to them by using calorie intake method the amount of energy available for the household is compared with the minimum subsistence requirement per adult equivalent per day (i.e. 2,100 kcal). Based on food security status 64% were food insecure and 36% were secure households. The model reveals that age of the household head, the size of land cultivated, use of fertilizer, oxen ownership, and soil conservation has positive impact on food security status of household but household size and education has negative impact on food security status of smallholder households.

Contradict to the above authors, Ejigayhu Sisay and Abdi Khalil Edriss (2012) analyzed determinants of food insecurity in Addis Ababa city, Ethiopia, by using calorie intake method about 52 percent of households were food secured and the remaining 48 percent were insecure, and the result of tobit regression model show that household size, household income, household head age, household head education, ownership of bank account and income from remittance and gift were found to be significant determinants of food insecurity in the study area.

Girma Gezimu (2012), analyzed the determinants of food insecurity among households in Addis Ababa city, Ethiopia by Foster, Greer and Thorbeck distributional measure of food insecurity and by applying binary logistic regression model. The head count index shows that 58.16 percent of the total households are below the food insecurity line and the remaining 41.84 percent were food secured. The food insecurity gap and severity were 20 % and 9.4 %, respectively. The result of binary logistic regression model estimate indicates that out of the 10 factors included, 6 were found to have a significant influence on the probability of being food insecure at less than 10 percent significance level. The variables considered were household size, age of household head, household head education, access to credit, household asset possession, and access to employment which agree with the finding of (Ejigayhu Sisay and Abdi-Khalil Edriss, 2012). They conclude that effort should be made to improve income earning capacity of households, their education level with particular focus on vocational training, reduce household size with a view to reducing their dependency ratio and access of credit to the needy and trained people needs to be provided with proper targeting criterion.

Tibebu Aragie and Sisay Genanu (2017) examine the determinants of food security in North Wollo Zone. By applying logistic regression model the age of household head, dependency ratio, average monthly expenditure, non-farm income, family size, distance from input market, farmland size, the number of oxen and livestock ownership were found to significantly affect food security status of households. About 42 percent of the sample households were measured to be food insecure and the remaining 58 percent were food secured. Also, the incidence of food insecurity, food insecurity gap, and severity of food insecurity was 42, 14 and 7 percent respectively. The study conducted by Shishay Kahsay and Messay Mulugeta (2014) in Layi Maichew *Woreda* Tigray, Ethiopia by using multiple regression analysis by taking calorie availability as dependent variable sex, education, off farm income, utilization of irrigation, land size and uses of fertilizer are positively and also insignificantly affect calorie availability but age of household head and adult equivalent ratio affect negatively. The empirical investigation about determinants of food security status of rural households indicates being food secured and food insecure is influenced by various factors. Generally, socio-economic characteristics and environmental factors like livestock diseases outbreak are considered in this study as factors which influence the food security status of households in Asayita *woreda.*

2.5.3 Effect of income diversification on household food security

For small holder farmers income diversification or participating in non farming activities has both positive and negative impacts Reardon *et al.*(1998), and also there is some controversy about the impact of income diversification on food access which are short run and long run effect. In the short run participating in income diversification or non/off farm activities and raising the cash is important to fill the food deficit. However, the controversy comes from the long run effect of income diversification or participating in non/off farm activities may reduce the availability of food and gradually it leads to food insecurity. According to Agbola *et al.* (2008), income diversification strategies are fruits, vegetables and sold farm labour to supplement cash income and to reduce household food insecurity. Households that combined enterprises were better off and able to meet their capital expenditure.

Additionally, According to Degefa Tolossa (2005), Small holder farmers often feel food secure throughout the year by participation in crop production and livestock rearing or through running own non-farm ventures or to work with somebody else. As he further explains, a small holder household is food insecure when it is incapable of sufficiently feed its household members from its own production or purchase from the market in return to own cash, which may be earned from the exchange of self-endowment. Arising from the above reviewed literature, this study will provide value addition to the literature on link between food security status of small holder farmers and income diversification strategies.

Similarly, according to Bereket Zerai and Zenebe Gebreegziabher (2011), on the study of effect of non-farm income on household food security in eastern Tigrai, Ethiopia to examine the effect of non-farm employment on food security status indicates that it creates additional income that enables small holder farmers to spend more on their basic needs including food, education, closing and health care. In addition to the above studies according to Bassie Yizengaw (2014) the coefficient of herfindahl diversification index is positive and significance at 5% level of significance. In other words, the higher the level of the household income diversification, the more food secures the households. The possible explanation for this as our prior expatiation, diversification of income sources provides an additional income that enables farmers to spend more on their basic needs include food consumption, education, closing and health care. Increase in the level of income diversification helps the households to revitalize from different shocks which make farm households food insecure. This result also consistent with the study of Oyewole (2012) in Nigeria with estimated coefficient of income diversification (0.877) was positive and significant at 5 percent level of significance. This implies that, as income diversification increases, food security of the households increase.

3. RESEARCH METHODOLOGY

3.1 Description of the Study Areas

The study was conducted in Asaita woreda, which is one of the *woreda* in the Afar region of Ethiopia. According to CSA (2012), it is part of the administrative of Awisi zone. Naturally, it is plain in terms of topography. In this *woreda* there are 13 kebles from which eleven are rural and the reaming two are urban kebles (WAO, unpublished 2017). Asaita *woreda* is bounded on the West by Dubti, on the South by Afambo, then on the North by the Awash River which separates it from Elidar, and on the East by Djibouti. The town has latitude and longitude of 11°34′N 41°26′E and an elevation of 300 metres (980 ft). In the woreda, pastoral and agro-pastoral system of livestock production is the dominant practice. The livestock population in the districtis71,383 cattle,16,943 sheep, 23,086 goats, 3,277 camel, and 482 donkeys (APARDB, 2009).
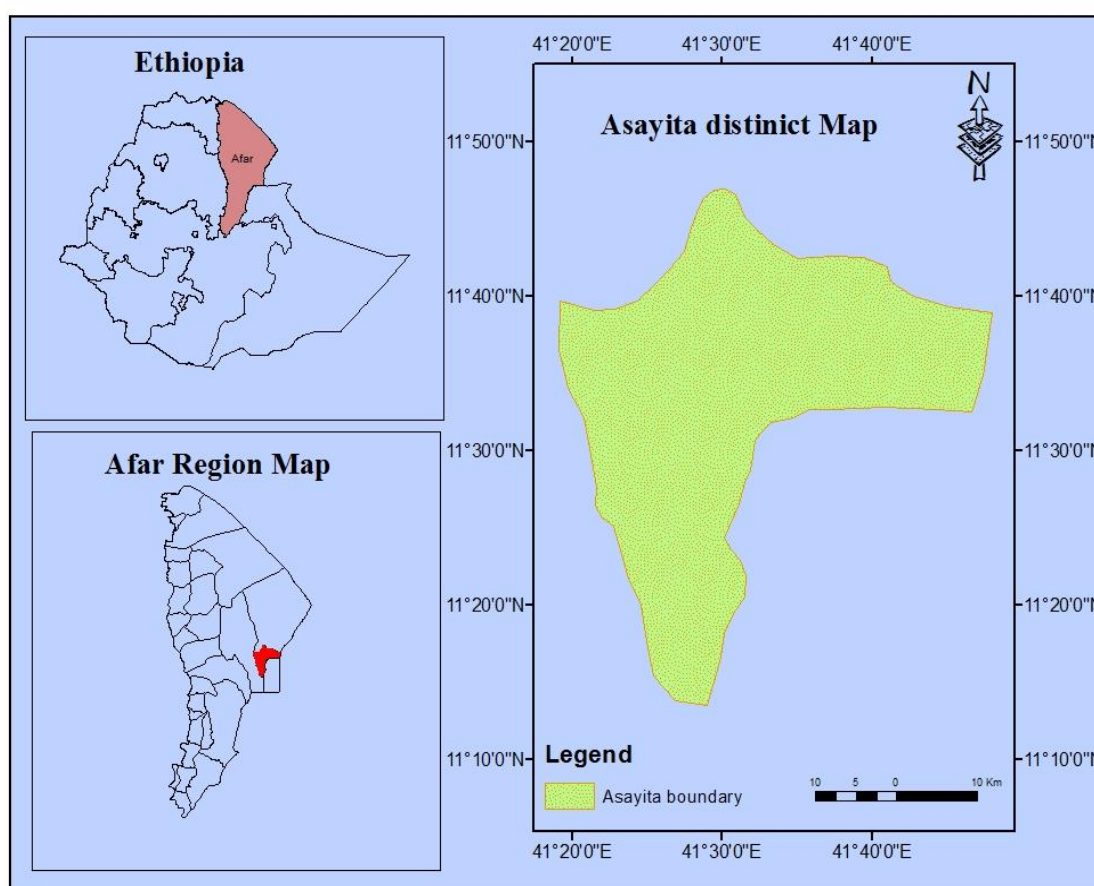
Figure 1: Map of the study area

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Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), the *woreda* has a total population of 50,803, of whom 27,284 are men and 23,519 women; with an area of 1,678.28 square kilometres, Asayita has a population density of 30.27. According to the CSA (2007) interviewed 3036 farmers in this *woreda,* who held an average of 1.78 hectares of land. 9.95% of the farmers both raise crops and livestock, while 25.79% only grow crops and 64.26% only raise livestock. Land tenure in this *woreda* is distributed between 66.49% own their land, 14.09 % rent, and the remaining 19.42% are held under other forms of tenure. For the land under cultivation in this woreda, 66.21% is planted in cereals like maize; none of the land was planted in pulses, but 9 hectares was planted in fruit trees, 0.81 hectares in bananas and 0.41 in guavas. Asaita town is one of the towns in Ethiopia located within the rift valley system. Its location connected with low altitude, makes it to have warm temperature. The temperature is very much varies among seasons, and the months of December and January are comparatively cold months while June, July, Augest and September are the hottest ones. The mean temperature is between 30ºc and 45ºc per annum. Bereha is the dominant agro-climatic zone covering 99.33% of the region with an average temperature greater than 27.5C° (ANRS, 2010).

3.2 Sample Size and Sampling Technique

Due to limited resources of finance, labour and time, it is mandatory to take a sample but need to worry about its representatives of the population under study. In doing so, the study attempted to select a sample following the laws of the statistical theory of sampling that help to make valid inferences about the population basing on the information or data obtained from the sample and to ascertain the degree of accuracy of the results. The total amount of households in Asayitta *worda* were 9943.Therefore, the sample size of this study was determined based on the following formula developed by Yamane (1967) and table one indicates the composition of sample households drawn in the study areas.

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

Where: n= sample size (153),   N=household size (9943) and   e= level of precision (0.08)

Table 1: Total population and sample size of small holder farmers by sample kebeles

Kebeles	Total number of households in the population	Percent	Number of sample households
Bergaset	1243	41.57	64
Kereguda	987	33.01	50
Mamulye	760	25.41	39
Total	2990	100	153

A total sample of 153 rural households was chosen randomly from a total of 2990 small - holder farmers inhabited in the three sample *kebeles* selected from Asaita *woreda.* The study used two stages sampling in combination with stratified and simple random sampling procedures to select the study *kebeles* and households. Asaita from the seven *woreda* in zone one was selected as the target *woreda.* In the first stage, three among the total 13 *kebeles* found in the *woreda* were drawn after stratifying them into three strata as near, medium and far based on the criteria of their distance from *woreda* town, three sample *kebeles* one from each strata were selected by using simple random sampling techniques. The study considered distance from *woreda* town as a stratification variable because it is afactor that plays an impo rtant role for rural households to diversifying their income sources or to participate in to non f arm activities (Bekelu Teshome and Abdi Khalil Edriss, 2013; Mideksa Fufa, 2015; YishakG echo, 2017). Finally, representative samples of 153 rural households were drawn from the total households following a lottery method of simple random sampling techniques.

3.3 Sources and Methods of Data Collection

Both primary and secondary sources were used for the study. The primary data were collected from sample rural households through interview using semi-structured questionnaires prepared and pre- tested for its validity and reliability. Structured interview schedule was used to collect data from sample households, focusing on the socio-economic, demographic, geographic and institutional characteristics of the respondents, existing income sources of households, the factors that influence non-farm income generating activities and

food security issues. Primary data were also collected from representatives of various government offices through use of the checklists prepared to guide the focus group discussions and key informant interviews. Both primary and secondary data were collected using qualitative and quantitative approaches since the study was specifically a survey method.

 Figure 2: Individual household interview

Focus group discussions were conducted to obtain supplementary information through clearly stated checklist. In each sample *kebeles* administration a FGD was held with a group of 8-12 people (Figure 3) for collecting data related to existing income sources in the study area, linkages between farm and non-farm activities, participation of people in different income generating activities, information about factors that influence income diversification strategies and the impact of income diversification on food security.

Figure 3: Focus group discussion with representatives of the rural community

Key informant interview was the other approach that used to collect qualitative data through using semi-structured interview guideline from selected 15individuals who know about the situation of that *woreda* in the three *kebeles* that could deliver baseline and background information clearly on the issues such as major sources of income of households, availability and use of improved agricultural technologies, frequency of extension contact, relationship between farm and non-farm activities, problems related to farmers' access to irrigation, credit utilization, market and transportation services, factors that affect income diversification activities and the effect of income diversification on food security in the *woreda.* Relevant and necessary secondary information and records for the study were collected through an in-depth review of the relevant published and unpublished literatures from different sources such as journal articles, reports of government and non governments' organizations, books and conferences, and internets. Accordingly, information that was used to describe geographical location and socio-economic activities of the study area were collected from Asaita *woreda* agriculture and rural development office.

3.4 Methods of Data Analysis

The empirical data were analyzed using both descriptive and inferential statistical tools. The information collected in the form of focus group discussion and key informant interview were presented in narrative form. STATA, SPSS and DASP(Distribute Analysis Stata Package) software were employed to analyze quantitative data. In addition to descriptive and inferential statistics fractional response probit regression model and binary logit model were used.

3.4.1 Estimating the degree of income diversification

Household income diversification consider diversification as a move away by rural households from growing crops (that is, being pure cultivators) to off-farm or non-farm labor, rearing livestock or migration of some members of the household to other cities (Brugère *et al.,* 2008). Household income diversification has been measured in various ways in the empirical literature. Singth (2018) indicated that there are quite a few methods which explain either concentration (that is, specialization) or diversification of commodities or activities in a given time and space by a single indicator, important ones include index of maximum proportion, Herfindal index, Simpson index, Ogive index and Entropy index. All indices measuring concentration utilize percentage shares of individual firms in a geographic market. But the difference resides in how to consider such percentages (Shepard, 1979).

Index of maximum proportion is used to determine farm level diversification. The expression is given as:

Index of maximum proportion (M_d) = Max P_i

Where P_i = the proportion of ith activity in total income. With increase in diversification, maximum proportion held by any activity (Jha B.K. and Jha D, 1995).

Hirschman Herfindahl index (HHI) is used to measure the degree of industry concentration. It can also be used to measure the degree of concentration of income from various sources at the individual household level. It is then calculated as the sums of squares of income shared from each income source. If a household has only one source of income the value of Hirschman Herfindahl index is one (Babatunde and Qaim, 2009). Ogive Index was first employed by Tress (1938) to study diversity in the field of economics. The Ogive measure can easily overestimate the degree of diversity between countries. To overcome this problem, one could use the modified Ogive Index of Jalan, J. and Ravallion, M. (1998) which employs absolute

deviations instead of squared values. The Ogive Index has been implemented by various studies in the context of country specialization (Bahl *et al.*, 1971); Hackbart and Anderson, 1975); Wasylenko and Erickson, 1978; Attaran and Zwick (1987). Entropy index is applicable to measure the extent to which groups is evenly distributed among organization (Massey and Denton, 1988). More specifically, Thiel and Anthony (1971) described entropy index as a measure of the average difference between a unit's group proportions and that of the system as a whole.

Simpson Index of Diversity *(SID)* is widely used to measure the level of income diversification. This study prefers (SID) to the other approaches used to estimate the degree of income diversification among farm households in the Asayita *woreda*, as it takes into consideration both the number of income sources as well as how evenly the distributions of the income between the different sources are (Joshi *et al.*, 2005; Agyeman *et al.,* 2014; Tithy Dev. *et al.,* 2016). The value of SID ranges between zero (0) and one (1). Thus, zero denotes specialization (only one source of income, where Pi = 1) and one the extremity of diversification.

The general formula of SID is given as:

$$SID = 1 - \sum_{i=1}^{n} p_i^2$$

Where *n* =number of income sources, P_i=Proportion of income coming from the source i^{th} source *to* the total household income obtained from all sources, and i = 1, 2... n.

