PARTICIPATION IN NON-FARM INCOME ACTIVITIES AND FOOD DIETARY DIVERSITY IN RURAL UGANDA

BY

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REG. NO: 2013/HD02/1906U

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A THESIS SUBMITTED TO THE DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS OF MAKERERE UNIVERSITY

NOVEMBER, 2019

DECLARATION

I, Racheal Namanda declare that **"Participation in Non-Farm Income Activities and Food Dietary Diversity in Rural Uganda"** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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DEDICATION

To my parents Irene Constance Nabwire and Julius Hannington Ssemmanda and my Fiancé Kintu Muteesasira Sr.

ACKNOWLEDGEMENTS

I want to express my sincere appreciation to my academic supervisors Dr. Gracious Malton Diiro and Prof. Bernard Bashaasha for their meticulous and thorough supervision, encouragement, motivation, guidance and enthusiasm, which helped in bringing this Master's Thesis to a successful completion. I am indeed grateful for all the invaluable comments, suggestions and corrections that culminated this thesis.

I would like to express my profound appreciation to the African Economic Research Consortium (AERC) for offering me this Master's Scholarship Award.

I express my heartfelt gratitude to my dear parents: Dad, Julius Hannington Semmanda and Mom, Irene Constance Nabwire and Fiancé, Kintu Muteesasira Sr. for their love, prayers, support, and encouragement to pursue higher studies.

Most importantly, I earnestly thank God, through whose providence and blessings I have been able to finally complete this thesis.

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LIST OF ACRONYMS

BMI	Body Mass Index
DDS	Dietary Diversity Score
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FVS	Food Variety Score
HDD	Household Dietary Diversity
HHDD	High Household Dietary Diversity Score
IDDS	Individual Dietary Diversity Score
IFPRI	International Food Policy Research Institute
ICF	ICF (Originally, Inner City Fund)
IV	Instrumental Variables
IVACG	International Vitamin A Consultative Group
LHDDS	Low Household Dietary Diversity
NAADS	National Agricultural Advisory Services
NEPAD	New Partnership for Africa's Development
NFAs	Non-Farm Activities
OLS	Ordinary Least Squares
PAHO	Pan-American Health Organization
RNFE	Rural Non-Farm Enterprise
RNFS	Rural Non-Farm Sector
SDGs	Sustainable Development Goals
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic Health Survey
UNPS	Uganda National Panel Survey
WFP	World Food Programme
WHO	World Health Organization

ABSTRACT

Food insecurity and malnutrition remain a major challenge to health and economic development in Uganda. About 50% of Ugandans have food energy deficiency and 19% are chronically undernourished. Reducing food insecurity in the developing world has therefore remained an essential part of the international agenda since the World Food Summits in 1996 and 2001. In this research study, we explore if engagement in non-farm income activities can reduce food insecurity in rural Uganda. This study examines the effect of farmer participation in non-farm income activities on household food dietary diversity in rural Uganda using three comprehensive waves of household level data of a nationally representative sample of 3123 rural households gathered by the Uganda National Household Survey from 2009, 2010 and 2011. Qualitative recall of the household's food consumption during the last seven days was used to calculate Household Dietary Diversity Score (HDDS= representing the number of food groups, based on a scale of 12 groups and the scores were divided into terciles low= ≤4, medium=5-8, and high= 9-12). We employed the Panel Ordered Logit Model approach in the analysis because of the categorical and ordinal nature of our dependent variable, HDD. The results show that the average HDDS of consumption across the years was 8.42 and 7.73 food groups for participants and non-participants in the rural non-farm sector respectively. Our findings show that more than 50% of the total income of households in rural Uganda is from non-farm income activities. We however, find households with non-farm work to be more food secure than those without non-farm work. Econometric results show that participation in non-farm income activities has a statistically significant (1% level) impact on household food dietary diversity. Specifically, households participating in non-farm income activities are significantly more likely to attain a higher HDD (4.48%) but are significantly less likely to attain low HDD (1.62%) or medium HDD (2.86%). The study results thus imply that non-farm employment has a role which is significant in maintaining household food and nutrition security. Therefore, efforts should be made to promote non-farm employment as a good strategy for supplementing the income of farmers as well as sustaining equitable rural growth and to realize its full potential towards food security.

Keywords: Food security, household food dietary diversity, non-farm income, diversification, panel ordered logit model, rural Uganda.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

1.1.1 Uganda's Economic Progress and Food Insecurity Status

Uganda has enjoyed relatively high rates of economic growth since the late 1980s. The proportion of the population living below the poverty line declined from 56% in 1993 to 19.7% in 2013 (Uganda Bureau of Statistics (UBOS, 2016). Poverty now stands at 27%, up from 19.7% in 2013. The report shows that Eastern Uganda was hit hardest, with poverty increasing by 27% while Northern Uganda, on the other hand, came out as least affected with people living in poverty there dropping from 3.1% to 2.4% (UBOS, 2017). The proportion of households living below the international extreme poverty line of US$1.90 a day (2011 prices) fell from 68.1% in 1993 to 34.6% in 2013. The rate of progress has been particularly fast in the last decade with international extreme poverty falling from 62.2% in 2003. The depth and severity of poverty have also fallen consistently.