In this study, the SID model is expressed as:

$$SID = 1 - \left\{ \left(\frac{CI}{THI}\right)^2 + \left(\frac{LI}{THI}\right)^2 + \left(\frac{FWI}{THI}\right)^2 + \left(\frac{NFWI}{THI}\right)^2 + \left(\frac{SEI}{THI}\right)^2 + \left(\frac{RMI}{THI}\right)^2 + \left(\frac{RTI}{THI}\right)^2 + \left(\frac{OI}{THI}\right)^2 \right\}$$

Where CI= Crop income, LI= Livestock income, FWI= Formal wage income, NFWI= Non formal wage income, SEI= Self-employment income, RMI= Remittance income, RTI= Rent income, OI= other income sources, and THI= Total household income from all income sources.

3.4.2 Determinants of income diversification for small holder farmers

The fractional outcome probit regression model is used to identify the factors that determine rural household's engagement in income diversification (measured by SID with values limited between 0 and 1). Fractional outcome probit regression model is applicable if the dependent variable is explained in the form of fractions, proportions, rates, indices and probabilities. Fractional outcome regression probit models are applicable as the value of dependent variables in this case income diversification is indices specified in [0, 1] or (0, 1). This is because using the fractional outcome regression probit methods for estimating the influence of explanatory variables on the dependent variables whose values are limited in [0, 1] or (0, 1) help avoid model misspecification and doubtful statistical validity and if we simply use regress, give state predictions could fall outside those intervals and hence fracreg and betareg captures particular non linear relationships, especially when the outcome variable is near 0 or 1 (Wooldridge, 2011).

The fractional response model (FRM) is an extension of the general linear model (GLM) to a class of functional forms that circumvent most of the known issues of the traditional econometric models for bounded variables. The fractional response probit accounts for the roundedness of the dependent variable from both above and below, predicts response values within the interval limits of the dependent variable and captures the nonlinearity of the data, thereby yielding a higher fit compared to linear estimation models. Furthermore, the fractional response probit regression does not require special data transformations at the corners and permits a direct estimation of the conditional expectation of the dependent variable given the predictors. The estimation of the model's parameters is based on a quasi-maximum likelihood method (QMLE), which generates fully robust and relatively efficient estimates under general linear model conditions (Papke and Wooldridge, 1996).

The dependent variable in many economic models is often proportion, percentage or fraction. Cook *et al*. (2008) indicated that many studies in corporate finance ignored the fact that proportion, percentage or fractional data are not normally distributed since data in these form are not observed and defined over the range of the normal distribution. The bounded nature of the fractional dependent variables raises some important issues in estimation and inference. To assume a linear functional form in estimating these models is conceptually flawed. Until the discovery of fractional regression models (FRM), the simple OLS (ordinary least square)

regression with Gaussian distributional assumption remained the most popular method to model fractional outcomes due to its simplicity.

According to Kennedy (2003), some of the desirable properties of the OLS estimate may no longer hold in case of a continuous fractional or proportional dependent variable. It is therefore required to use an appropriate estimation technique to analyze bounded nature data. Over the past years researchers who have interest in statistical models for fractional outcomes have developed models for data analysis in the financial, education and other sectors of the economy. The distinctive statistical nature of fractional outcomes is that the variance is not independent of the mean. For example a problem of heteroscedasticity is seen in regression models where the variance shrinks as the mean approaches boundary points [0, 1]. It is also important to note that fractional outcomes in a unit interval are not defined on the whole real line hence they should not be considered normally distributed. It is important to note that data measured in a continuous scale and restricted to the unit interval, i.e $0 < y < 1$ as in the case of percentages, proportions, fractions and rates.

Papke and Wooldridge (1996) used fractional outcome regression model to analyse 401(k) retirement plan participation rates, Papke and Wooldridge (2008) test pass rates for exams on students, Calabrese, R. (2012), probability of a defendant's guilt and the verdict and gini index values for the prices of art. Fractional outcome regression methods include both fracreg (fractional response regression) and betareg (Beta regression) models. Beta regression (Betareg) models are applicable when the dependent variable is not including zero and one but between zero and one. Fractional response probit regression (fracreg) model is applicable when the dependent variable includes zero, values between zero and one and one itself.

In this case the presence of zeros and one as values of the dependent variable (SID) for some respondents (thus showing no diversification and extreme diversification) demands the use of fractional response probit regression model. Under the general formulation for fractional response regression model we have a continuous dependent variable y in [0, 1], and a vector of independent variables (x). Fit a regression for the mean of y conditional on x: E(y/x) because y is in [0, 1], restrict that E(y/x) is also in [0, 1]. Papke and Wooldridge (1996) consider the following model for the conditional expectation of the fractional response variable.

$$E\ (y_i/x_i) = G\ (x_i\ \beta) + \varepsilon_i\ ,\quad i = 1,2\ldots\ldots\ldots\ldots N$$

Where $0 \leq y_i \leq 1$ denotes the dependent variable SID and (the $k \times 1$ vector) x_i refers to the explanatory variables of observation i typically, $G(.)$ is a distribution function.

The specification of fractional response regression model that used to identify determinants of income diversification (SID) of the households is expressed as follows,

SID= β_0+ $\beta_1$sex+ $\beta_2$age+ $\beta_3$edu+ $\beta_4$household size +$\beta_5$dependncy ratio+$\beta_6$recive remitance+β_7 farm size+β_8 livestock ownership+β_9 access to electric power + β_{10} special skill+β_{11}annual household income+β_{12}access to tranning+β_{13}utlization of formal credit+β_{14} distancefrom market +e_i

3.4.3 Measuring food security status of households

For measuring food security status of households two methods have been widely applied in earlier studies (Maxwell S., 1996). The first method is called expenditure method for which the index is: Food security = (food expenditure of ith household ÷ two-third of the mean per capita food expenditure of all households) (Omonona, 2007). The second method is called calorie intake method (Olayemi J. K, 1998; Fakiyesi, O. M., 2001; Ejigayhu Sisay and Abdi-Khalil Edriss, 2012; Tewodros Tefera and Fikadu Tefera, 2014; Tibebu Aragie and Sisay Genanu, 2017). The daily calorie intake method is better than food expenditure method as the former represents the actual food consumption pattern of households. Therefore, this study used the daily calorie intake approach to measure the food security status of households based on the food security line defined in terms of the daily calorie intake recommended by (FAO, 2005). The government of Ethiopia has set the minimum acceptable weighted average food requirement per person per day at 2100 kilo calorie (FDRE, 1996) as cited in Kifle Lemma and Yosef Gebrehiwot (1999); Shiferaw Feleke *et al. (*2003); Tewodros Tefera and Fikadu Tefera (2014) and Alem Shumiye (2015) which is estimated to be 225 kg of food (grain equivalent) per person per year. The food security line which is 2100 kilo calorie used as a cut of point after converting all household members in to adult equivalent unit (May J., 1996; Swindale A. and Ohri-vichaspati P., 2005).

The formula of adult equivalent is as follows.

$$\text{AEU= (A+0.5C)}^{0.9}$$ .... Tibebu Aragie and Sisay Genanu (2017)

Where, AEU = Adult equivalent unit,

A = Number of adults above the age of 15 years,

C = Number of children below the age of 15 years in a household.

There are two steps to construct a food security index such as identification and aggregation (Coates J. *et al.,* 2007). Identification is the process of defining a minimum level of food necessary to maintain a healthy life and this is known as the food security line which is 2100 kcal/day/AEU. Aggregation is the process of deriving the food security statistics for the households.The household daily calorie intake is obtained from the survey and where the quantity of food consumed by the household is estimated in the 7 days period.The calorie content is estimated by using the nutrient composition table of commonly eaten foods in Ethiopia. Weekly per capita calorie is calculated by dividing estimated total household calorie intake by the family size (all adult equivalent) and to get the household's daily per capita calorie intake divided the household's per capita calorie intake by seven (Babatunde *et al,.* 2007). A household whose daily per capita calorie intake is at least 2100 kcal/day/AE is regarded as food secure, while those with less than 2100 kcal/day/AE are food insecure.

The food security index as applied (Fakiyesi O. M., 2001) is given by the formula as

$$F_i = Yi/R$$

Where, F_i =Food security index (Food security status) of the ith household)

Y_i = Daily per capita calorie intake of the ith household

R = Recommended per capita daily calorie intake (2100 kcal per day per adult equivalent).When, $F_i \geq 1$, the ith household will be food secure and Fi < 1, the ith household will be food insecure

A food secure household is that whose daily per capita calorie intake is above or on the recommended per capita daily calorie intake line. On the other hand, a food insecure household is that whose daily per capita calorie intake falls below the recommended per capita daily calorie intake line. Based on F_i, other related measures are calculated and these are the HCR (head count ratio), shortfall/surplus index (P), and the food insecurity gap (Fakiyesi O. M., 2001; FAO, 2005).

Foster, Greer and Thorbeck (FGT) index

To estimate head count ratio, food insecurity gap and severity of household food insecurity the Foster, Greer and Thorbeck (FGT) index was employed. This model was used by international food policy research institute (IFPRI) for the analyse the extent of household food insecurity (Hoddinot, 2001).Several researchers have used the FGT model to analyze the extent of severity of poverty and food insecurity (Amsalu Mitiku *et al.,* 2012; Mequanent Much *et al.,* 2014; Tibebu Aragie, and Sisay Genanu, 2017)**.**

The FGT model can be expressed as follows

$$P(\alpha) = \frac{1}{N} \sum_{i=1}^{q} \left(\frac{m - y_i}{m} \right)^{\alpha}$$

Where: N is the number of sample households,

q represents number of food insecure households

m represents the cut off between food security and insecurity

y_i is the measure of per adult equivalent calorie intake of the ith household and

α   is the   weight attached to the severity of food insecurity

As far as the weight to α is concerned, Hoddinot (2001) further explained that giving no weight to the severity of food insecurity is equivalent to assuming that α = 0. So then, the formula collapses to P (0) = q/n, this is called the head count ratio. Giving equal weight to the severity of food insecurity among all food insecure households is equivalent to assuming that α = 1. Summing the numerator gives the food insecurity gap; dividing this by m expresses this figure as a ratio. This index p (1) provides the possibility to estimate resources required to eliminate food insecurity through proper targeting. That is, the product (n*m*p1) gives the total calorie commitment required to bring the food insecure households to the given daily calorie requirement level. Further giving weight to the severity of food insecurity among the most food insecure households is equivalent to assuming that α > 1. Hence P (0) is headcount index and it defines the proportion of the population whose measured standard of living is less than the poverty line, P (1) is food insecurity gap measures the distance to the poverty

line for the average poor person and P (2) is the severity of food insecurity which indicates the most sever group from food insecure households.

3.4.4 Determinants of food security status for small holder farmers

Binary logistic regression analysis is based on predicting a binary dependent outcome from a set of dependent variables. When the dependent variable is binary, multiple linear regression model, binary logit and probit models can be used (Green W., 2003). Fitting the standard multiple linear regression model of a binary response variable on a set of continuous and dichotomous regression encounters violations of some of the fundamental least squares assu mptions homoscedasticity, normality of errors, and the predicted values that the regression analysis yield could fall outside the range 0 to1 (Montgomery and Peck, 1992). Probit model, which is the inverse of the Gaussian distribution, has similar type of limitations and advantag es with logistic regression.

The logistic and probit transformations are quite similar to each other, but from the computati onal viewpoint, the logistic transformation is more convenient. The logistic transformation is preferred to other transformations due to its direct interpretation in terms of the logarithm of the odds in favour of a success. Besides, models that are based on the logistic transformation are particularly appropriate for the analysis of binary type of dependent variable (Collet, 1991). Since the dependent variable is binary outcome binary logit regression model is applicable. Many researchers like Fekadu Beyene and Mequanent Muche (2010); Amsalu Mitiku *et al. (*2012); Indris Siraje and Adam Bekele (2013); Mequanent Much *et al.,* (2014) used binary logit regression model to identify the determinants of food security status of households.

Let, the probability that a household is food secure can be written as

$$P_i = E \ (Y=1/ \ X_i) = \beta_0 + \beta_i X_i + ... + \beta_n \ X_n + u_i$$

Where, P_i = the probability of an ith household being food secure stands for dummy, X_i is the independent variable and Y=1 means that the household is food secure and y=0 the household is food in secure.

Whereas:

β_0	Constant	X_7	Farm size
β_i	Coefficient of explanatory variable	X_8	Tropical livestock unit
X_1	Sex of household headed	X_9	Livestock diseases
X_2	age of household head	X_{10}	Credit utilization
X_3	Educational statuses	X_{11}	Distance from market
X_4	Household sizes	X_{12}	Number of extension contact
X_5	Dependency ratios	X_{13}	Annual household income
X_6	Remittance	X_{14}	Level of SID

Multicollinearity is a research problem that exists when the relationship between explanatory variables are perfect. The aim of this diagnosis was to show the relationship between variable aren't linear. Multicollinearity problem makes significant variable insignificant. The problem of multicollinearity is serious when VIF is equal to 10; $R^2=0.9$ and tolerance is close to zero for continuous variables and contingency coefficient close to one for discrete variables. The existence of multicollinearity problem between continuous explanatory variables were detected by variance inflation factor (VIF); whereas, contingency coefficient (C) was used to detect multicollinearity problem between discrete explanatory variables.

Mathematically:

$$VIF_j = \frac{1}{1-R2}$$

Where; $R^2 =$ Coefficient of determination

$VIF_j \geq 10$ then there is a problem of high multicollinearity

In addition to muliticolinality hetrosckedasticity and endoginity test were check by using appropriate test.

3.5 Operational Definition of Variables and Hypothesized Relationships

This section presents the dependent variable and explanatory variables of the study with their hypothesized effect on the dependent variable.

Dependent variables: Income diversification (SID) is a continuous variable and indicates degree of income diversification of household engaged in farm alone income generating activities or farm and non-farm income generating activities. It depends on their engagement in income sources and the amount gained from each income sources. Food security status (FSI) is the other dependent variable with dichotomous, discrete choices of food secure and food insecure households.

Explanatory variables: Based on the information gleaned from an in depth review of both theoretical and empirical literatures on the similar topics of this study, the potential explanatory variables of income diversification and food security status are identified, defined/described and their relationship with the dependent variables are hypothesized as follows.

Male headed household (MALEHEAD): This is measured as a dummy variable taking the value of 1 for male headed household and 0 otherwise. Most of the time male headed households perform well compared to female headed both in income diversification activities and improving food security status. As a result, this study hypothesized that male headed household's level of income diversification and being food secured more than female headed households. This hypothesis is supported by the empirical findings of (Amare Demissie and Belaineh Legesse, 2013).

Age of household head (AGE): It is a continuous explanatory variable measured in number of years. As age of the household head increases, it is assumed that s/he acquire more knowledge and experience about income diversification in their day to day activities because older household heads have better information about the trends of income diversification and their contribution towards the food security status of the society as compared to young household heads. As a result, this study hypothesized that age of the household head has positive relationship with level of income diversification and positive relationship with food security status. This hypothesis is supported by the empirical findings of (Bereket Zerai and Zenebe Gebreegziabher, 2011; Adugna Eneyew, 2012).

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Educational status (EDUSTAT): Educational status of the household head is measured in terms of dummy variable which takes 1 if the head is literate and 0 otherwise. It is an important determinant of income diversification and food security status. This is because of the fact that education enhances farmers' ability to perceive, interpret, and respond to new technology. This study hypothesized that literate household head has positive relationship with degree of income diversification and food security status. This hypothesis is supported by the empirical findings of (Girma gezimu, 2012; Beyan Ahmed, 2016).

Household size (HHSIZ): This is a continuous variable which refers to the number of household members in a household. Household size is an important factor for income diversification. This study hypothesized that household size of the household head has positive relationship with degree of income diversification and negative effect on food security status. This hypothesis is supported by the empirical findings of (Fekadu Beyene and Mequanent Muche, 2010; Bereket Zerai and Zenebe Gebreegziabher, 2011).

Dependency ratio (DEPR): It is a continuous variable measured as inactive labour force (<15 years and >65years) divided by the number of individuals working to support the household (15-64 years). The presence of dependent household members tends to create pressure on active labour force both in cash requirement and labour to support them. This situation reduces the household's level of income diversification and food security status. So, it has a negative relation for both for level income diversification and food security status of households. This explanation is supported by (Tibebu Aragie, and Sisay Genanu, 2017)

Receiving remittances (REMITA): Receiving remittance refers to relative economic support in the form of money or kind to the household received from relatives and friends not presently living with the household. This variable is dummy variable which takes the value of 1 if the household receives remittances and 0 otherwise. This study hypothesized that receiving remittance positively related with level of income diversification and food security status of households. This explanation is supported by (Agboola, 2004; Mideksa Fufa, 2015).

Farm size of the household (FARMSIZ): It is continuous variable and refers to the size of farm owned and cultivated by household in hectare. The higher the land size for cultivated, the more s/he is being food secure and leads to less participation in non-farm income generating activities. So, it is positively hypothesized with food security status and negatively

related with level of income diversification. This hypothesis is supported by the empirical findings of (kidane *et al.,* 2005).

Livestock ownership (LIVESTOCK): This refers to the total number of livestock owned by the household measured using Tropical Livestock Unit (TLU). Those households who have more number of livestock will contribute more for food security status because livestock are the major source of income in our country, Ethiopia. It is positively hypothesized with food security status and negatively related with level of income diversification. This hypothesis is congruent with the empirical findings of (Shishay Kahsay and Messay Mulugeta, 2014; Yishak Gecho, 2017).

Frequency of Extension Contacts (FEXTC): This is continuous variable. The variable refers to the number of times the household received advice/training from extension agents' within a year. It was measured as number of household heads contact extension agents per year. Household who got more extension contact have a chance to improve production system and increase productivity so that it improves food security situation and decrease degree of income diversification.

Access to training (ATTRA): This variable is measured as a dummy taking a value of 1 for those household heads who have gotten training on farming and non- farm income generating activities and 0 otherwise. The household head who has gotten training is more diversified than not taking training. This explanation is supported by (Tibebu Aragie, and Sisay Genanu, 2017).

Utilization of formal credit (CREDITU): It is dummy variable, which takes a value of 1 if the farm household uses credit and 0 otherwise. Credit utilization is important for income diversification and food security status as it solves liquidity problem to start new business and increasing purchasing power of household. This study hypothesized that credit utilization of the household head has positive relationship for both level of income diversification and food security status. This hypothesis is supported by the empirical findings of (Bereket Zerai and Zenebe Gebreegziabher, 2011; Girma gezimu, 2012).

Distance from the market (DAM): It is continuous variable. This is the distance between household living area and the place where a household can get necessary things for their production and consumption. It refers to the distance of the household's home to the nearest market centre measured in hours of walking on foot. This study hypothesized that distance

from market of the household head has negative relationship for both level of income diversification and food security status. This hypothesis is supported by the empirical findings of (Yisihake Ergicho and Abebe Markos, 2015).

Access to electric power supply (ACCEP): It is dummy variable, which takes a value of 1 if the households have electric power access and 0 otherwise. To participate in income diversification activities electric power access is an important variable. Based on this it is positively related with level of income diversification. This hypothesis is congruent with the empirical findings of (Bereket Zerai and Zenebe Gebreegziabher, 2011).

Special skill (SKILL): For income diversification and food security having special skill of household is important factor. It is dummy variable, which takes a value of 1 if the household has special skill (masonry, handcrafts etc.) and 0 otherwise. Household having special skill has higher level income diversification index than not having special skill. This hypothesis is congruent with the empirical findings of (Bereket Zerai and Zenebe Gebreegziabher, 2011).

Incidences of livestock diseases (LIVEDISE): It is dummy variable, which takes a value of 1 if the diseases are occurred within this year and 0 otherwise. This study hypothesized that Incidences of livestock diseases has negative relationship with food security status. This is because those pastoralists who face the incidence of livestock diseases, could lose a significant portion of their income for treating sick animals and productivity and income loses could lead to food insecurity. This hypothesis is supported by the empirical findings of (Indris Siraje and Adam Bekele, 2013).

Annual household income (INCOME): It is a continuous explanatory variable measured by the amount of Ethiopian birr earned annually. Income of the household is the major determinant for income diversification and food security status. The more the income the household head has the more diversification index and improved food security status. This hypothesis is in line with the findings of (Tibebu Aragie, and Sisay Genanu, 2017; Yishak Gecho, 2017)**.** In addition to the above demographic, economic, institutional and geographical factors for food security status   income diversification is used as explanatory variable and it continuous variable.

Table 2: Definition of variables and hypothesized relationships

Variables	Definition	Measurement	Expected sign	
			SID	FSI
MALEHEAD	Sex of household	Male/female 1 if male, 0 Otherwise	+	+
AGE	Age of household	Years	+	+
EDUSTAT	Educational status	1 literate,0 otherwise	+	+
HHSIZ	Household size	Number	+	-
DEPR	Dependency ratio	Ratio	-	-
SKILL	Special skill	Yes/no 1 if yes, 0 otherwise	+	+
INCOME	Annual income of hh	Birr	+	+
LIVEDISE	Livestock diseases	Yes/no 1 if yes, 0 otherwise	-	-
ACCEP	Electric power access	Yes/no 1 if yes, 0 otherwise	+	+
DAM	Distance from market	Hour	-	-
REMITA	Remittance	Yes/no 1 if yes, 0 otherwise	+	+
ATTRA	Access to training	Yes/no 1 if yes, 0 otherwise	+	+
FREQEXT	Extension contact	Numbers of contact	-	+
CREDITU	Credit utilization	Yes/no 1 if yes, 0 otherwise	+	+
LIVEST	Tropical livestock unit	TLU	+	+
FARMSIZ	Farm size	Hectare	-	+
SID	Simpson index	Continuous		+

4. RESULTS AND DISCUSSION

This section discusses the results of descriptive analysis of socio-economic characteristics of households because of their perceived effect on income diversification and food security status, descriptive analysis age, sex, household size, farm size, educational status, extension contact, utilization of improved agricultural input, marital status, access to training, utilization of credit and level of income diversification status among others.

4.1 Socio-economic Characteristics of Households across Food Security and Income Diversification

This section presents both categorical and continuous variables and their association with food security status and level of income diversification of households. Based on table three among 153 sample households, 118 were male headed households; whereas 35 were female headed households. As far as sex ratio of the household head is concerned, male headed households are greater female headed households. From food secured households, 72.1% were male-headed, and 27.9% were female-headed. Similarly, within food, insecure households 80.4% and 19.6% were male and female-headed respectively. The chi-square test of association of sex of household and food security status is not significant. Regarding their marital status, about 80.39% of sample households were married while 13.73% and 5.88% were divorced and widowed respectively. From food secure households, 80.33% were married while 13.11% and 6.56% were divorced and widowed respectively. Similarly, within food insecure households, 80.4% were married while 14.2% and 5.4% were divorced and widowed respectively. The chi-square test of association of marital status of household head and food security status is not significant.

Distribution of the respondents by educational status indicates that 40.52% had literate and 59.48% had illiterate. These results showed that majority of the respondents in the study area were illiterate. From food secure households 85.25% were literate and 14.75% were illiterate. Similarly, within food insecure households, 10.87% were literate while 89.13% and were illiterate. The chi-square test indicates that household educational status associate with food security status significantly at 5 percent probability level.

From the total sampled household 39.22% are got remittances from financial support, non-governmental organization and from their families living elsewhere but 60.78% were not get remittance. The chi-square test indicates that household receiving remittance associate with food security status significantly at 1percent probability level. From total sample respondents' 59.48% of household have no credit access and 40.52% of households have credit access. There is significant difference between food secured and insecure households who had credit access with percentage of 24.6 and 51.09%. The chi-square test indicates that credit utilization is associate with food security status significantly at 5percent probability level.

On average the 56.49% of sample household have not utilized improved agricultural input while 43.51% have utilized agricultural input. The chi-square test revealed that there is no significant mean difference between food secured and food insecure household who utilize improved agricultural input. Improved agricultural input includes utilization of improved seed, fertilizer, pesticide and herbicide. From our sample respondents'87.58% of household have own land and 12.42% of households have no own land which they cultivated. There was statistically significant difference between food secured households who own land and not with chi-square test at 10 percent probability level. Distribution of the respondents by received training during 2009 production year 48% got training but 52% were not take any types of training. From food secured household 87.5% of household received training while 12.5% were not got training. Similarly, within food insecure households 22% got training but 78% are not received any training. The major training providers were district of agricultural office and non- governmental organizational (NGO) staffs and types of training were farming, finance and credit management, health training, gender based training. But training provides by the above institutions were not focus on different income generating activities other than farming. The chi-square test revealed that there is a significant mean difference between food secured and food insecure household who take training at 10 percent probability level.

Table 3 : Descriptive statistics of categorical variables across food security

Variables	Variable descriptions	Food security status				Total household (n=153)		Chi-square value
		Food secure (61)		Food insecure (92)				
		Freq.	%	Freq.	%	Freq.	%	
MALEHEAD	Male	44	72.1	74	80.4	118	77.1	
	Female	17	27.9	18	19.6	35	22.9	1.024
MARITALSTA	Married	49	80.33	74	80.4	123	80.39	
	Divorced	8	13.11	13	14.2	21	13.73	
	Widowed	4	6.56	5	5.4	9	5.88	2.459
EDUSTAT	Literate	52	85.25	10	10.87	62	40.52	
	Illiterate	9	14.75	82	89.13	91	59.48	17.6**
REMITTANCE	Yes	46	75.4	14	15.22	60	39.22	7.33***
	No	15	24.6	78	84.78	93	60.78	
CREDITU	Utilize	15	24.6	47	51.09	62	40.52	-3.93**
	Not utilize	46	75.4	45	48.91	91	59.48	
INPUTUSE	Yes	40	65.58	26	28.26	66	43.14	0.98
	No	21	34.42	66	71.74	87	56.86	
LANDOWND	Yes	50	81.97	84	91.3	134	87.58	17.77*
	No	11	18.03	8	8.7	19	12.42	
ATTRA	Yes	53	87.5	20	22.2	73	47.71	65.75*
	No	8	12.5	72	77.8	80	52.28	

Note: ***, ** and * Significant at $P<0.01$, 0.05 and $p<0.1$ respectively

Source: Survey result, 2017

Based on table four presented below the mean age of the sample household heads was found 53.64 with a standard deviation of 13.08. The maximum age observed was 80 while the minimum was 26 years. The mean age of food insecure households was 49.57 years, and that of secure food households was 59.77 years. The t-test revealed that there is no significant difference in the mean age of the household head between food secure and food insecure households.

 The maximum and the minimum household size were fifty and two respectively. The mean household sizes for food secured households were 4.80 while for food insecure were 6.08. The average household size for the surveyed households was 5.57 with a standard deviation of 2.69. The study result shows that there is a significance difference between food secure and food insecure households based on average household size with t- value at 1 percent probability level of significance.

Table 4: Descriptive statistics of continuous variables across food security

Variables	Variable descriptions	Food secure households		Food insecure households		
		Mean	St. Dev.	Mean	St. Dev.	T-value
AGE	Age of household head	59.77	12.74	49.57	11.56	0.862
HHSIZ	Household size (number)	4.8	2.11	6.08	2.91	0.00[***]
DEPR	Dependency ratio	1.04	0.78	1.19	0.93	0.00[***]
FARMSIZ	Farm size (ha)	3.20	1.73	2.55	1.97	0.034[**]
LIVESTOCK	Livestock size (inTLU)	27.26	22.56	13.88	1.61	0.00[***]
FREQEXT	Frequency of extension contact (days/year)	17.5	17.16	21.23	16.48	0.096[**]
SID	Income diversification index of the household	0.62	0.08	0.26	0.179	0.00[***]
INCOME	Annual income of the household (ETB)	80071.59	28191.08	65009	27106.75	0.00[***]
DAM	Walking distance to local market (hours)	0.78	0.2	2.05	0.85	0.00[***]

Note: ***and**Significant at P<0.01and 0.05 respectively

 Source: Survey result, 2017

The survey result indicated that the average dependency ratios for the total sampled households were 1.13. The t-test indicates that dependency ratio relate food security status significantly at 1 percent probability level. The average land holding size of the study area is 2.81 hectare with standard deviation of 2.03, while the average land holding size for food secured and insecure households are 3.20 and 2.55 hectare respectively. Almost 12.42 percent of the respondents do note have their own land. The maximum amount of land in the study area was 5 hectares. The t- test indicates that land size associate food security status significantly at 5 percent probability level. The mean values of livestock holding for food secured households were 27.26 TLU while for food insecure were 13.88 TLU. The average livestock holding for the surveyed households was 19.39 TLU with a standard deviation of 19.7.The result of this study shows that there is a significance difference between food secure and food insecure households based on average livestock holding with chi-square value at 1 percent probability level of significance.

For food secured household the average number of extension contact is 17.50 with standard deviation of 16.79. Similarly for food in secure household the average number of extension contact is 21.23 with standard deviation of 16.48. The purpose of extension contact is to give advice on agricultural issue, to teach adult education and to give advice on finance and credit management. The t- test indicates that number of extension contact affect food security status significantly at 10 percent probability level.

The mean values of annual households' income for food secured households were 80,071.59 birr while for food insecure were 65,009 birr. The average annual households' income for the surveyed households was 71,211 birr with a standard deviation of 28,455.38. The study result shows that there is a significance difference between food secure and food insecure households based on average annual households' income with t-value at 1 percent probability level of significance. The mean distances from market/hour for respondent were one hour and fifty-three minutes. For food secured household the average distance from market per hour is one hour and sixteen minutes with standard deviation of 0.42. Similarly for food in secure household the average distance from market is two hour and seven minutes with standard deviation of 0.85. The t- test indicates that distance from market associate with food security status significantly at 1 percent probability level. Food insecure household went long distance as compared to food secured households.

Table 5: Descriptive statistics of categorical variables with income diversification

Variables	Variable descriptions	Diversification index (SID)				
					St.	
		Freq.	%	mean	Dev.	T- value
MALEHEAD	Male	118	77.1	0.24	0.26	
	Female	35	22.9	0.24	0.27	- 0.09
EDUSTAT	Literate	62	40.52	0.38	0.26	
	Illiterate	91	59.48	0.14	0.21	5.9***
CREDITU	User	62	40.52	0.22	0.26	
	Non user	91	59.48	0.25	0.26	0.76
ACCEP	Access	77	50.33	0.3	0.27	
	No access	76	49.67	0.17	0.23	3.5***
SKILL	Skill	55	35.95	0.51	0.14	
	No skill	98	64.05	0.09	0.18	2.7**
ATTRA	Yes	73	47.71	0.18	0.28	
	No	80	52.28	0.3	0.22	2.6**

Note: * and * Significant at P<0.01 and p<0.1 respectively**

Source: Survey result, 2017

Based on table five the level or degree of income diversification is affected by different socio economic characteristics of households. From the total sample households 77.1% was male and the remaining 22.9 were female headed households. The mean value of male and female were 0.24 with standard deviation of 0.26 and 0.27 respectively. The study t- test result shows that there is no significance difference between male and female households on the level of income diversification index. According to educational status of households 40.52 percent were literate and 59.48 were illiterate. The man values of literate and illiterate households were 0.38 and 0.14 respectively and the standard deviation were 0.26 for literate and 0.21 for illiterate households. T-test was employed to depict the association between educational status of the respondents and their level of income diversification. The result indicated that there is statistically significant association between educational status and level of income diversification at 1percent probability level. In terms of credit utilization of

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respondents 0.22 and 0.25 were the mean value for credit utilizes and none utilize and with 0.26 standard deviation respectively.

From the total sample households 50.33 percent were having access to electric power and the remaining 49.67 were having not access to electric power. The mean value of household who having access to electric power were 0.3 with standard deviation of 0.27 and for households who have not access to electric power were 0.17 with standard deviation of 0.23. The study t-test result shows that there is significance difference between having access to electric power and having no access to electric power households on the level of income diversification index at 1 percent probability level.

In terms of having special skill 35.95 percent of respondents were have special skill and the remaining 64.05 were have not special skill. The mean values of having special skill were 0.51 with standard deviation value of 0.14 but the mean values of don't having special skill were 0.09 with standard deviation value of 0.18. The result of t-test indicated that there is statistically significant association between special skill of households and level of income diversification at 5 percent probability level.

Access to training is another variable which affect level of income diversification and from sample households 47.71 percent of household's heads have got training access and the remaining 52.28 percent were not get training access. The mean value households who got training access were 0.18 with standard deviation of 0.28 and the mean value households who not got training access were 0.3 with standard deviation of 0.22.The t- test indicates there is significance difference among level of income diversification based on training access of households at 5 percent probability level.