However, income inequality has persistently remained high. For example, during the period 2003-2006, the distribution of income slightly improved from 0.428-0.408 but worsened to 0.426 in 2010. Income inequality however, reduced from 0.426 in 2010 to 0.395 in 2013. Wide variations in poverty levels and income inequality are also evident between urban and rural households, and across regions. Urban households exhibited higher income inequality (0.410) in the year 2013 than rural households (0.341). At regional level, inequality is particularly high in the central region, despite the reported low poverty rates in the region relative to other regions in the country. (UBOS, 2016).

Despite the general improvement in economic conditions in the country, Uganda still faces a major challenge in reducing food insecurity and malnutrition to the acceptable levels targeted by the Sustainable Development Goals (SDGs). According to World Food Programme (WFP) Uganda

and the Uganda Bureau of Statistics (UBOS, 2013), about 50% of Ugandans had food energy deficiency between September 2009 and August 2011, with the northern region registering the highest food insecurity of 59%. With regard to dietary diversity, the report shows at least one third of the population having low dietary diversity that was highest in the western region at 55%.[1]

Food insecurity was more of a rural phenomenon across all food security indicators except for caloric deficiency. The reported poor food consumption in many households may be responsible for the increased malnutrition in the country. The Uganda Demographic Health Survey reports that, about 19% of the people in Uganda are chronically undernourished (UDHS, 2011).

The prevalence of undernutrition is particularly high among women, children and babies. In 2011, about 38% of children under 5 in Uganda were stunted (about 2.3 million young children in the country). At the regional level, the proportion of stunted children is highest in Western (43.9%) followed by West Nile (37%), Central (33.4%) and then East Central (33.5%) (UDHS, 2011). Stunting is greater among children in rural areas (30%) than urban areas (24%). Stunting ranges from a high of 41% in Tooro sub-region to a low of 14% in Teso sub-region. The prevalence of stunting decreases with increasing levels of the mother's education.

About 4 in 10 children born to mothers with no education (37%) are stunted compared with 1 in 10 (10%) of children born to mothers with more than a secondary education (UBOS & ICF, 2017). The UDHS (2011) results further estimate that 12% of Ugandan women of reproductive age are underweight with BMI less than 18.5 kg/m^2. There are variations in prevalence of wasting among women across regions. The proportion of underweight women of reproductive age is highest in West Nile (20.9%) followed by East Central (11.9%) then Western and Central regions with a prevalence of 7.8%. Stunting is slightly higher among male children (31%) than among female children (27%).

[1] The report further shows that about 5% of the population had an extremely unbalanced diet, and 17% consumed a slightly more varied diet with more pulses, vegetables and sugars, albeit no any animal proteins, milk or fruit.

High prevalence of food insecurity and malnutrition in the rural parts of the country may be attributed to the high levels of poverty in these parts of the country. Poverty remains firmly entrenched in rural areas in the country despite strides made by the Government of Uganda to reduce its incidence. About 21% of all rural people still live below the national rural poverty line (UBOS, 2016). Poor households remain food insecure because they are unable to invest in improved inputs and technologies needed to increase farm yields.

Further, poor households in the rural areas often lack financial buffer to protect them from shocks such as accident or illness of a household member or poor harvest/crop failure due to drought. Many rural households may respond to the shocks by reducing food intake, further exacerbating food insecurity and poverty. This implies the need to design and implement strategic interventions which can break the vicious cycle of food insecurity, malnutrition and low micronutrient intake.

1.1.2 Malnutrition and Dietary Diversity

A diverse diet is important in meeting the requirements for essential nutrients especially for those who are at risk of nutrient deficiencies, as this may lead to malnutrition. Malnutrition refers to an abnormal physiologic condition caused by inadequate or excessive consumption of macronutrients and/or micronutrients (FAO, IFAD, & WFP, 2013). It can be under nutrition or over nutrition as well as micronutrient deficiency usually referred to as *hidden hunger* (FAO, IFAD & WFP, 2013). It is a major cause of morbidity and mortality in children under five years of age globally with approximately one-third of the nearly eight million deaths attributed to it (WHO, 2013).

Hunger and malnutrition are complex global problems. Despite substantial improvements in food and nutrition security over the last few decades, the prevalence of undernutrition remains high, especially in Sub-Saharan Africa and Asia (FAO, IFAD, & WFP, 2015; IFPRI, 2014; Dubé et al., 2012; Godfray et al., 2010;). Despite the overall progress to reduce global food insecurity and chronic undernourishment, Sub-Saharan Africa remains the most food-insecure region in the world with close to 223 million people undernourished (FAO, IFAD & WFP, 2015; FAO, IFAD, & WFP, 2012). The limited decline in undernutrition rates being linked to low levels of household food security (FAO, IFAD & WFP, 2015; Harris-Fry et al., 2015). This made it difficult to achieve the Millennium Development Goal (MDG) which sought to “eradicate extreme poverty and hunger”

by 2015, and to halve the proportion of those suffering from hunger (UN, 2008) as more than one in four people are still undernourished (FAO, IFAD & WFP, 2012).