Table 6 : Descriptive statistics of continuous variables with income diversification

Variables	Variable descriptions	Diversification index (SID)				
		Mean	St. Dev.	Min.	Max.	Correlation coefficient
AGE	Age of the head	53.64	13.08	26	80	-0.11
HHSIZ	Household size (number)	5.57	2.69	2	15	0.19**
DEPR	Dependency ratio	1.13	0.87	0	3	-0.17**
FARMSIZ	Farm size (ha)	2.81	2.03	0.5	5	-0.28***
LIVESTOK	Livestock herd size (in tropical livestock unit)	19.39	19.7	0	67	-0.15*
DAM	Walking distance to local market (hours)	1.53	0.95	0.2	4	-0.79***
INCOME	Annual income of the household (ETB)	74339.6	36664.12	12,000	276,300	0.37***

Note: *****, ** and * Significant at P<0.01, p<0.05 and p<0.1 respectively**

Source: Survey result, 2017

Based on the above table age of the respondents was a range from 26 to 80 years with a mean and standard deviation of 53.64 and 13.08 years, respectively. The correlation between age of the household and Simpson diversification index is not significant. Household size refers to the number of individuals who live in the same house having common goal for a minimum of six months. The survey result indicated that the average household size of the total observation was 5.57 with standard deviation of 2.69. Based on table six the maximum and the minimum household size were fifty and two respectively. The correlation between household size of the household and Simpson diversification index is significant positively at 5 percent probability level.

Based on dependency ratio the result of this study indicated that the minimum and maximum number of dependents were 0 and 3 with mean and standard deviation of 1.13 and 0.87, respectively. The correlation between dependency ratio of the household and Simpson diversification index is significantly and negatively at 5 percent probability level. The average size of the land owned by sample households was 2.81 hectare with standard deviation of 2.03 hectare. The maximum and the minimum land size were 5 and 0.5 hectare

respectively. The land size of the households with Simpson diversification index correlates significantly and negatively at1percent probability level.

Based on livestock ownership the result indicated that the respondents own 19.39 TLU on average with standard deviation of 19.7 TLU. The maximum and the minimum tropical livestock unit were 67and 0 TLU respectively. Livestock unit of the household and Simpson diversification index correlate significantly and negatively at 10 percent probability level. Distance from the market was considered as one factor for affecting the level of income diversification. The result indicated that the average distance of the market from the respondents' house was nearly one hour and fifty-three minutes with standard deviation of 0.95 minute. The maximum and the minimum walking distance to local market were four hour and twenty minute respectively. The correlation between distance from the market of the household and Simpson diversification index is significantly and negatively at 1 percent probability level. Based on annual household income the result indicated that the average annual household's income was 74339.6 birr with standard deviation of 36664.12 birr. The maximum and the minimum annual household income were 276,300 and 12,000 birr respectively. Annual household income correlates with degree of income diversification significantly and positively at 1 percent probability level.

Figure four show the reason behind household's unwillingness to taking loan from formal credit institution was due to it require asset for collateral, they do not want , not allowed by religion , the interest rate is too high and they use their own cash were the main reasons. From the total sample household 59.48 % not take any credit from credit lending institution. The reason behind why they not take credit from formal credit institution 27 (29.67%) was said formal credit institution require asset for collateral, 20 (21.97%) they do not want,19(20.87%) not allowed by religion,10 (10.98 %) interest rate is too high ,6(6.59 %) they use their own cash,3 (3.29 %) loan payment time is not appropriate, 2 (2.24 %), the institution is far from the kebeles and 4 (4.39) the institution is not available. The sources of credit for sample respondents were 40.32 % from cooperatives, 25.8 from neighbours, 11.28 from banks , 4.8 from afar credit and saving company and 4.8 from iqubs.6.5 from private money lenders and 6.5 from iddirs.
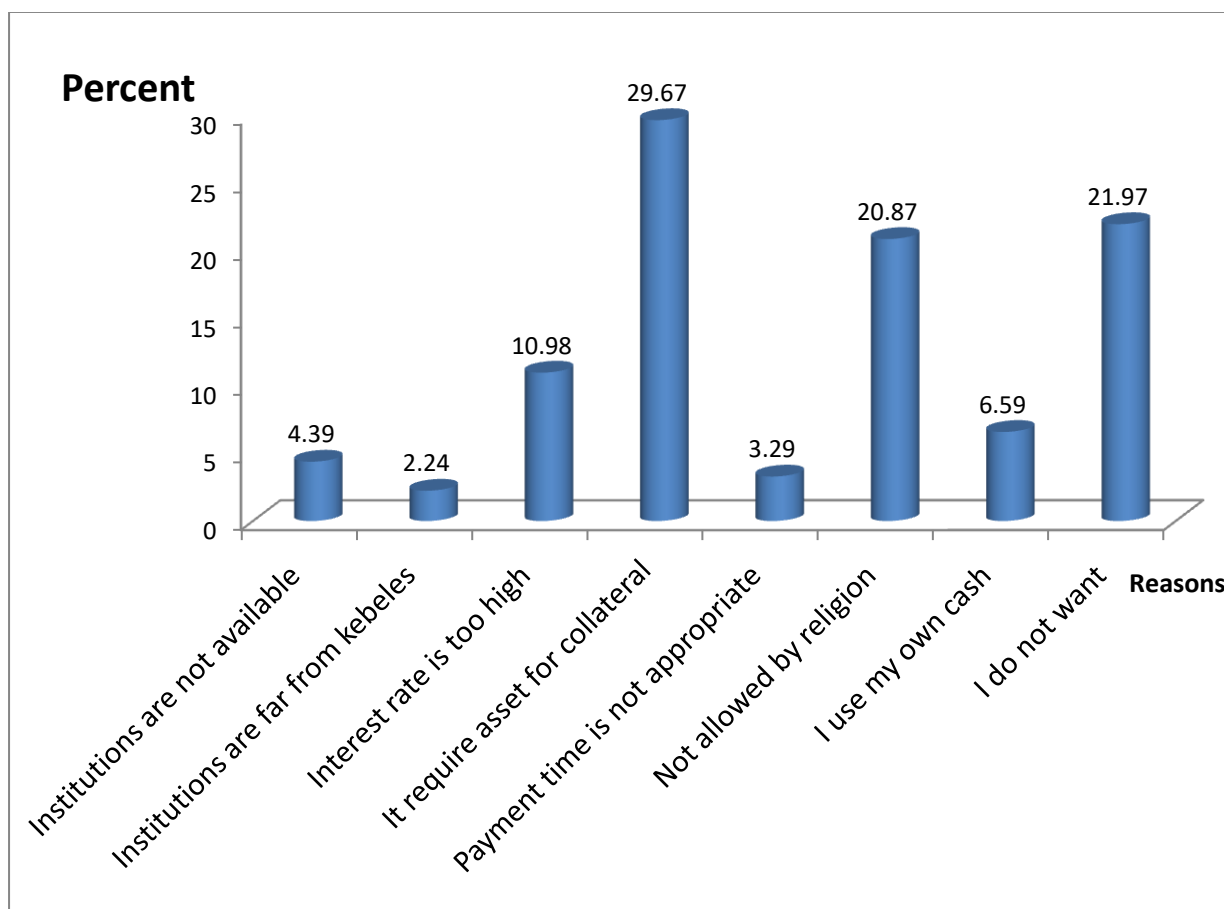
Figure 4: Reason for not taking loan from formal credit institution
Source: own survey, 2017

4.2 Distribution of Household Income sources

In Asayitta *Woreda* income sources can be broadly divided in two: agricultural income (livestock rearing and crop production) and non-farm income. In general in this study six different income sources for the households are identified such as, farm income, non- formal wage-employment, formal wage- employment, self -employment, remittance income and rent income. This result is agreed with the finding of Yisihake Ergicho and Abebe Markos (2015). However, here income from agricultural wage employment and non-agricultural wage employment were merged together as wage income, since there is a very small number of observations that generate income from each source of income. Table seven shows how different income sources contribute to the overall household income. From the total sample size, on average the total income of rural households in the study area is 74,339.6 Ethiopian birr (ETB) generated from a wide variety of income generating activities. Almost 92.86% households drive income from agricultural activity (crop income and livestock income),

which on average accounts 52 percent of the total household income which is lower than the study of Amare Demissie and Belaineh Legesse (2013), agriculture contribute 77 percent of the total household income. Within this category the most important source of income is livestock income providing about 33% of the total agricultural household income. Livestock income refers to any income generated by the household from livestock by-product, livestock sells, or rental services such as ox rent. In addition to this, income from crop production activities contributes about 19% of the total agricultural income. Non-farm income sources contribute on average 48 percent of the total household income which is lower than the result found by Fassil Eshetu and Elias Mekonnen, (2016). Formal wage employment includes professionals workers like teachers, government worker, administration, and health workers. Formal wage employments contribute on average 18% of the total household income and 37.36% of households receive income from this activity. The other dimension of non-farm income is receiving income from non-labour income sources, which accounts 4% of the total income and 30.52% of households receive income from this activity.

Non-labor income is income received from the government, non-governmental institutions (NGOS), family /friends in the form of remittance, gift, inheritance, donation, compensation, transfer etc. Non-farm self employment activities accounts nearly 15% of the total income and 57.14% of households receive income from this income sources. These non-farm self employment activities mainly include shop running, petty trade (clothes, livestock, coffee, spices, salt, *etc*.), food processing for sale and fuel wood and/or charcoal sale etc. Rent income contributes on average 9% of the total household income and 54.55% of households receive income from this activity. These income sources activities mainly include rent house or room, rent out animals (oxen and horse) and rent of land. Generally, when we look at the income composition of rural households in Asayita *Woreda,* agricultural income takes the highest share followed by formal wage employment income sources. And also from agricultural income, livestock income takes the highest share which include selling livestock products or livestock themselves followed by crop production income.

Table 7: Distribution of the farmers according to their income sources

Variable	Mean	Std. Dev.	Participation rate (%)
Total income of households	74339.6	36664.12	100
Agricultural income share	0.52	28851.1	92.86
Livestock income share	0.33	24087.35	86.36
Crop income share	0.19	15769.09	83.77
Formal wage income share	0.18	26211.64	37.36
Self employment income share	0.15	20430.08	57.14
Non formal wage income share	0.02	2055.799	1.95
Remittance income share	0.04	6171.748	30.52
Rent income	0.09	12170.87	54.55

Multiple responses were allowed, hence total frequency exceeded sample size

Source: own survey, 2017

4.3 Degree of Income Diversification

Households in the study area mainly earn their income from farming, petty trading, wage labour and service etc. However, most of the people in the study area are involved in agriculture. Households were classified into six categories based on how they obtain their living. Six income diversification sources were identified among the households, namely, farming, formal wage income, self employment income, non formal wage income, remittance income and rent income share. Majority of the household's members derived their livelihood by farming. The Simpsons Index of Diversity (SID) was used in this study to estimate the degree of income diversification among farm households in the Asayita *woreda.*

According to Tithy Dev *et al*. (2016), the level of income diversification from 0 up to 0.3, 0.31 up to 0.6, and 0.61up to 1 was low, medium and high level of income diversification index. The results in figure six show the degree of income diversification among the farmers in the study area. Respondents with the most diversified income sources had the largest index and those with the least income sources had the smallest index. From the total sample household 76 in number or 49.67% percent had a diversity index of 0. Based on the result almost half of the sample household does not diversify their income sources. This implies that those farmers did not diversify their income sources or participating in one economic activity. Small holder farmers whose Simpson diversity index equal to zero means household participate in one types of economic activity it may be agriculture, formal employment or petty trade only etc. They specialize in to one economic or one income generating activity. About 32 households or 21.01% had diversity index between 0.12 up to 0.3, 23 households or 15.03% had between 0.31up to 0.6 and about 22 households or 14.29% had diversity index between 0.61 and 0.78.

The mean income diversification index is 0.24 which is low in the study area. The mean degree of diversification of 0.24 is lower than observed by Babatunde and Qami (2009) of 0.479 in Nigeria, the finding of Agyeman B. *et al.* (2014) in Ghana 0.338 and the finding of Tithy Dev. *et al*. (2016) in Bangladesh with the SID value of 0.25. The reason behind this is that most of the people living in the rural area are vulnerable as they depend only on agriculture related activities for their livelihood and they are subject to different types of risks (natural disaster) like drought, scarcity of irrigation water, non-availability of other income sources, etc. In addition to this the above causes lack of electric power, roads, training, and skills and under development of urban centers. Although formal wage employment, rent income and self employment income are the new sources of income emerged to the rural households, these activities are mostly run by the educated and rich farmers. The low observed degree of income diversification shows that farm households in the Asayita *Woreda* are less diversified in relation to the income generating activities they engage in. This implies that an average respondent in the study area had its members involved in small types of income generating activities simultaneously. These activities were distributed between the two sectors, that is the farm and non-farm sectors due to long list of activities identified in the area. On average, a respondent was involved in at least one farming activity and one non-farm activity.
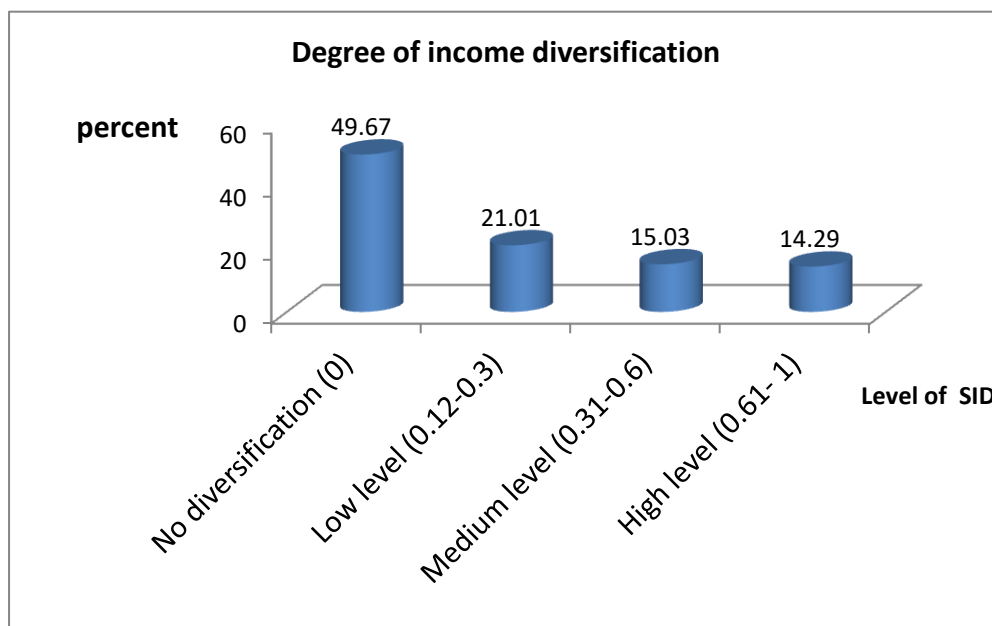
Figure 5: Distribution of the farmers by their degree of income diversification
Source: Survey result, 2017

4.4 Trend and Problems of Income Diversification

Table eight indicates how the overall household income sources changed from 2008 to 2009 production year in Asayita *Woreda.* From the total sample of the respondent their trend of income level over the past two years 52.94% were increasing 18.95 % decreasing and 28.11% remain constant. Similarly for food in secure household their trend of income level over the past two years was 41.31%, 25% and 33.69% increasing, decreasing and remains stagnant respectively. Whereas for food secured household 70.49%, 9.84% and 19.67% increasing, decreasing and remains stagnant respectively. Based on variability of income sources 82.35% were not vary their income sources and the remaining 17.65% vary their income sources by participating in to different income generating activity.

Table 8: Trend income diversification during harvest season in 2008 and 2009

Variables	Categories	Food security status				Total household (n=153)	
		Food secure (61)		Food insecure (92)			
		N	%	N	%	N	%
Trend of income level	Increasing	43	70.49	38	41.31	81	52.94
	Decreasing	6	9.84	23	25	29	18.95
	No change	12	19.67	31	33.69	43	28.11
Variability of income sources	Yes	15	24.59	12	13.04	27	82.35
	No	46	75.41	80	86.9	126	17.65
Increase in income sources	Yes	10	66.67	3	25	13	48.14
	No	5	33.44	9	75	14	51.86

Source: Own survey, 2017

The reason behind increasing their income sources of sampled household in Asayita *Woreda* was some of them build house and make available for rent and they can get some amount of income from rent of house, purchase horse and donkey to participate in transport services and also for rent, Employed in some organization who want guard services and participating in petty trade. But the reason behind decreasing their income sources of households in Asayita *Woreda* was because of livestock diseases horse and donkey were died and income from either cart income and rent income decrease, shop was closed because of not profitability and some agreement between employee and employer were terminated due to different reason. Under food secured and insecure household there is a significant difference for no variability of income sources and there is variability in income sources with 75.41% to 86.96% and 24.59 % to 13.04 % respectively. So when we look the probability of food secure household to increase income sources by participating in to different income generating activities is higher than not secured household in the study area. From food secured household 66.67% were increase their income sources but for food insecure household 25% were increase their income sources. Similarly from food secured 33.33% and not secured 75% of sampled household income sources were decrease.
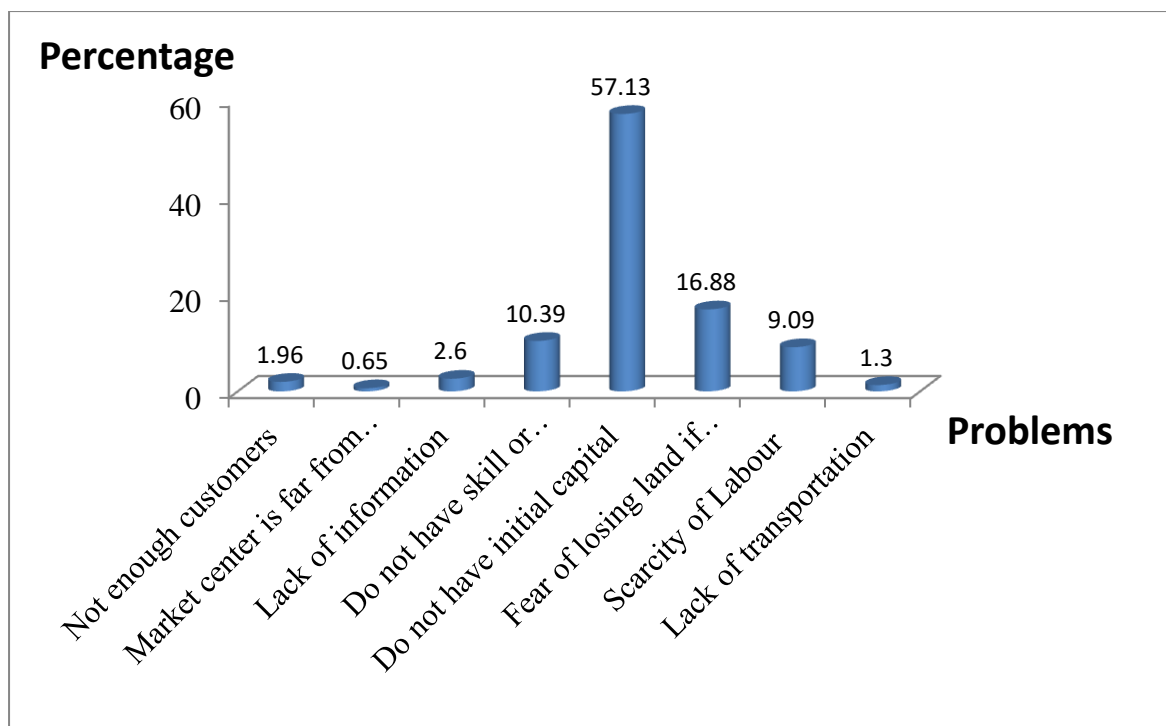
Figure 6: Factors affecting rural household's income diversification
Source: Own survey, 2017

The result of focus group discussions and key informant interviews showed that various problems hinder households to diversify their income apart from agriculture. These include lack of initial capital ,skill, no market information flow to farmers, lack of awareness and supply of modern agricultural inputs, inability to promote culture of work on different activities, lack of road transportation services, climatic factors (drought and floods), lack of water pump although water sources are there in the study area and so on. From the above figure 57.13% of the respondent says lack of initial capital is the major problem to diversify their income sources rather than farming. Similarly from the sample household fear of losing land if involving in activities outside agriculture, lack of special skill or knowledge,scarcity o f labour,lack of informtion about income diversification and not enough customers influence i ncome diversification strategies of farmers in the study area.

4.5 Households Food Security Status

Household caloric acquisition was used to measure household food security in the study area. To identify food secure and food insecure households, the following activities are undertaken; food items consumed for seven days were obtained from respective households. After converted to kcal/day basis and it was made ready to calculate kcal/day/AE. Family size which was collected in number was converted to adult equivalent. Finally the household whose caloric consumption is greater than or equal to 2100 Kcal/day/AE was categorized as food secure; on the other hand, the household caloric consumption is less than 2100 Kcal/day/AE was categorized as food insecure households. Accordingly, the percentages of food insecure and secure households were found to be 60.1% and 39.9 % respectively. This result is different with the study conducted by Indris Siraje and Adam Bekele (2013) in chifra district with food secured 65.8 percent and 34.2 percent insecure households and Abubeker Mohammed *et al*. (2011) they found that52.8 percent of households were food insecure and the remaining 47.2 percent were food insecure.

The result indicates that the mean value of the energy available for food insecure households was 1,766.01Kcal/AE/day but for secure it was 2,491.49 Kcal/AE/day. From the results of the analysis, more than half of the respondents were not food secure with an average daily per capita calorie consumption of 1,766.01calories which is about 15.91 percent less than the recommended minimum daily calorie requirement and 39.9 percent of the respondents were food secure with average daily calorie intake of 2491.49 which is 18.64 percent greater than the recommended daily calorie intake requirement. The minimum and maximum energy available for food insecure households was 967 Kcal and 2,070 Kcal, respectively. While the minimum and maximum energy available for food secure households were 2,230 Kcal and 3,240 Kcal, respectively. The mean energy intake of all sample households was 2055.26 kcal.

Table 9 : Distribution of the respondents by their food security status

Statistical Estimates	Food Secure	Food Insecure
Frequency	61 (39.9)	92 (60.1)
Average daily calorie intake	2491.49	1766.01
Maximum daily calorie intake	3240	2070
Minimum daily calorie intake	2230	967
Standard deviation	269.55	288.61

Note: Figures in parentheses are percentages

Source: Survey result, 2017

Extent and Severity of Food Insecurity

The FGT result revealed that the incidence of household food insecurity was 60.1 percent. This implies that about 60.1 percent of the sampled households were not able to meet the daily recommended caloric requirement which is 2100 kcal per day per adult equivalency. The calculated value for food insecurity gap was 9.5 percent. This showed food insecure households were 9.5 percent far off from the minimum level of calorie requirement which also implied 9.5 percent of the caloric need of every food insecure households was required to bring up to the recommended daily caloric requirement level, In addition to food insecurity gap and headcount ratio, the severity of food insecurity households was 2.6. This implies about 2.6 percent of households are the most food insecure groups of households in the study area which was lower than the study made by (Girma gezimu, 2012). The heading count ratio, food insecurity gap and severity of food insecurity of this research finding is greater than the research conducted by Abubeker Mohammed *et al*. (2011*)* in Asayita *Woreda* whose value of 52.8, 0.1621 and 0.0686, respectively.
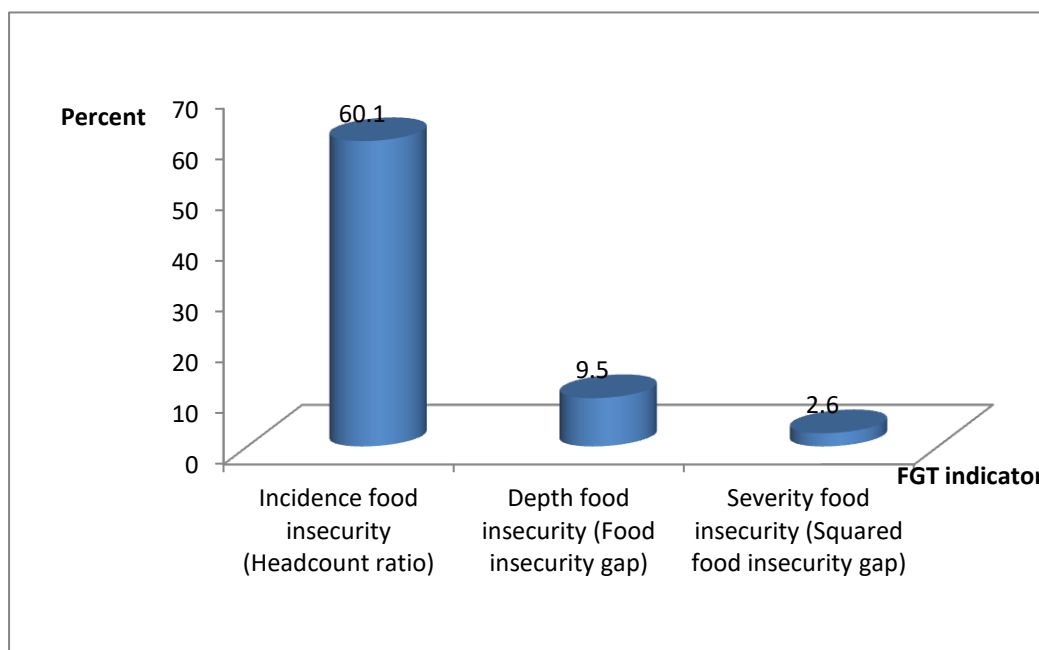
Figure 7: Household incidence, depth and severity to food insecurity
Source: Survey result, 2017

4.6 Degree of Income Diversification and Food Security Status

The following table shows household food security status by level of income diversification in Asayita *Woreda*. According to this table household that have higher value of diversification index are more food secured. The level of diversification has four different cat egories. Zero represents no diversification, from 0.12 to 0.30 indicates low diversification 0.3 1 to 0.60 indicates moderate diversification and 0.61-1.0 indicates high diversification (Tithy Dev *et al*., 2016). From the total households who fall under no diversification level among them 8(10.5%) are food secured where as 68 (89.5 %) are food insecure. Households who fall under low diversification category among them 13(40.6 %) are food secured where as 19 (59.4%) are food insecure. Similarly in the moderate diversification level 18 (78.26 %) are food secured and 5 (21.74 %) are food insecure. But in case of higher diversification the rate of food secured households were 22 (100%) and no food insecure household in high diversification category. Among the total sample household about 61 (39.9) households are food secured where as 92(60.1%) households are food insecure. This result indicates that the level of income diversification has a positive effect on food security status of households by creating additional income.

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Table 10: Households food security status by income diversification Strategies

Food security status	No diversification (0)		Low diversification (0.12-0.3)		Medium diversification (0.31-0.6)		High diversification (0.61-1)		Total	
	N	%	N	%	N	%	N	%	N	%
Food secured	8	10.5	13	40.6	18	78.26	22	100	61	39.9
Food in secured	68	89.5	19	59.4	5	21.74	-	-	92	60.1
Total	76	100	32	100	23	100	22	100	153	100

Source: Survey result, 2017

4.7 Econometric Estimation

4.7.1 Model specification test (diagnostics)

Fractional regression response model was used to analyze the determinants of income diversification and logistic regression model to identify determinants of food security status of households using STATA version 14. Before the variables were included into the model, the existence of multicollinearity problem among continuous and dummy explanatory variables was tested using variance inflation factor (VIF) and contingency coefficient, respectively. The existence of multicolinearity implies that two variables are near perfect linear combinations of one another. The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated. The VIF command used after manipulates regression to check for multicollinearity problem. As a rule of thumb, a variable whose VIF values are greater than 10 may merit further investigation. Tolerance, defined as 1/VIF, is used by many researchers to check on the degree of collinearity (Ejigayhu Sisay and Abdi Khalil Edris, 2012; Tilksew Getahun and Fekadu Beyene, 2014). If tolerance value is lower than 0.1 it is comparable to a VIF value of 10 (Gujarati, 2003). It means that the variable could be considered as a linear combination of other independent variables. Based on this rule of thumb, the maximum VIF among the explanatory variables considered in this study is less than 10 (see Appendixes 1 and 2). Therefore, our model is free from multicollinarity problem.

The overall significance of the model was measured using log likelihood ratio test. The fitness of the model increases when the value of the log likelihood ratio test decreases due to increase in explanatory variables. The result of the chi-square test value indicates by how much the value of the log likelihood ratio test decreases after fourteen explanatory variables were fitted in to the model. The chi-square value is significant at less than one prcent probability level. This indicates that the overall significance of the model is good. In addition, normality, multicollinearity, endogeneity and heteroscedasticity detection test were performed using appropriate test statistics. Endogeneity test results show that there is no endogeneity problem for income diversification and food security status and no any heteroscedasticity problem for income diversification and food security status (Appendix1 and Appendix 2).Table eleven and twelve shows the sign, magnitude, statistical tests and significance level of each explanatory variable.

4.7.2 Determinants of income diversification

In this section, selected explanatory variables were used to estimate the fractional response probit regression model to analyze the determinants of households' level income diversification index (Simpson index of diversity). A fractional response model was fitted to estimate the effects of the hypothesized explanatory variables on the households' level of income diversification. Finally, a set of 14 explanatory variables (seven continuous and seven discrete) variables were included in the fractional response probit regression analysis. These variables were selected on the basis of theoretical explanations, personal observations and the results of empirical survey studies. The fractional response probit model results used to study factors influencing SID are shown in table 11.Among the 14 explanatory variables used in the model, eight were significantly affecting income diversification index. These variables include male headship, household size, educational status of the head, and distance from market, credit utilization, access to electric power services, special skill and total household income. Their effect is discussed as follows.

Male headed households: Sex of household head affects diversification sources, including the choice of income-generating activities (both farm and non-farm) due to culturally defined roles, social mobility limitations and differential ownership of/access to assets. From the result of focus group discussion and key informant interview the above listed problems hinder female head households to participate in different income generating activities. It was found that male headship has a positive and significant effect on income diversification at 5 percent probability level. This result agrees with the prior findings of Ellis (1999); Olale *et al.* (2010); Amare Demissie and Belaineh Legesse (2013); Yishak Gecho (2017). Thus, keeping other thing remain constant; the level of diversification increase by 4.28 percent when the household head is male (male headed households).The opposite is true for the female counterparts implying that they are less likely to participate in non-farm income generating activities. The possible reason is that female heads have more responsibilities in home management (non-income earning activity) while their counterparts have more tendency of engaging in different non-farm income generating activities improving their income earnings. Studies indicated that women rarely own land, may have lower education and their access to productive resources as well as decision-making tend to occur through the mediation of men (Amare Demissie and Belaineh Legesse, 2013).

As observed in the tradition of Afar region and especially in the study area, gender disparity reduces the ability of female-heads to participate in off-farm income generation activities. Focus group discussion and key informant interview confirmed that this is due to the fact that women in Afar region face constraints related to time availability (given their extensive child care, cooking, and water-carrying duties, in addition to livelihoods activities) and mobility, both of which affect women's ability to participate in trainings, meeting development agents (DAs), and getting to know market actors. For instance, women mobility and travel to urban area in search of off-farm activities is not culturally perceived as positive. As a result of these and other factors, women have less access to credit, inputs and extension services than men.

Household Size: Most studies on non-farm income diversification agree on the positive effect of household size as the larger family size the higher probability of the households to the supply labour to the non- farm sector (Bereket Zerai and Zenebe Gebreegziabher, 2011; A mare Demissie and Belaineh Legesse, 2013; Bekelu Teshome and Abdi Khalil Edriss, 2013). However, one can argue that household size could be a liability for the overall welfare of the household if the number of labour-contributing members is less than the dependents. Thus, in order to capture this aspect of household labour supply, we have included dependency ratio as one explanatory variable in the model. The results show that dependency ratio is not a key demographic variable that negatively relates to non-farm activity participation or Simpson diversity index. Household size is also found to be among the influential variables in the model. It has a positive and significant effect on income diversification at 10 percent significant probability level. This is in line with what is expected, in the sense that having more household size in a limited and marginalized land agricultural income alone could not meet food security/livelihood and hence farmers might tend to involve in different non- farm activities that bring additional income. Thus, keeping the influence of other factors constant the level of income diversification index increased by 0.91 percent when the household size of household increased by one person.

Unquestionably, land is a fixed input for all the farmers in the study area. Therefore, it is unproductive to involve all the household members in this limited size of land resources. Consequently, household members would try to find other alternatives income sources to generate additional income. Thanks to the "agricultural transformation and industrialization" policy of the country, helps create good opportunity for farmers to get employed in construction projects around the locality. In addition to this, as household size increases members of the household who are capable of working, would participate in one or more non-farm activities stated earlier, which also increase income of the household in question. This suggests that the larger the family size the more the income earned from non-farm activities. Descriptive analysis result indicates the level of diversification increase as household size of households increase.