The prolonged problem of energy deficiencies has made it a continued focus of global efforts to deal with the issue of malnutrition (Ingram et al., 2010). Food and agricultural productivity has been increased through extensification and intensification to meet the needs of all people in the world yet this did not assure food security for all (Poppy et al., 2014). Some poorer societies and communities lack access to sufficient quantity or quality food as close to one billion people are facing challenges of not having enough food and two billion are suffering from micronutrient deficiencies (IFPRI, 2015). When food is available, many low-income households consume monotonous diets which are of low quality, cereal based, and lacking in vegetables, fruit, and animal-source foods, thereby increasing the risk of micronutrient deficiencies which is already high in some resource-poor settings (FAO, IFAD & WFP, 2012; Kennedy, 2009; Arimond et al., 2010). Monotonous diets are closely associated with food insecurity (Kennedy, 2009), resulting in malnutrition. Ruel (2002) noted that lack of dietary diversity is a challenge for rural communities in developing countries. Their diets are by default defined on starchy staples with inadequate animal products, fresh fruits and vegetables (Ruel et al., 2004).

In Uganda, about 10.3 million people are undernourished and the prevalence has been rising (FAO, 2016b). Half of households restrict themselves to two meals a day (UBOS, 2014). The most recent available data shows almost half the population as food energy deficient (i.e. their diet did not provide the minimum energy needed) (WFP, 2013). Those living in poverty, women, and children were the most food insecure. Children in the poorest wealth quintile were twice as likely to be stunted or underweight as the richest. One quarter of women-headed households were food insecure, compared to one fifth headed by men (WFP, 2013).

Unfortunately maternal malnutrition is acknowledged as a major predisposing factor for morbidity and mortality in African women (Lartey, 2004), notably caused by inadequate food intake, poor diet quality and frequent infections (Ajani, 2010). Several authors therefore argue that, quality of diets is directly correlated to dietary diversity and inversely related to malnutrition in terms of

faltered growth in children, nutrient deficiencies and the risk of chronic diseases (Azadbakht et al., 2005; Steyn et al., 2006).

Nutritional deficiencies are responsible for a large health burden in terms of lost productivity, impaired physical and mental human development, susceptibility to various diseases, and premature deaths (Lim et al., 2013). Nutritional deficiencies are not only the result of low food quantities consumed, but also of poor dietary quality and diversity. In fact, the level of dietary diversity was shown to be a good indicator of people's broader nutritional status in many situations (Kant et al., 1993; Ruel, 2003; Headey and Ecker, 2013; Steyn et al., 2006; Moursi et al., 2008; Arimond and Ruel, 2004; Arimond et al., 2010). More diverse diets tend to be associated also with lower rates of overweight and obesity—other nutritional problems of rising magnitude in many parts of the world (Popkin and Slining, 2013).

Increasing dietary diversity is thus an important strategy to improve nutrition and health. This implies that agricultural and non-agricultural production also needs to be diversified, so that a wide range of different types of foods are available and accessible also to poor population segments (Pingali, 2015; Kennedy, 2009). The consumption of a wide variety of foods among and within food groups helps in ensuring adequate intake of micronutrients which are essential to nutritional adequacy (Kennedy, 2009). Diversifying into non-farm income activities is therefore often perceived as a promising strategy to improve dietary quality and diversity. In Africa and Asia, the majority of the undernourished people live in rural areas and many of them are smallholder farmers (Pinstrup-Andersen, 2007).

According to the Food and Agriculture Organisation (FAO, 2011b), dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individuals. Dietary diversity can be assessed by using tools such as dietary scores which sum the number of food groups consumed over a reference period and these are good proxies of overall dietary quality (FAO, 2011b; Martin-Prével et al., 2015; FAO, 2016a) and are useful indicators of household food security (Hoddinott & Yohannes, 2002).

1.1.3 Non-Farm Sector as a Strategy for Reducing Food Insecurity and Malnutrition

Reducing food insecurity continues to be a major public policy challenge in developing countries. Almost 1 billion people worldwide are undernourished, many more suffer from micronutrient deficiencies, and the absolute numbers tend to increase further, especially in Sub-Saharan Africa (FAO, 2008b).

Empirical literature on food security and non-farm sector in developing countries suggest that diversification into non-farm income activities may be an important strategy for rural households to smooth consumption and thus reduce malnutrition (De Janvry and Sadoulet, 2001; Barrett et al., 2001; Reardon et al., 2007; Iiyama et al., 2008; Quinn, 2009)[2]. The stream of income earned from non-farm activities does not only enable farmers to smooth consumption (Kijima et al., 2006; De Janvry and Sadoulet, 2003) but may also provide them with liquid resources to purchase modern farm inputs (Reardon, 1997; Barrett et al., 2001).[3] The non-farm sector accounts for 30% to 45% of rural households' income in the developing world (Haggblade et al., 2010), providing employment to about 20% to 50% of the rural population in developing countries (Islam, 1997).

In terms of rural employment, based on census data, rural non-farm activities involve about one job in four in Asia, West Asia and North Africa, with higher figures in Latin America (about one third) and lower in Africa (10%) (Haggblade et al., 2005). Furthermore, the limited evidence from recently developed countries suggests that this diversification increases as economies grow (Haggblade et al., 2005).

In Africa, the income share of the rural non-farm income ranges between 22% and 93% Reardon (1997) and 30–50% of this is in the sub-Saharan Africa, Ellis (2000). For the case of Uganda, about 60% of rural households engage in some form of non-farm income generating activity, and the proportion of those with positive non-farm earnings increased from 49% in 2003 to 53% in

[2] Sustainable rural livelihoods are not exclusively dependent on income obtained from agricultural activities, but are often supplemented by non-farm activities (Reardon, 1997; Ellis, 1998; Carswell, 2000).

2005 (Kijima et al., 2006). The share of total income from non-farm activities for rural households increased from 34% in 1996 (Canagarajah et al., 2001) to 54% in 1999 (Balihuta and Sen, 2001) and from 46% in 2000 to 65% in 2006 (UBOS, 2010), and are above the average of 35% reported for Africa (Haggblade et al., 2010).

Further, the level of household participation in rural non-farm activities in Uganda has significantly increased from 49% in 2003 (Kijima et al., 2006) to about 59% in 2009 (UBOS, 2010). The rural non-farm sector is very diverse in its nature and activities. This fact makes it complicated to be understood by the rural economy of developing countries (Lanjouw and Lanjouw, 2001). Therefore, Saith (1992) defined the Rural Non-Farm Sector (RNFS) as economic activities that include; manufacturing, handicrafts, processing, repairs, construction, mining and quarrying, transport, trade and commerce, communication, community and personal services in rural areas.

Similarly, the rural non-farm economy is described as a heterogeneous collection of trading, agro-processing, manufacturing, commercial and service activities (Haggblade et al., 2007). Therefore, the common non-farm income generating activities in Uganda include mining and quarrying, household manufacturing, processing, repair, construction, trade and commerce, transport and other services in villages and rural towns undertaken by enterprises varying in size from household own-account enterprises to factories.

This research study therefore tests if engagement in the non-farm sector can reduce food insecurity in the rural areas as measured by dietary diversity. If so, increased recourse to improved food security and nutrition in Uganda can be enhanced by promoting mechanisms that encourage income diversification in the rural areas.[4]

1.2 Research Problem

There is growing literature on the role of non-farm sector on household livelihood indicators (World Bank, 2008; Slesnick, 1994). In Uganda, particular attention has been paid to its impact on poverty (e.g. Kijima et al., 2006), and farm investment (e.g. Diiro and Sam, 2015).

[4] The terms off-farm and non-farm are used interchangeably in several places in this paper.

A study by Kijima et al. (2006) on non-farm employment, agricultural shocks, and poverty dynamics found that households that experience shocks shift towards the non-farm sector due to small magnitudes of farm labour income ($3 for seven months) while Diiro and Sam's (2015) study on agricultural technology adoption and non-farm earnings shows that a farmer with annual income of $4,363 has an adoption capabiltiy of 32.8%. However, the above studies have concentrated on the impact of non-farm activities on rural poverty alleviation in general, ignoring the potential effects on household food security. The linkage between off-farm work and household food dietary diversity has not been empirically addressed. This linkage is of policy relevance in Uganda as food insecurity and malnutrition remain high in rural areas, amidst increasing significance of the non-farm sector. This research thus investigates the causal effect of non-farm income participation on household nutritional security. The food security impact of non-farm sector is ambiguous. On one hand, income diversification is expected to contribute to increased food security, through increased food supply diversity and nutrition. Non-farm work is associated with higher and stable incomes and food consumption over the years (Reardon et al., 1992). On the other hand, participation in the non-farm sector may hamper agricultural productivity and thus food insecurity because it may reduce supply of labour to the agricultural sector production (Scherr and Hazell, 1994). In this case food security would be achieved through the market rather than by own production. If labour markets are imperfect as is the case for Uganda, having non-farm activities may therefore decrease the probability to adopt labour intensive fertility management practices like Soil and Water Conservation, hence leading to depletion of soil nutrients, and low yields.

1.3 Objectives of the Study

The general objective of this study is to understand the effect of non-farm income diversification on household nutritional diversity in rural Uganda. The specific objectives of this study are;

1. To characterize and analyze trends in participation in the non-farm income sector among rural farmer households in Uganda.
2. To determine and compare the level of household dietary diversity between participants and non-participants in the rural non-farm sector in Uganda.
3. To assess the effect of farmer participation in non-farm income activities on household food dietary diversity in rural Uganda.

1.4 Hypothesis

1. There is no significant difference between participants and non-participants in the rural non-farm income sector with respect to household food dietary diversity.

1.5 Significance of the Study

Income diversification is important for poverty reduction in rural households in Uganda, where risky agriculture is a dominant source of income. The study will provide an important input for policy formulation to promote nutrition sensitive growth of the non-farm sector. Formulation of effective policies that promote household income diversification requires an understanding of the factors that drive and enhance non-farm income diversification in these households. An understanding of the significance and nature of non-farm activities (especially its contribution to rural household income or resilience) is of utmost importance for policy makers in the design of potent agricultural and rural development policies. Findings of this study will also be of value to other scholars who may be seeking to further understand the dynamics of the rural economy and dietary diversity in Uganda. Results of the findings would also help in drawing policy prescriptions with respect to rural poverty reduction, rural development and food security.

1.6 Scope of the Study

This research is limited to the effect of rural non-farm income participation on household food dietary diversity. It specifically covers rural farm households in the Central, Eastern, Western, and Northern regions of Uganda and their participation in non-farm income activities and non-farm earnings. It only covers three comprehensive waves of household level data of a nationally representative sample of 3123 rural households gathered by the Uganda National Household Survey from 2009, 2010 and 2011.

Despite these limitations, the main results of this research constitute an initial baseline by providing a greater understanding of the dietary diversity of the indigenous communities of Uganda. These findings would help the decision makers to develop effective strategies to fight against food insecurity. Future researches should focus on the conduct of researches on food security, especially, in the rural areas and paying particular attention to the communities at risk and indigenous populations.