Educational status of household head: As expected, the level of education is significant at 1 percent probability level, and has a positive relationship with the level of income diversification index. This implies as the level of education (years of schooling) of the household increases by one year, the level of income diversification index increases by 8.75 percent, ceteris paribus. This results agrees with the prior findings of Beyan Ahmed (2016); Yishak Gecho (2017) and contradicts with Oluwatayo (2009); Amare Demissie and Belaineh Legesse (2013) by arguing that educated persons specialized one activity rather than diversification. Relatively more educated farmers recognize the advantages of farm technology more than farmers with less educated. This is because of the fact that education enhances farmers' ability to assess available opportunities with little or no stress, perceive, interpret, and respond to new technology. It also enables farmers to be more aware of the improved technology and participate in additional income generating activities and also increase the level of income diversification index.

Special skill: As expected, having special skill of household member is significant at 10 percent probability level, and has a positive relationship with the level of income diversification sources. A special skill is the other factor that significantly influences the non-farm employment participation of households positively suggesting that skilled households are more likely to engage themselves in more paying self-employment activities. More specifically possessing skills such as masonry, driving licences, handcrafts and merchants increase the probability of involvement in non-farm activities to the villages that are closer to the nearby towns while skills such as tannery, pot making, and goldsmith are associated to the villages that are far from towns. This implies as the level of having one additional special skill of household members increases, the degree of income diversification increases by 4.4 percent ceteris paribus. This result is in line with the findings of (Bereket and Zenebe ,2011).

Credit utilization: Access to credit affect the level of income diversification of household's positively and significant at 1 percent level of significance. The result defines to our prior expectation. This means credit utilization by household would increase income diversification level by 9.03 percent. This result is similar to that reported by Babatunde (2009); Bereket Zerai and Zenebe Gebreegziabher (2011) who noted that credit can reduce liquidity constraints and increase the capacity of households to start non-farm business. Access to credit market is found to be one of the strong and major determinants of participation in non-farm activities. Households with access to formal credit are more likely

to participate in non-farm activities than those without access and it improve the level of income diversification. Access to the credit market gives opportunities to farm households to get the necessary capital to start up or to be participated in non-farm employments.

Distance from market: As hypothesized, distance from the market was significantly and negatively related to level of income diversification index into the combination non-farm and farm income generating activities at 1 percent probability level. This implies that farther the household from market centre lower the degree of income diversification. If the other factors remain constant, the marginal effect of farm household's level of income diversification decreases by 11.8 percent as household's residence increase from *woreda* weather market cen tres by one hour.This result is consistent with result reported by Oluwatayo (2009); Amare D emissie and Belaineh Legesse (2013); Bekelu Teshome and Abdi Khalil Edriss (2013); Mide ksa Fufa (2015); Yisihake Ergicho and Abebe Markos (2015); Yishak Gecho (2017). This ne gative relationship indicates that households who lived farther away from the market are less likely to be involved in non-farm and off- farm activities. The possible justification could be households who are closer to the market centres do not have much cost to access market incentive for diversification of income sources. It is obvious that, if farmers are unable to reach the market to sell their outputs from non-farm activities, they could be discouraged to involve in such activities. Moreover, the common non-farm and off - farm activities in the locality such as petty trade require immediate market in order to produce more. Therefore, a long distance to the nearest market reduces the level of income diversification index. This result revealed that road infrastructure is the most important factor in participation of non-farm activities and to increase degree of income diversification in all cases of rural income diversification strategies to earn income from non -farm employments in addition to farming income.

Access to electric power supply (Access to EPs): Consistent with the hypothesis, access to electric power supply has a positive significant at 1 percent probability level influence on Simpson diversification index. The positive sign in the model output implies that electric power supply access have effect on increasing income sources of households. The marginal effect of electric power access was found to be 0.0659. This implies, ceteris paribus, if household have electric power supply access Simpson diversity index is increased by 6.5 percent. This result is consistent with result reported by Bereket Zerai and Zenebe Gebreegziabher (2011). A positive influence of village electrification on non-farm employment participation was expected due to the fact that villages having electricity are close to the town/city and thus more non-farm employment opportunities and labour market. The variable electricity is consistent with our prior expectation. We found positive and significant influence of electricity on level of income diversification evident from the result.

Annual household income: This variable was found to have positive and significant influence on the level of income diversification into non- farm activities at l0 percent probability level. This result implies that households having large cash income are more likely to diversify the income generating activities into non- farm activities and increase the level of diversification index and those farmers with low income are less likely to participate in income diversifying income activities than those who have high income and their level of diversification index were low. Small holder farmers who have adequate income sources can overcome financial constraints to engage in alternative income-generating activities and leads to improve income diversification level. Hence, higher income can encourage households to invest in other income-generating activities. From the model result, other things being constant, marginal effect reveals that if the household income is increase by one percent level of income diversification increased by 2.3 percent. Yishak Gecho (2017) show that income is one of the most important determinants of income diversification in to non-farm and/or off-farm activities.

Table 11: Fractional response probit model results on income diversification

Predictor variables	dy/dx	Coefficient	Robust std. Err	Z- value	P>|z|
MALEHEAD	0.0428	0.129**	0.057	2.25	0.024
AGE	0.0001	0.000	0.002	0.15	0.877
HHSIZ	0.0091	0.027*	0.015	1.83	0.068
EDU	0.0875	0.265***	0.075	3.5	0.000
DEPR	- 0.0071	-0.021	0.033	-0.64	0.523
REMITA	0.0325	0.098	0.066	1.48	0.139
SKILL	0.0441	0.132*	0.073	1.8	0.072
FARMSIZ	- 0.0091	-0.004	0.015	-0.32	0.747
CREDITU	0.0903	0.274***	0.086	3.16	0.002
LIVESTOCK	-0.0011	-0.003	0.002	-1.51	0.132
DAM	-0.1177	-0.357***	0.046	-7.73	0.000
ACCEP	0.0659	0.199***	0.064	3.09	0.002
Log INCOME	0.0231	0.085*	0.046	1.85	0.065
ATTRA	0.0092	0.028	0.079	0.36	0.722
CONSTANT	-	-1.444	0 .515	-2.8	0.005

Number of obs = 153, Wald chi^2 (14) = 365.35, Prob > chi^2= 0.0000, Pseudo R^2 = 0.1388, Log pseudo likelihood = -89.097634. ***, **, and * indicates statically significant at 1, 5 and 10 % respectively

4.7.3 Determinants of food security status

Binary logistic regression model was used to identify determinants of food security. Accordingly, variables assumed to have influence on household food security in different contexts were tested in the model and ten out of 14 variables were found to be significant. Among variables fitted into the model age of household head, educational level of household head, remittance, farm size, tropical livestock unit, and distance from market, credit utilization, household size and annual household income were found to be significant in determining household food security status.

Age of household head: The model reveals that age of household head has a significantly positive relationship with household food security status at 5 percent probability level. The probability of households being food secure increases by a factor of 1.14 as the age of a household head increases by one year keeping the other variables constant. The possible explanation for such positive association is that an older household head devotes his/her time on income generating activities like farming and non -farm income sources compared to young farmers. Young people spend much time in towns and prefer urban life than the rural for a number of reasons. Additionally, as household age increases, one can acquire more knowledge and experience becoming successful in exploiting these experiences. These results agree with the prior findings of Indris Siraje and Adam Bekele (2013); Tibebu Aragie and Sisay Genanu (2017) but contradict with Fekadu Beyene and Mequanent Muche (2010); Girma gezimu (2012).

Education status of household head: This variable affects food security status positively and significantly at 5 percent probability level. The positive relationship indicates that literate households are less food insecure than illiterate households. The log-odd ratio implies that the probability of households being food secure increased by approximately 1.355 as household's years of education is increased by one year. The possible explanation is that household head education largely contributed on working efficiency, competency, diversify income, adopting technologies and becoming visionary in creating conducive environment to educate dependants with long term target to ensure better living condition than illiterate ones. As a result literate households reduce the probability of becoming food insecure in the sample households. This is due to educated household head plays a significant role in shaping household members to participate in to different income generating activities. This result

agree with the prior findings of Fekadu Beyene and Mequanent Muche (2010); Ejigayhu Sisay and Abdi-Khalil Edriss (2012); Girma gezimu (2012).

Household Size: This variable affects food security status negatively and significantly at 5 percent probability level. The negative relationship indicates that smaller households are less food insecure than larger households members. This implies that, as household size increases by one person, the probability of becoming food secure decreases by a factor of 0.4527. The negative sign shows that the probability to be food secure decrease as household size in adult equivalent increases. The possible explanation is that households with large number of household members could face the probability of food insecurity because of high dependency burden created as a result of sharing available limited resources. Increases in household size, whose members are more of inactive labour force enhances the number of dependent household members and reduce the availability of enough food for a household. On the other hand households with larger household are vulnerable to food insecurity. As the sizes of the households are increasing the consumption expenditure increases. The expenditure is from consumable goods, school fee, farm, fertilizer and labourer for farm activities. Since the area is vulnerable to drought and famine more household leads to high food insecurity. This result is consistent with the finding of Haile Kidane *et al.* (2005); Ejigayhu Sisay and Abdi Khalil Edriss (2012); Indris Siraje and Adam Bekele (2013); Tibebu Aragie and Sisay Genanu (2017).

Remittance: The result also showed as there is a positive relationship between taking remittance or gifts on the household food security status of the household at 10 percent probability level. The odd ratio implies as taking remittance of the household increases by one unit the probability of a household being food security increases by factor of 4.424. This is due to the fact that an increase in remittance and gifts income will have a positive effect on household income because the change in income will lead to change in expenditure. Thus, the income received from remittance and gifts increases the income so that capacity of the households to consume more will increase. Remittance and gifts increase the accessibility of food security but the sustainability of this income source is in question also, it creates dependency syndrome. The result is the same with Agboola (2008); Ejigayhu Sisay and Abdi-Khalil Edriss (2012).

Farm size: The result also showed as there is a positive relationship between land sizes of the household and food security status at 5 percent probability level. This means households with large cultivated land produce more for household consumption and for sale and have better chance to be food secure than those having relatively small size of cultivated land. The odds ratio for this variable is 2.189. This indicates that keeping other things constant, one additional hectare of farm size will enhance food security status of the household by factor of 2.189 and vice versa. The result is the same with Haile kidane *et al*. (2005); Shishay Kahsay and MessayMulugeta (2014); Tibebu Aragie and Sisay Genanu (2017). Since the majority of the household are agrarian land is everything for them. An increase in land means household will have a probability to produce more foods which helped them to be food secured.

Livestock holding (LIVESTOCK): Livestock owned had a significant and positive impact on the household food security status. The positive sign of the coefficient indicates that when livestock owned increase by one TLU, the probability of a household to become food secure, ceteris paribus, increase by a factor of 1.043. It implies that the more livestock a household has the better its food security position. This is because as farmers have a large number of livestock, they become in a better position to be more food secure than farmers who own few. Animals have so many purposes like the source of food and income, and transportation. In addition, households with more livestock produce more milk, milk products and meat for direct consumption. Besides, livestock enables the farm households to have better chance to earn more income from selling livestock which enables them by increasing purchasing power of stable food during food shortage and could invest in purchasing of farm inputs that increase food production, and able in ensuring household food security. The result is consistent with the research finding of Fekadu Beyene and Mequanent Muche (2010); Shishay Kahsay and MessayMulugeta (2014); Tibebu Aragie and Sisay Genanu (2017).

Credit service: The sign of the coefficient of this variable showed a negative relationship with food security status and it is significant at 5 percent probability level. The negative relationship implies that households with access to credit service have less chance to be food secured than without access ones. This result is not conformity with the prior expectation. Even if credit utilization helps to smooth consumption when household face with temporary food shortage problem it leads to food insecure in the long run.

Credit by itself may increase the purchasing power of household so it improve the food access in the short run but to be said one household is food secure it must fulfill food availability, food utilization and stability of food credit by itself does not maintain this one. Some credit lender requires collateral and makes some agreement with borrower if the borrowers not pay interest rate based on the agreement that collateral will be taken by lenders. This lead to household who take credit will be food insecure in the long run. The odds ratio of the variable shows that for households with access to credit the probability of food secure decrease by 0.1103 levels. This result contradicts with the prior findings of Girma gezimu (2012). This is due to the fact that credit gives the household an opportunity to be involved in income generating activities so that derived revenue increases financial capacity and purchasing power of the household to escape from risk of food insecurity. Moreover, it helps to smooth consumption when household face with temporary food problem.

Distance from market: It affects food security status negatively and significantly at 1 percent probability level. The negative relationship indicates that in the study area, households who are travelling long distance to the market are food insecure. This result fully agrees with prior expectation. The log-odd ratio implies that the probability of being food secure decrease by approximately 0.018 as households travelled extra one hour. The households are both consumer and producer as far as they are going long distance to purchase farm input, consumption goods and sell their farm output this cost farmer to lose more money and time for travel to market which leads to being food insecure. The result is consistent with prior expectation and the finding of Girma gezimu (2012); Tibebu Aragie and Sisay Genanu (2017).

Total household income: The survey result shows a positive relation between annual income of household and food security and the coefficient is significant at 10 percent probability level. The result corresponds with the prior expectation and the possible explanation is that income determines purchasing power of the household with the prevailing price so that those households having higher annual income are less likely to become food insecure than low income households. The odds ratio for this log annual household income is 1.013. This indicates that maintaining other determinants constant, if household annual income increase by one percent it enhance food security status of the household by factor of 1.013 and vice versa. The result is the same with Ejigayhu Sisay and Abdi Khalil Edriss (2012); Indris Siraje and Adam Bekele (2013).

Table 12: Binary logit result on determinants of food security status

variables	Odds Ratio	Coef.	Std. Err.	Z	P>z
MALEHEAD	3.4072	1.225	1.145	1.07	0.284
AGE	1.1420	0.132**	0.055	2.40	0.016
EDU	1.3550	0.303**	0.123	2.46	0.014
HHSIZ	0.4527	-0.792**	0.315	-2.52	0.012
DEPR	0.9362	-0.065	0.432	-0.15	0.879
REMITA	4.4244	1.487*	0.873	1.70	0.089
FARMSIZ	2.1898	0.783**	0.314	2.50	0.013
LIVESTOCK	1.0430	0.042**	0.021	1.96	0.050
LIVDEAS	0.3983	-0.920	0.887	-1.04	0.300
CREDITU	0.1103	-2.204**	1.097	-2.01	0.045
DAM	0.0181	-4.008***	0.982	-4.08	0.000
FRIQEXTS	0.9873	-0.012	0.023	-0.53	0.594
Log INCOME	1.0133	0.013*	0.008	1.65	0.098
SID	1.2324	52.83**	23.78	2.22	0.026
CONSTANT	0.0025	-5.984	3.112	-1.92	0.054

Number of obs = 153, LR chi^2 (14)   = 187.23, Prob > chi^2 = 0.000, Log likelihood = -10.04, Pseudo R^2 = 0.71, ***, **, and * indicates statically significant at 1, 5 and 10 % respectively.

4.7.4 Effect of income diversification on food security status

The results presented in table 12 revealed that there is significant relationship between level of income diversification and food security status of the households. This variable affects food security status positively and significantly at 5 percent probability level. The odds ratio obtained for the diversification index was 1.2324. The positive sign of the coefficient indicates that when diversification index increase by one unit, the probability of a household to become food secure, ceteris paribus, increase by a factor of 1.2324.This implied that as income diversification increases, food security status of the respondents also increases. Income diversification has been reported to cause a significant increase in total household income, which would, in turn, increase household food security status.

This implies that that additional non-farm employment has a significant role in maintaining household food security. This result is similar to that of Agboola *et al.* (2008) who found that food security among farming households was influenced by income diversification strategies. This is because 61% of individuals that derived their livelihood from a combination of crop production and off farm activities were food secured. The result agreed with Olusola s. (2012) which explained coefficient of herfindahl diversification index is positive and significance at 5 percent probability level of significance on food security status of households. Diversification of income sources provides an additional income that enables farmers to spend more on their basic needs include food consumption, education, closing and health care. Increase in the level of income diversification helps the households to revitalize from different shocks which make farm households' food insecure. The effect of diversification index on food security status of household indicates positive and significant.