CHAPTER TWO

LITERATURE REVIEW

In this chapter, we give a brief review of empirical literature on the impact of non-farm income participation in developing countries. We therefore summarize and present the literature into two strands including impact of non-farm income participation on household income, wellbeing and poverty and the effect of non-farm income participation on food and nutrition security.

2.1 The Rural Non-Farm Sector

Non-farm enterprises are ubiquitous in rural Africa. Around 42% of rural households in a recent survey in Africa operated non-farm enterprises (Nagler and Naudé, 2014) and between 40% and 50% of rural household income in Africa are estimated to be from rural non-farm enterprises (Rijikers and Costa, 2012; Haggblade et al., 2010). Growth in rural populations, declines in agricultural employment, and rising demand for higher-value added farm products amongst a rising middle class in Africa is making the non-farm economy increasingly vital for job creation, livelihoods and stability (De Brauw et al., 2013; Rijikers and Costa, 2012; Janvry and Sadoulet, 2010). Non-farm activities account for 30% of full-time rural employment in Asia and Latin America and 10% in Africa (Haggblade, 2007). These figures do not include farmers who engage in non-farm activities as part-time employment or during agricultural slack seasons. When these are considered, the participation rates are 83% for Asia, 82% for Latin America and 78% for Africa (Winters et al., 2009).

Obviously, agricultural development is crucial for reducing hunger and poverty in rural areas, but non-agricultural growth can be important as well (Diao et al., 2007). Studies in different developing countries have shown that the non-farm sector contributes a significant share to employment and income in rural areas (Ellis, 1998; Lanjouw and Lanjouw, 2001; Haggblade et al., 2007; Davis et al., 2010; Reardon et al., 1998 and 2007). Specifically for African countries like Uganda, with strong population growth and increasingly limited agricultural resources, the potential role of the rural non-farm sector deserves particular consideration. Smallholder farm households usually maintain a portfolio of income sources, with non-farm income being a major

component (Barrett et al., 2001). But often a clear policy strategy to promote the non-farm sector is lacking. Non-farm sector development generally entails multiple benefits. For instance, the non-farm sector may absorb a growing rural labour force that cannot be employed in the agricultural sector and it may slow down rural-urban migration.

Similarly, non-farm sector expansion may enhance growth and promote a more equitable distribution of income (Lanjouw and Lanjouw, 2001) also by enabling more effective and beneficial income diversification opportunities for rural households (Reardon, 1997)[5]. The non-farm employment has also been generally recognised to have the potential in raising agricultural household income, and therefore reducing rural poverty (FAO, 1998; Arif et al., 2000; Lanjouw and Murgai, 2008). Ranjan (2006) has pointed out several grounds on the desirability of developing the non-farm sector as a vehicle to reduce rural poverty. Among them are: (i) the growing rural communities cannot be sustained by the agricultural sector alone; (ii) rural economies are not purely agricultural and most of the rural communities derive their incomes from various sources rather than from agriculture per se; (iii) avoid rural-urban migration; (iv) reduce the rural-urban economic disparities; (v) reduce rural unemployment since rural industries are usually labour-intensive and hence, expected to absorb more labour; (vi) intensifies linkages between industry and agriculture, and thus support agricultural growth; (vii) reduce income inequality in the rural areas since the lower income group is expected to participate more intensely in non-farm activities; and (viii) encourage the participation of women in the non-farm sectors and hence empowering them.

2.1.1 The Impact of Non-Farm Income Participation on Household Income, Wellbeing and Poverty

Several studies (Canagarajah et al., 2001; Adams, 2001; Dabalen et al., 2004; De Janvry et al., 2005; Kijima et al., 2006; Karttunen, 2009; Olugbire et al., 2011; Hadijah et al., 2011; Shehua and Sidiquea, 2014) exist on the impact of non-farm income participation on household income,

[5] (Reardon, 1997) suggests four possible advantages from wider income diversification: (1) reduction of income risk (due to the uncertainty linked to their farming activities) by ex-ante diversification; (2) maintaining food security in the face of low farm productivity or shocks; (3) ex-post diversification because of insurance market failure, and (4) earning cash income to finance farm investments in case of credit market failure.

wellbeing and poverty in Africa and outside Africa; showing detrimental effects of non-farm income diversification on household livelihoods.

In Uganda, Kijima et al. (2006) examine the role of non-farm employment in poverty reduction over a short period of time using panel data of 894 rural Ugandan households in 2003 and 2005. Results indicate that 60% of rural households earned non-farm income in the year 2005. Results also showed that Ugandan households' non-farm labour supply increases if they experience agricultural shocks in the previous harvest, especially if they are asset poor households. Results further reveal that those engaged in regular salaried jobs tend to have a higher level of education and receive higher income from non-farm employment than all other categories which include; self-employed, artisan, and casual farm wage labour. Canagarajah et al. (2001) show that the contribution of growth to poverty reduction was higher for non-farm participanting households in Uganda and Ghana. They also show that non-farm earnings indeed lead to more rapid growth in household earnings and consumption. Non-farm earnings also fuel increased income inequality in Uganda. Their study further revealed that the shares of non-farm income were larger in higher income brackets.

Adams (2001) on his study in Egypt and Jordan, finds that non-farm income has a greater impact on poverty and inequality. The poor receive almost 60% of their income from non-farm sources in rural Egypt, while in rural Jordan they receive less than 20%. The justification for this difference is, agricultural land in rural Egypt is very productive but its access is quite limited, and so the poor are pushed into non-farm work; while in rural Jordan, agricultural land is not very productive but easily accessed.

Karttunen (2009) also reported non-farm income source to constitute up to one third of the total income of Zimbabweans. But Gittinger et al. (1990) reported the rural non-diversified households to be the poorest group in Zimbabwe. Several studies in Nigeria reported a substantial and increasing share of non-farm income in the total household income. For example Babatunde and Qaim (2010) reported that 65% of small-holder farmer households participated in off-farm employment in which 50% of the total income comes from off-farm activities.

Olugbire et al. (2011) from Nigeria used a propensity score matching model to investigate the impact of non-farm employment (disaggregated by wage- and self-employment) on household income and poverty. They evaluated the differences in outcomes between households who participate in non-farm employment and those who do not. The results from the study show that non-farm wage-employed households have a significantly higher income than self-employed households. Non-farm wage-employment impacts more on household welfare than non-farm self-employment.

In the same vein, Shehua and Sidiquea (2014) used the propensity score matching technique to examine the impact of participation in non-farm enterprise activities on household wellbeing in Rural Nigeria. They used recent data of nationally representative sample of 3380 households from rural Nigeria. Household economic wellbeing was measured by the total annual consumption expenditure and food security status of the household. The household consumption expenditure was measured as the total annual expenditure for all goods and services consumed by the household. While food security status of the household was captured by a dummy that has a value of 1 if household responded that he experienced food shortage in the past one year, and 0 otherwise. Specifically, the estimates of the average treatment effect show that households that engaged in non-farm enterprises have on average, more annual consumption expenditure of $524 than those who did not engage into non-farm enterprise activities, depending on only farm activity. Similarly the average treatment effect on the treated (ATT) suggested that non-farm enterprise households were more food secure than non-enterprise households. Their result shows that participation in non-farm enterprise activities has a significant and positive impact on household wellbeing by all measures. Estimates of the Propensity Score Matching results of the impact of non-farm income on household welfare. Two matching algorithms were used for the matching and for every matching algorithm; the ATT is positive which means that income diversification accounts for a positive and statistically significant difference in per capita expenditures between diversified households and non-diversified households. The results also show that, households with non-farm wage- and self-employment have higher consumption expenditures than households engaged in farming only. Outcome difference between non-farm wage-and self-employment shows that non-farm wage-employment impacts more on household welfare than non-farm self-employment. The results of the descriptive analysis show that income from non-farm sources takes a higher share in

household income. The results of the impacts of non-farm income on household welfare show that non-farm income has a positive and robust effect on household consumption expenditure and could be a way out of poverty for rural households. This implies that non-farm income diversification significantly improves household consumption expenditure.

In Rwanda, Dabalen et al. (2004) used propensity score matching methods to investigate the differences in outcomes (earnings and consumption) between individuals (households) who participate in the non-farm sector activities and those who do not, where they created appropriate comparison groups of individuals and households. First they find that non-farm self-employed individuals in rural Rwanda have significantly higher earnings than farm workers and non-farm formal employees. Second, they show that the benefits to non-farm self-employment are much higher among the non-poor than among the poor. Third, they show that diversified households, those with a farm and a non-farm enterprise, are less likely to be poor.

Besides Africa, diverse countries have experienced a similar impact of non-farm income participation on household income, wellbeing and poverty, In Latin America, Lanjouw (2000) proved through the study of households in the state of Ecuador on the role played by non- farm sector to poverty reduction in rural areas. The results showed that the non-farm sector contributed 40% of rural incomes. Nearly 40% of men and 50% of the women were involved in this activity and also income from non-farm employment is associated positively with the level of education and infrastructure.

In Malaysia, Hadijah et al. (2011) used an FGT index proposed by Foster-Greer-Thorbecke (1984) to study the effect of non-farm income on the incidence of poverty among farmers in Kedah, Malaysia. The study finds that about 32% of the households have non-farm activities and, that non-farm income reduces the level, depth and severity of poverty in Kedah. Non-farm income has a greater impact on reducing the severity of poverty as opposed to the level and depth of poverty. The study also showed that non-farm income reduces the poverty rate by 42.94%, while poverty declined by 51.47% and the squared poverty gap which measures the severity of poverty fell by 55.72% when non-farm income was included in household income. Meanwhile, the same indicator (severity) fell by 23.35% when transfer payments were included in household income. This is true

because agricultural households receive a very large share of their total household income from non-farm income compared to transfer payments. Another study by Roslan and Hadijah (2011) found that farmers that participate in non-farm activities have a clearly shorter average time to exit poverty compared to those who do not participate in non-farm activities.

De Janvry et al. (2005), study in China, involving 7041 households with agricultural and non-agricultural income showed 72% of rural households have non-farm income. Non-farm income is not only able to absorb surplus labour in rural areas, but more importantly what it can improve is the quality of life in rural areas. It can be concluded that non-farm income can be considered as a potential successor to the agricultural income. His study also found that the factors of education, close to town, the influence of neighbours and the influence of residential area, is crucial in helping particular households gain the opportunity to diversify its economic activities.

2.1.2 Impact of Non-Farm Income Participation on Food and Nutrition Security

Nearly one billion people suffer from food insecurity worldwide and the number of food insecure has been increasing recently (FAO, 2008b). Food insecurity is prevalent in Africa and it jeopardizes attainment of the 2015 Millennium Development Goal target for hunger reduction (FAO, 2008b; NEPAD, 2008). Four broad concepts fit within the definition of food security: food availability, food access, utilization and sustainability. "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996; IFPRI, 2002). Food security is not only concerned with ensuring adequate supply of dietary energy, but includes a diet which is sufficient to meet all nutritional needs, thus incorporating sufficient intake of vitamins and minerals.