The result of this study implied that diversification has a role which is significant in maintaining household food security. This result is similar to Fassil Eshetu and Elias Mekonnen (2016) whose result showed that, participation in off farm activities (livelihood diversification) diminishes the probability of being poor of rural farm households. Thus, participation in non-farm activity negatively and statistically significantly affects the rural poverty. Most of rural households depend on agricultural production which is heavily affected by vagaries of nature and this motivates rural farm households to diversify their livelihood strategies and manage any risk associated with low agricultural production. The coefficient of off-farm participation showed that the probability of being poor of households participating in off farm activities is lower than that of households with no off farm activities

by 7.5% and this is also statically significant. Similarly,Degefa Tolossa (2005); Bereket Zerai and Zenebe Gebreegziabher (2011); Bassie Yizengaw (2014) indicates that participation of small holder farmers in to non farm income generating activities generate additional income and this income is important to fulfil basic needs for their family members. But Tithy Dev *et al*. (2016) indicated that income diversification has a positive insignificant effect on food security status among small holders' farmers in Bangladesh. As a result they conclude that participation in non -farm activities has a positive effect to improve the food security status of small holder farmers. Based on the findings of this study, the hypothesis which states that level of income diversification has positive effect on food security status of the farmers is satisfied income diversification has positive effect on food security status of the farmers is accepted.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Agricultural production has been declining from time to time due to frequent land fragmentation, uncontrolled population growth and recurrent drought, and this has forced people to look for alternative income options other than agriculture. A number of rural households engage in diverse income generating activities away from purely crop and livestock production. Agricultural sector alone cannot be relied upon as the main activity for rural households as a means of improving livelihood, achieving food security and reducing poverty in Ethiopia. This study attempts to investigate the determinants of income diversification and its effect on food security status using the survey data collected from 153 randomly selected households from three *kebeles* of Asayita *Woreda,* Afar region Ethiopia. Both descriptive analysis and econometric estimation results have been used to answer the stated key research questions. Income diversification is considered as the most important strategy for raising income and food security status in Asayita *woreda.*

The chi-square test of association indicated that educational status of household heads, receiving remittance, and credit utilization had statistically significant association with food security status. This implies that literate households' and households who have got remittances are more food secured households. Likewise, the independent T-test result also indicated that the mean of household size, dependency ratio, farm size, Simpson diversification index and annual households' income had statistically significant mean difference between food secured and not secured respondents. Based on income diversification the independent T-test result indicates that educational status, access to electric power, having special skill and access to training had statistically significant effect on level of income diversification. Households in Asayita *woreda* generate income from farm and non-farm activities.

Generally households classified in to six categories based on income sources, those are farm income, formal wage employment, non formal wage employment, self employment, remittance and rent income. The income composition of rural households indicates that agricultural income takes the highest share followed by formal wage employment income sources. From the above findings it is clear that income diversification has significant effect on households 'food security status.

This study show that activities outside of the agricultural sector play an important role in this study area contributing about 48 percent of the total household income. The result of Simpson index of diversity (SID) indicates that the mean value of level income of diversification index is 0.24 which is low in the study area. Under no, low, medium and high level of diversification 49.67%, 21.01%, 15.03% and 14.29% of households' categorized respectively. The reason behind is that most people have no idea about area and strategy of income diversification, most of the people living in the rural area are vulnerable as they depend only on agriculture related activities for their livelihood and they are subject to different types of risks (natural disaster) like drought, scarcity of irrigation water, non-availability of other income sources and due to lack of industrial infrastructure, electricity and service sectors, there is limited scope to diversify their sources of income etc. Smallholder's farmers have been constrained by various factors while accessing the non-farm employments or the level of income diversification. A frequently cited reason are lack of initial capital, fear of losing land if involving in activities outside agriculture, do not have skill or knowledge and Scarcity of labour.

The calorie intake method result indicated that 60.1 percent of households are food insecure and the remaining 39.9 percent were food secure. The mean value of the energy available for food insecure households was 1,766.01Kcal/AE/day but for secure it was 2,491.49 Kcal/AE/day. More than half of the respondents were not food secure with an average daily per capita calorie consumption of 1,766.01calories which is about 15.91 percent less than the recommended minimum daily calorie requirement and 39.9 percent of the respondents were food secure with average daily calorie intake of 2491.49 which is 18.64 percent greater than the recommended daily calorie intake requirement. The minimum and maximum energy available for food insecure households was 967 Kcal and 2,070 Kcal, respectively. While the minimum and maximum energy available for food secure households were 2,230 Kcal and 3,240 Kcal, respectively. The mean energy intake of all sample households was 2055.26 kcal. The Foster-Greer-Thorbecke (FGT) result indicates that the incidence of food insecurity, food insecurity gap and severity of food insecurity households were 60.1, 9.5 and 2.6 percent respectively.

Fractional response regression probit model was employed to answer the question "what are the factors that determine the level of income diversification among the farm households."

The result of the model indicated that male headed household, education, household size, special skill, electricity, credit utilization and annual household income had statistically significant positive effect on households' level of income diversification. This implies that the above variables increase the level of income diversification of respondents unlike negatively related variables. But distance to the market had negative and significant effect on the level of income diversification.

In addition to fractional response regression model binary logit model was employed to answer the question "what are the factors that affect food security status of smallholder farmers." The result of the model indicated that age of household, educational status, household size, remittance income, farm size, tropical livestock unit, credit utilization, distance from market and annual household income were found to be significant in determining household food security.

Except household size, credit utilization and distance from market all other variables like the age of household, educational status of household head, remittance, farm size, tropical livestock unit and annual household income affect food security status positively and significantly. Increases in family size, whose members are more of inactive labour force enhances the number of dependent family members and reduce the availability of enough food for a household. As the sizes of the households are increasing the consumption expenditure increases. The expenditure is from consumable goods, school fee, farm, fertilizer and labourer for farm activities. Since the area is vulnerable to drought and famine more family leads to high food insecurity. Food insecure household went the long distance as compared to food secured households. The primary occupation of the household was farming.

At household level, food security is maintained either by adequate production or earning sufficient income that enable household to purchase the required food. Here the policy option towards food security at household level is either to promote agricultural production or creating accesses to additional source of income such as non-farm employments or a combination of both. In areas where agricultural production is not viable household should try to seek additional cash by involving in non-farm employments. In line to this the study generally highlighted that non-farm employments have positive contribution in meeting household food security. However, non-farm employment opportunities are found to be limited. Therefore, rural development policy should promote non-farm employments in attempt to address issues of food security.

5.2 Recommendations

To make considerable improvement on level of income diversification and food security status in Asayita *woreda* the following measures and actions should be taken by household heads, administration of region and *woreda,* national and international organizations. The possible areas of intervention that emanate from the results of this study are presented as follows:

✓ To increasing the extent of income diversification, government should continue its efforts to generate income earning opportunities in the rural areas and support the farmers to enhance agricultural productivity through supportive policies including input utilization and creating market for their product.

✓ To reduce food insecurity, government policies would better aim at increasing access to non-farm activities for all rural households, particularly for households with little human resources, land and monetary assets (opportunities) and decreasing the constraints those hiders the rural households from participating in non- farm activities.

✓ Government and other responsible bodies design necessary strategies so as to create awareness among the community to participate women equally with man in all development activities.

✓ As household size and food security are negatively related serious attention has to be given to limit the increasing population size in the study area. This can be achieved by create sufficient awareness to effective family planning in the rural households. Further, household heads are advised to reduce the size of their household and their dependency ratio.

✓ Maintaining sustainable rural livelihood, especially electric power, road accessibility play vital role in facilitating access to markets, Hence, need to provide more rural roads and rehabilitate eroded ones in order to reduce the high transaction cost of buying from or selling to markets, as transaction cost reduces the returns from market sales. This will encourage the development of rural road to facilitate farmers' participation in diversified economic portfolio. Therefore, government policy should pay more attention on infrastructure to reduce the entry barriers and facilitate easier access to non-farm activities.

- ✓ Farmers should be encouraged to engage in livestock husbandry through providing with improved livestock production technologies (health service, improved breeds and feeds) to improve production and productivity of the sector, this will ultimately increase food security status.

- ✓ The concerned body has to work more to increase the access to education in the study area in order to explore the existing opportunity of income diversification via non-farm activities. Moreover, community based health and nutrition related education should be strengthened through direct educational support as well as awareness raising programmes.

- ✓ The government of Afar region should not only invest more on pro poor development programs such as productive safety net program (PSNP) but also improve social accountability to increase the ability of citizens to provide feedback on the services they received.

- ✓ The international NGOs, local organizations, private sector and government should continue to work together on strengthening the livelihoods, rural market structures and providing the climate resilience services that improve the ability of poor households to cope with shocks.

- ✓ Generally, this finding recommends that appropriate policy measures be taken towards limiting dependent population size through integrated and accessible health and education services, improving the contribution of the pastoralist women through trainings that could help remove cultural barriers and supporting the livestock sector through proper forage development as well as extended veterinary service and disease control programs.

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APPENDIXES

Appendixe 1: Multicollinearity, hetroscedasticity and endogeneity test for income diversification

Multicollinearity diagnosis

Variable	VIF	1/VIF
Dam	1.95	0.512369
spskill	1.83	0.545153
farmsiz	1.66	0.603574
creditu	1.53	0.654855
Age	1.47	0.679200
hhsiz	1.45	0.692026
logtothinc	1.37	0.730241
livest	1.37	0.732106
epaccess	1.32	0.759459
Depr	1.24	0.809184
Atra	1.23	0.812455
Edu	1.21	0.825427
Sex	1.20	0.833778
remita	1.17	0.851823
Mean VIF	1.43	

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of SID

$\text{chi}^2(1)$ = 0.54

$\text{Prob} > \text{chi}^2$ = 0.4617

Tests of endogeneity

Ho: variables are exogenous

Durbin (score) chi2(1)   = 2.05622   (p = 0.1516)

Wu-Hausman F(1,139)   = 1.89351   (p = 0.1710)

Robust score chi2(1)   = 1.90903   (p = 0.1671)

Robust regression F(1,139)   = 1.76244 (p = 0.1865)

Appendixe **2**: Multicollinearity, hetroscedasticity and endogeneity test for food security
 Multicollinearity

Variable	VIF	1/VIF
SID	2.99	0.334870
DAM	2.87	0.348471
HHSIZ	2.13	0.468490
EDU	1.76	0.567348
AGE	1.71	0.584761
LIVDEAS	1.58	0.631208
MALEHEADED	1.47	0.681266
LnTOHY	1.42	0.702765
FARMSIZ	1.38	0.726170
DEPR	1.36	0.735927
REMITA	1.29	0.775448
LIVEST	1.28	0.780535
CREDITU	1.24	0.807557
FRIQEXTS	1.06	0.940018
Mean VIF	1.68	

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of FSI

$chi^2 (1) = 0.4$ and $Prob > chi^2 = 0.8499$

Tests of endogeneity

Ho: variables are exogenous

Durbin (score) chi2(1)　　 $= 1.07565$　$(p = 0.2997)$

Wu-Hausman F(1,139)　　　 $= .984139$　$(p = 0.3229)$

Robust score chi2(1)　　 $= 1.32208$　$(p = 0.2502)$

Robust regression F(1,139)　 $= 1.29447$　$(p = 0.2572)$

Appendixe 3: Correlation coefficient for income diversification and food security

	FSI	malehe	AGE	EDU	HHSI	DEPR	REMIT	FARMS	LIVEST	LIVDEAS	CREDIT	DAM	Lntohy	FRIQE	SID
FSI	1.0000														
Malehed	-0.0818	1.0000													
AGE	0.0141	0.2372	1.0000												
EDU	0.2260	0.0064	0.3548	1.0000											
HHSI	-0.2235	0.3655	0.5417	0.4122	1.0000										
DEPR	-0.2897	-0.0464	0.1287	0.2207	0.1456	1.0000									
REMITA	0.2189	-0.2645	0.1591	0.1536	-0.0313	0.0721	1.0000								
FARMSI	0.1714	-0.1073	0.1293	0.1698	0.2247	0.1101	0.0573	1.0000							
LIVEST	0.3353	-0.0814	0.0420	0.0819	0.0967	0.0793	0.0423	0.3027	1.0000						
LIVDEAS	-0.4432	0.1681	0.2324	0.3867	0.4010	0.1303	-0.2234	0.1612	0.1060	1.0000					
CREDITU	-0.1603	-0.0502	0.1106	0.3234	-0.2284	0.0124	-0.0568	-0.1268	0.1724	-0.0352	1.0000				
DAM	-0.6709	0.0683	0.1239	0.1733	0.3059	0.3565	-0.0720	0.0582	0.2278	0.3570	0.1213	1.0000			
Lntohy	0.4192	0.2336	0.0746	0.1540	0.0627	0.2014	-0.0816	0.2350	0.2478	-0.1270	-0.0691	0.3013	1.0000		
FRIQEXT	0.1351	0.1396	0.0201	0.0207	0.0581	0.0276	-0.0138	-0.0496	0.1283	0.0480	0.1020	0.0486	0.0547	1.0000	
SID	0.7529	-0.0783	-0.0447	0.2597	-0.2938	-0.4011	0.1356	0.0588	0.2285	-0.3514	-0.0590	-0.773	0.3217	-0.082	1.0000

corr sid sex age edu famsiz depr remita farmsiz livest atra creditu dam logtothinc spskill epaccess (obs=153)

	sid	sex	age	edu	hhsiz	depr	remita	farmsiz	Livest	atra	creditu	dam	logtot	spskill	epac
Sid	1.0000														
Sex	0.2575	1.0000													
Age	-0.1146	0.1368	1.0000												
Edu	0.3854	0.0672	-0.0780	1.0000											
Hhsiz	0.1947	0.2433	0.2955	-0.0575	1.0000										
Depr	-0.1737	0.0539	0.0272	-0.1203	0.2256	1.0000									
Remita	0.1507	-0.0591	0.0975	-0.0437	-0.0108	0.0305	1.0000								
Farmsiz	-0.2847	0.0198	0.3174	-0.1478	0.2578	0.1397	-0.2111	1.0000							
Livest	-0.1541	0.1019	0.2164	-0.1361	0.1836	0.1300	-0.1134	0.4325	1.0000						
Atra	0.1258	0.1127	-0.0487	0.0879	-0.0921	-0.2494	-0.1248	0.0525	0.1736	1.0000					
Creditu	0.5389	0.1563	-0.3254	0.2110	0.0753	-0.1737	0.0364	-0.2327	-0.2257	0.0374	1.0000				
Dam	-0.7963	-0.2237	0.1632	-0.2562	-0.1239	0.1262	-0.0852	0.2874	0.0547	-0.1450	-0.4076	1.0000			
Lntotinc	0.3767	0.0555	-0.0886	0.0109	0.1501	-0.1453	-0.0093	0.1064	0.1067	0.2413	0.2236	-0.3365	1.0000		
Spskill	0.6474	0.1980	-0.0150	0.1829	0.1642	-0.1164	0.2068	-0.2115	-0.0381	0.0869	0.3750	0.6014	0.3428	1.0000	
Epacces	0.4524	0.0166	-0.0069	0.3106	0.1689	-0.0894	-0.0286	-0.1881	-0.0970	-0.0245	0.1676	-0.3294	0.1482	0.2891	1.00

Appendixe 4: marginal effect of explanatory variables

Variables	dy/dx	Std. Err.	Z	P>z	[95% Conf.	Interval]
Sex	.0428392	.0190336	2.25	0.024	.0055341	.0801444
Age	.0001348	.0008711	0.15	0.877	-.0015726	.0018421
Edu	.0875125	.0244766	3.58	0.000	.0395392	.1354858
Hhsiz	.0091747	.0050276	1.82	0.068	-.0006793	.0190286
Depr	-.0071374	.0111704	-0.64	0.523	-.0290309	.0147562
Remita	.0325768	.0219424	1.48	0.138	-.0104295	.0755831
Farmsiz	-.0016129	.0050068	-0.32	0.747	-.0114262	.0082003
Livest	-.0011155	.0007413	-1.50	0.132	-.0025684	.0003375
Atra	.0092929	.0261162	0.36	0.722	-.0418939	.0604798
Creditu	.0903693	.0282628	3.20	0.001	.0349752	.1457634
Dam	-.1177396	.0146016	-8.06	0.000	-.1463582	-.0891209
Logtothinc	.0280754	.0151534	1.85	0.064	-.0016249	.0577756
Spskill	.0436987	.0242507	1.80	0.072	-.0038318	.0912292
Epaccess	.065911	.0210347	3.13	0.002	.0246838	.1071383