Given this definition of food security, the construction of a single indicator or a reasonable set of indicators for security is a complex task. Indicators suggested in the literature can be categorised into four categories: caloric deprivation indicators; monetary poverty indicators; dietary diversity indicators, and subjective indicators (Headey and Olivier, 2013). Carletto et al. (2013) compiled the following list of the most common indicators of food security: measures of undernourishment,

food consumption scores, household food security access scales, coping strategy indices, food adequacy factors and non-food factors.

The positive contribution of non-farm activities in improving household food security is a subject of discussion and has been rarely explored (Chang and Mishra, 2008). The emphases of the earlier studies (Reardon et al., 1998; Lanjouw and Lanjouw, 2001; Davis, 2003; Barrett et al., 2001; Block and Webb, 2001; De Janvry and Sadoulet, 2001; Lanjouw et al., 2001) have been on the role of non-farm activities in poverty reduction, household income and wealth. Moreover, although rural households tend to participate in such activities in order to fulfil their household needs, their participation appears to be constrained by capital assets including human, social, financial, physical, and land.

Nutrition impacts might be positive, because non-farm income contributes to higher household income and therefore better access to food. But the impacts might also be negative, at least when controlling for total household income, as working off the farm could potentially reduce household food availability due to the competition for family labour between farm and off-farm work (Pfeiffer et al., 2009; Huang et al., 2009). Barrett et al. (2001) have noted that one of the possible pathways out of the vicious cycle of food insecurity in Sub-Saharan Africa is the promotion and establishments of non-farm work in the rural sector.

Agricultural intensification and commercialisation may offer solutions to food insecurity in rural areas through increased income from farm and non-farm sources (Haggblade et al., 2007; Southgate et al., 2007) as agricultural growth benefits both rural and urban poor by providing more food, raw materials at lower prices, capital and labour for development, reducing poverty and increasing the participation of the poor in the growth process. The short-term effects of rural non-farm income on farm household food security are reasonably clear. Non-farm incomes provide the cash that enables a farm household to purchase food during a drought or after a harvest shortfall. Non-farm income is also a source of farm household savings, used for food purchase in difficult times. On the long-term effects on food security, however, there is relatively little empirical evidence and what exists is inconclusive (Barrett and Reardon, 2001).

A few empirical studies have looked into related linkages, but most of them have limited the investigation to issues of household food expenditure or calorie availability. For instance, In the case of Burkina Faso, Reardon et al. (1992) employ a recursive system to examine the interaction between non-farm diversification, household income and consumption expenditure. The result shows that non-farm diversification has a positive impact on the income and food consumption expenditure of the households. Non-farm work is associated with higher and stable incomes and food consumption over the years. They further showed found that income diversification into the non-farm sector improves daily per adult equivalent calorie consumption in the Sahelian and Guinean agro ecological zones of Burkina Faso. They urged that prior wealth is vital in income diversification.

Ruben and Van den Berg (2001) obtained similar results for Honduras where they demonstrated that calorie intake adequacy is strongly enhanced through engagement in non-farm activities among rural households, and the study also showed that non-farm income has a positive effect on the use of external farm inputs in agricultural production, directly affecting household food availability and consumption. Also in Zimbabwe, Ersado (2003) showed that non-farm income diversification is associated with a higher level of consumption expenditure in rural areas, following the economic policy change and drought of the early 1990s.

Similarly, Tschirley and Weber (1994) showed that non-farm income has a small but positive effect on calorie availability among rural households in Angoche district of Northern Zimbabwe. By using the 24-hour consumption recall data, the study found that a 1% increase in non-farm income would increase calorie availability by 0.04%.

In Nigeria, Babatunde and Qaim (2010) examine the mechanisms through which off-farm income affects household calorie and micronutrient supply, dietary quality, and child anthropometry. They find that participation in non-farm activities is associated with better food access and nutrition, and they challenged the skepticism sometimes expressed towards the impact of the non-farm sector on food security. Additionally, results indicated that non-farm income has a positive and significant effect on dietary quality. That is, when non-farm income increases, it results in not only more food in general, but also more higher-value food is consumed, and again the marginal effects are

identical for farm and non-farm income. Non-farm income contributes to higher total income, and, since more nutritious foods have a higher income elasticity of demand than staple foods, their absolute and relative importance in household diets increases. They also find that the prevalence of child stunting, underweight, and wasting is lower in households with non-farm income. Using a structural model, they also show that non-farm income contributes to higher food production and farm income by easing capital constraints, thus improving welfare in multiple ways.

Owusu et al. (2011) used propensity score matching approach to assess the impact of non-farm work on food security status and households' income among farm households in the Northern region of Ghana. Matching results revealed that non-farm work exerts a positive and statistically significant effect on household income and food security status which demonstrates that households with a higher probability of participating into non-farm work are able to obtain higher incomes and improve their food security status over and above those that are less inclined to participate in non-farm work. Thus non-farm work appears to be crucial in raising the incomes of farm households and improving their food security status. These findings are generally consistent with the widely held view that income from non-farm work is crucial to food security and poverty alleviation in rural areas of developing countries (Reardon, 1997).