Source: Survey result, 2017

Appendixe 5: Odds ratio of explanatory variables

FSI	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Male headed	3.407206	3.901647	1.07	0.284	.3611385	32.14572
AGE	1.142038	.0630999	2.40	0.016	1.024825	1.272656
EDU	1.355052	.1671796	2.46	0.014	1.063993	1.72573
HHSIZ	.4527896	.1426389	-2.52	0.012	.2442017	.8395452
DEPR	.9362592	.405153	-0.15	0.879	.4009135	2.18646
REMITA	4.424427	3.865558	1.70	0.089	.7983153	24.52107
FARMSIZ	2.189839	.6878002	2.50	0.013	1.183207	4.052879
LIVEST	1.043088	.0224465	1.96	0.050	1.000009	1.088023
LIVDEAS	.3983926	.3535611	-1.04	0.300	.0699675	2.268434
CREDITU	.1103278	.1210593	-2.01	0.045	.0128436	.9477244
DAM	.0181536	.0178386	-4.08	0.000	.0026456	.1245649
FRIQEXTS	.9873359	.0236017	-0.53	0.594	.9421444	1.034695
Lntohy	1.013345	.0081225	1.65	0.098	.9975492	1.02939
SID	1.2324	23.78	2.22	0.026	.8028643	2.870529
_cons	.0025177	.0078355	-1.92	0.054	5.65e-06	1.122249

Source: Survey result, 2017

Appendixe 6: Conversion factor used to calculate adult equivalent

Age category (Years)	Male	Female
Less than 10 years	0.60	0.60
10 – 13	0.80	0.90
14 – 16	0.75	1.00
17 – 50	0.75	1.00
Greater than 50	0.75	1.00

Source: Institute Pan African Pour le Development (1981); cited in Strock *et al.* 1991

Appendixe 7: Conversion Factor for Tropical Livestock Unit

Animal Category	Tropical Livestock Unit (TLU)
Ox	1.10
Cow	1.00
Heifer	0.50
Bull	0.60
Calves	0.20
Sheep	0.01

Goat	0.09	
Donkey	0.50	
Horse	0.80	
Mule	0.70	
Camel	1.25	
Poultry	0.01	

Source: Storck, *et al.* (1991)

Appendixe 8: Calorie value of food items consumed by sample households

Food item	Unit	Kcal
Teff	Kg	3589
Wheat	Kg	3623
Sorghum	Kg	3805
Maize	Kg	3751
Barley	Kg	3723
Oat	Kg	3599
Peas	Kg	3553
Lentils	Kg	3522

Fenugreek	Kg	3824
Irish potato	Kg	1037
Sweet potato	Kg	1360
Onion	Kg	713
Meat	Kg	1148
Milk	Lt	737
Egg	Each	61
Butter	Kg	7364
Edible oil	Lt	8964
Coffee	Kg	1103
Sugar	Kg	3850
Spaghetti/Macaroni	Kg	3550

Source: EHNRI, 1998; Dire Dawa Food Complex

BAHIR DAR UNIVERSITY

SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF AGRICULTURAL ECONOMICS

Dear respondents this study will be realized with your kindly cooperation in providing genuine information to data enumerator. The researcher, Mohammed Adem, kindly reminds you that your responses are utilized for the research work only. To ensure this, I am not taking your names. In addition the researcher would like to be grateful to you the sacrifices you paid in completing interview schedule developed by me. This interview schedule is designed to **Analyze the Socio-economic Determinants of Income Diversification and Its Effect on Food Security Status of Small Holder Farmers in Asayita Woreda of Afar Region.** The interview schedule is composed of both open and closed ended questions to provide you with an opportunity to elaborate your response. The purpose of this interview is to gather information on factors influencing households' income diversification and its effect on food security status of small holder farmers in Asayita woreda. Therefore, the responses that you give for the questions are very vital for the study. Your genuine participation by responding patiently to the questions is highly appreciated.

Thank you in advance for your kind cooperation!

Instruction to enumerators

1. Introduce about yourself and the organization working for

2. Make clear the purpose and objective of the study to the selected respondents.

3. Please ask each question so clearly and patiently until the respondents gets your point

4. Please fill up the interview schedule according to the respondents reply (do not put own opinion)

5. Encircle all closed questions and write respondents' answer on the space provided

General information

Region	Zone	Woreda	Kebele	Gott
Afar	Zone one	Asayita		
	Name	Date (day/month/year)		Signature
Enumerator				
Supervisor				

Part I: Household profile

1. Sex of respondent   1. Male   2. Female

2. Age of respondent_____

3. Marital status: 1. Single 2. Married 3.Divorced 4. Widow/wer

4. Educational Status: 1.Illiterate   2. Literate

4.1. If literate, years of schooling------------------------------------

5. Occupations of the household head: 1.Farmer 2.Others(specifies) ---------------

6. Household Size: Male--------------- Female--------- Total-------------

7. How many of your household members fall under the following group

S. No	Name	Age	Male	Female
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				

Part II: Questions Concerning Factors Influencing Income Diversification
8. **Farm size**

    8.1. Do you own the land on which you cultivate your crops?   1. Yes   2. No

    8.2. If your response to question 8.1 is 'yes' how many hectares (timad) of farming land does your household own now? _____

   8.3. If 'No' to question 8.1, how do you access to it?

  1. Sharecropping   3.Rental   5. Inherited from parents

  2. Leased land in   4. I do not want   6. Others (specify) ----------

8.4. If you access either in the above sources, how many hectares (timad) of farming land does your household own now? _____

9. Agricultural extension services

9.1. Did extension staff visit you last growing season   1.Yes   2. No

9.2. If yes, how many times did extension staff visit you last cropping season----------------?

9.3. What were the purposes of these visits?

  1. To give advice on agriculture related issues   4. To give advice on petty trading

  2. To give advice on handicraft   5. To give advice on finance and credit management

  3. To teach adult education   6. Others (Specify) _____

10. **Use of improved agricultural inputs**

 10.1. Do you use improved agricultural input in 2009? 1. Yes   2. No

10.2. If your response to Q10.1 is 'yes' explain the amount

N**o**	Agricultural input	Yes	No	Quantity (kg,liter, quintal, etc)	Value (birr)
1	Seed				
2	Fertilizer				
3	Pesticide				
4	Herbicide				
5	Others				

10.3. If your response to Q10.1 is 'No', why?

    1. Not available   3. Very expensive

    2. Never heard of it   4. No awareness about it   5. Others (specify) -----------------

11. Total number of livestock and income from livestock

  11.1. Do you own livestock?   1. Yes   2. No

  11.2. If your response is 'yes" to Q11.1, indicate the number of livestock owned currently and income earned

S/N	Type livestock	Number livestock	Did you sale your livestock in 2008 year and 2009 year? 1. Yes 2. No	If yes, Income obtained in 2009 year	If yes, income obtain in the 2008 year
1	Ox				
2	Cow				
3	Calf				
4	Bull				
5	Heifer				
6	Horse				
7	Camel				
8	Donkey				
9	Goats				
10	Sheep				
11	Chicken				
12	Others (specify				

Note: Reason for sale animals can be:

1. Purchase of farm inputs   4. Household expenses in food, clothing and other supplies

2. Hiring labour   5. For loan repayment

3. Purchase of jewelry   6.Others specify---

11.3. Annual income from livestock products sale

Type of livestock Product	Yes	No	Quantity sold in the last 12 months(litre/kg/number)	Income generated(birr)
Milk				
Eggs				
Cheese				
Butter				
Hide and skin				
Sub total				

11.4. Expenses of livestock production in 2009

Description	Expense in average month of 2009(birr)	Total expense in 2009 (birr)
Feed		
Vet. Medicine		
Others		
	Sub total	

12. Receiving remittances

12.1. Do you receive foreign and/or home remittances from relatives or friends during the last 12 months   1.Yes   2. No

12.2. If your response to Q 12.1 is yes, indicate amount of total cash you received in (ETB) ------

----

13. Utilization of credit

13.1. Did you take any credit from credit lending institution?   1. Yes   2. No

13.2. If your response to Q13.1 is 'Yes' for what purpose (s)?

1. To purchase agricultural inputs   6. Payment for hired labour

2. To purchase clothes to the children   7. To start nonfarm business

3. To purchase food   8. Health expenses

4. To pay loan taken from others   9. Social ceremonies

5. To buy livestock   10. Others (Specify)   ---------------

13.3. Indicate sources of credit

1. Afar credit and saving company   5. Private moneylenders

2. Cooperatives   6. *Iddirs*

3. NGOs   7. Neighbors

4. Banks   8. *Iqubs*

                9. Others specify_____

13.4 If your response to Q13.1 is '**No**', what was the reason for not taking loan from formal credit institution?

1. The institution is not available   5. The loan payment time is not appropriate

2. The institution is far from the kebeles   6. Not allowed by religion

3. It require asset for collateral   7. I use my own cash

4. The interest rate is too high   8. I do not want   9. Other (Specify) ---------

14. **Distance from market center**

14.1. What is the distance from your home to market center (in hours)? _____ in Km------

14.2. Do you feel there is a problem in transportation of your products to the nearest market?

      1. Yes   2.No

14.3 If yes, what do you think is the problem?

1. Long distance to the nearby market   3. No favourable road

2. No transportation service   4. Others (specify)_____

15. **Access to training**

15.1. Have you received training during 2009?   1. Yes   2. No

15.2. If yes to Q15.1, what type of training did you get?

    1. Services providing   4. Finance and credit management

    2. Petty trading   5. Farm training

    3. Handicraft   6. Others (Specify) ----------------------

  15.3 From whom did you get the training?
    1. Micro and small scale enterprise office   3. District agriculture office
    2. Cooperative office   4. NGO staff   5. Others (Specify)_____

15.4. If No to Q15.1, why?
    1.   Not educated   3.I am not present when training was given
    2.   Not getting opportunity   4. Others (specify)--------------------------

16. Electric power access
    16.1 Do you have electric power access? 1. Yes   2. No

17. Special skill
  17.1 Do you have special skill?   1. Yes   2. No
  17.2. If your answer for question 17, please specify--
--.

18. Irrigation utilization

18.1. Are you irrigation user?   1. Yes   2. No

If your answer to question 16.1 is '**yes**',

18.2. What hectare (timad) of your plot of land is under irrigation?_____

18.3. How long do you use irrigation farming (in years)? _____
18.4. If your answer is No, what was the reasons not using irrigation?

 1, No farmland I have and/or cultivated is far from water sources (river)

 2. No awareness about it   5.Sufficient rain and moisture
 3. Lack of water pump   6. High cost of irrigation material
 4. Lack of labour force   7. Others (specify)_____

Part III: Questions Regarding to Trends in Income Generating Activities

19. How will you describe the trend of your income level over the past two years?

       1. Increasing   2. Decreasing   3. Remained stagnant

20. Is there variability in number of income sources between the years 2008 and 2009?

       1. Yes   2. No

21. If yes to Q20, is there an increase in number of income sources?   1. Yes 2. No

22. If yes to Q21, the amount of income sources increased (in number) _____

23. If no to Q21, the amount of income sources decreased (in number) _____ and what should be the reason behind increasing or decreasing-- -- -- --------------------

Part IV: Questions Regarding to Income Earning from Different Sources of Income

24. Annual income from on farming activities (ETB)

24.1. Annual income from crop production activities.

S.N	Type	Yes	No	Total harvest (k.g/ Qt) during 2009	Amount consumed(k.g/Qt)	Total amount sold		
						Kg/Qt	Unit price	Total income
1	Maize							
2	onion							
3	Tomato							
4	Pepper							
5	Tree planting							
6	Sales of grass and others							
7	Others							
	Sub total							

25. Annual income from non-farm activities (in birr)

		Yes	No	Monthly Income In birr	Annual Income In birr
25.1	**Self Employment**				
A	Shop running				
B	Petty trade (grain, livestock, coffee, spices, salt, *etc*.)				
C	Food processing for sale-local drink like areqe, tela (alcohol, oil)				
D	Fuel wood and/or charcoal sale				
E	Handicraft (blacksmithing, embroidery, weaving, pottery, *etc*.)				
F	Services (repair of shoes, barber, grain milling, tailor,)				
G	Others				
	Sub total				

25.2	**Formal Employment**	yes	No	Monthly Income In birr	Annual Income In birr
A	Employment in private enterprises				
B	Employment in government offices and enterprises				
C	Employment in non-government organizations				
D	Local election position (paid)				
	Sub total				

25.3	**Remittance**	Yes	No	Monthly Income In birr	Annual Income In birr
A	Remittance from relatives				
B	Remittance from friends				
C	Other remittance (specify)				
	Sub total				

25.4	**Rent income**	yes	No	Monthly Income In birr	Annual Income In birr
A	Rent house or room				

					Monthly Income In birr	Annual Income In birr
B	Rent out animals (oxen, donkey, horse, mule)					
C	Rent of land					
D	Others (Specify)					
	Sub total					

26. Annual income from **non formal wage** activities (in birr)

S.N	Non formal wage	Yes	No	Monthly Income In birr	Annual Income In birr
1	Housemaid				
2	Sale of labour for agricultural/non agricultural work (Daily wage work)				
	Sub total				

27. Annual income from other activities (in birr) -----------------------

Part V: Questions Related to General Problems that may Influence Income Diversification

28. What are the major constraints/obstacles prevents/discourage you from starting or expanding

non/off farm income-earning activities? Rank the following constraints.

No	Constraints	Yes	No	Rank
1	Not enough customers			
2	Market center is far from my home			
3	Lack of information			
4	Do not have skill or knowledge about non farm income			
5	Do not have initial capital			
6	Fear of losing land if involving in activities outside agriculture			
7	Scarcity of Labour			
8	Lack of transportation			
9	Health problems			
10	Others, specify			

29. Do you face difficulty in the way of income diversification? 1. Yes   2.No

If   yes please specify---

----

30. What are the associated problems/constraints/ you face from on farm activities?

----

31. What are the associated problems/constraints/ you face from non-farm livelihood activities?

32. What are the associated problems/constraints/ you face from linking together farm and non-farm activities? --

Part VI. Food security indicators

Instruction - This Part will be answered by the responsible for meal preparation and distribution.

33. Yesterday, how many times did the older children and adults (above 13 years) in this household eat? _____ times .

34. Yesterday, how many times did children (6-13 years) in this household eat? _____ times

35. Could you please tell me how many days in the past one week (7 days) your household has eaten the following foods and what the source was (use codes on the right, write 0 for items not eaten over the last 7 days and if several sources, write up to two)

Food items consumed in the last 7 days	Quantity		Number of days eaten last 7 days	Sources
	Local unit	Standard unit (Kg		
Maize				
Wheat				
Sorghum				
Teff				
Barely				
Oat				
Peas				
Lentils				
Milk				
Meat				
Butter				
Egg				
Edible oil				
Coffee				

Sugar				
Rice				
Spaghetti/Macaroni				
Onion				
Potato				
Cabbage				
Tomato				
Orange				
banana				
avocado				
papaya				
mango				
others				

Source: 1 own production 2 received from relatives   3 purchased from the market   4 received from hiring out of labour   5 received from food aid   6. Borrowing

Thank you very much for your cooperation!

Key Informants Interview Guideline

Representatives of Asayita Agriculture and Rural Development Office and representatives of Cooperative Promotion Office of the woreda

1. What are the major income generating activities of the rural farmer in the district?

2. What are the major improved agricultural technologies available to the farmers?

3. Are there the differences between different social groups in use of improved agricultural technologies? If there are differences, what do you think are the reasons?

4. How frequently do Development Agents give advices to farmers in a month? Do they encourage farmers' participation in non agricultural activities in order to increase their income sources?

5. What are the major problems in relation to farmers' access to irrigation, market, credit and transportation services?

6. What non- agricultural activities are pursued by the rural communities?

7. What are the major factors that affect income diversification activities in the district?

8. What are the positive and negative relationship between on farm and nonfarm/off farm income generating activities?

9. How do you rate the trend of income diversification over time?

Focus Group Discussion Checklist

(Kebele leaders, leaders of local institutions, development agents, model farmers, elders and traders)

1. What are the main sources of income in your community?

2. How do you describe the trend of involvement of the rural people in different income generating activities (farming and non-farm activities)?

3. What are the major constraints that block or discourage rural households' entrance to diversified income sources in the area?

4. What is/are the positive and negative linkages between on farm and non farm income?

5. Do you think diverse activities (on-farm and non-farm) helps the rural people to increase their income or improve the food security situation of the HHs? How?

BIOGRAPHICAL SKETCH

Mohammed Adem was born in Metene kebele, Kombolicha Woreda, South Wollo Zone of Amahara Regional State in April 1990. He attended his primary education at Metene Elementary School. He attended his secondary and preparatory school education at kombolicha secondary and preparatory high school in South Wollo Zone. After completion of his secondary and preparatory school education, he joined Mekelle University in October 2008 and graduated with BSc. Degree in Economics since in July 2/2011. Soon after his graduation, he was employed in Ambasel trading house pvt. ltd. company in Dessie branch as marketing researcher and promotion officer. After four years experiences he join Samara University in October 2015 and also the author joined Bahir Dar University College of agriculture and environmental science since in October 2016 to pursue of his M.Sc. degree in Agricultural Economics in regular program.