Similarly, Ali and Peerlings (2012) also used propensity score matching approach to investigate the impact of entry into and exit from non-farm enterprises on farm households' wellbeing in Ethiopia using total household income and food security status of the household, and the household's ability to raise enough money in case of emergency as indicators of their wellbeing. Results found that entry into non-farm enterprises significantly increases household's income and food security status. Exit from the non-farm enterprises, on the other hand, is found to significantly reduce household's income.

Dietary diversity generally increases with household expenditure or income, as expected and findings by Ecker et al. (2012) show that dietary diversity is higher among farm households than among non-farm households, although non-farm households are richer and could therefore afford a more diversified diet. It suggests that the direct access to food through farming can indeed

contribute to an improved diet. In contrast to Ecker's findings, Block and Webb (2001) found that non-farm participants had a greater increase in both income and calorie intake.

There is an obvious connection between income diversification through non-farm work and food consumption among farm families in developing countries. For example, Anderson (2002) notes that off-farm income is extremely important to the household livelihood in many developing nations and essential to food security among farm households. Specifically, households with non-farm work will have a better chance to reallocate their labour and can more efficiently offset the negative price effect on their food security compared to those who have fewer non-farm options (Chang and Mishra, 2008). Further, Chang and Mishra (2008) find that households with more access to income generating activities or access to higher paying work, have higher income and are more food secure than households who do not have these benefits.

A recent study by Osarfo et al. (2016) employed the propensity score matching technique to investigate the impact of non-farm employment on household income and food security among farm households in the Upper East and Upper West regions of Ghana. A food security index, using the Recommended Daily Calorie Required (RDCR) approach, was constructed to ascertain the food security status of households. They found only 45% of households to be food insecure. The propensity score matching results show that non-farm employment has a statistically significant positive effect on the income of households as well as their food security status. The ATT (Average Treatment Effects for the treated) on food security from non-farm work participation is 0.42, which is statistically significant and indicates that participating in non-farm work increases the food security index by 0.42 points. An ATE (Average Treatment Effects for the whole sample) of 0.37 on food security shows that non-farm work participation increases food security index by 0.37 for the total population. An ATU (Average Treatment Effects for the Untreated) of 0.32 on food security indicates that if non-participants of non-farm work were to participate, their food security index points would increase by about 0.32. This finding indicates that households with a higher probability of participating in non-farm employment receive higher incomes and enjoy improved food security status compared to households that do not participate in non-farm work.

2.2 Determinants of Farmers' Decisions to Diversify into Non-Farm Income Activities

Similar to the importance of non-farm income for total income, analysis of the determinants of non-farm income diversification has received considerable attention in the literature. Decisions by rural households concerning involvement in rural non-farm activities depend on two main factors, that is to say; incentives offered and household capacity (Reardon et al., 1998).

In poor rural areas, some households will make a positive choice to take advantage of opportunities in the rural non-farm economy, taking into consideration the wage differential between the two sectors and the riskiness of each type of employment. Rising incomes and opportunities off-farm then reduce the supply of labour on-farm. However, other households are pushed into the non-farm sector due to a lack of opportunities on-farm, for example, as a result of drought or smallness of land holdings (Davis, 2003).

Detailed reasons for non-farm income diversification include declining farm incomes and the desire to insure against agricultural production and market risks (Kijima et al., 2006; Matsumoto et al., 2006; Reardon, 1997). That is, when farming becomes less profitable and more risky as a result of population growth, crop and market failures, households are pushed into non-farm activities that are less risky and returns are higher than in agricultural production leading to "distress-push" diversification (Babatunde, 2008). Babatunde further argued that, shrinking land availability is among the main reasons for the growing role of off-farm income among farm households in developing countries.

In other cases, however, households are rather pulled into the non-farm sector, especially when returns to non-farm employment are higher or less risky than in agriculture, resulting in "demand-pull" diversification (Behrman, 1999). While both effects have been recognized in principle (Reardon et al., 2001), many studies implicitly assume that distress-push effects dominate: shrinking per capita land availability is often considered the main reason for increasing non-farm activities (Van den Berg and Kumbi, 2006; Matsumoto et al., 2006). Relative profitability of off-farm employment is considered as a "pull" factor. Risk and seasonality of agricultural productivity, inadequate farm income, absence or failure of factor input and credit markets are among the "push" factors (Reardon, 1997; Ellis, 1998; Barrett et al., 2001).

One of the components of rural non-farm activities, in which the poor can participate because it does not require any complementary physical capital, is wage employment (Mduma and Wobst, 2005). In the study by Mduma and Wobst (2005) education level, availability of land, and access to economic centres and credit were the most important factors in determining the number of households that participated in a particular rural local labour market and the share of labour income in total cash income. Similarly with Zerai and Gebreegziabher (2011), Davis et al. (2007) and Babatunde (2009); land size, education, age, income, family size, special skill, road, telecommunication, water, electricity, credit, distance to the nearest market and access to irrigation were the most influencing factors in determining household's participation in non-farm activities.

Barrett et al. (2001) found a strong positive relationship between education and non-farm income. Reardon (1997) points out that education tends to be correlated with the ability to mobilize capital through non-farm work. Although it may appear that basic technical skills are normally acquired outside the formal school system, the broader skills of reading, writing and numeracy are acquired within it, making schooling an important determinant of participation in non-farm work (Norcliffe, 1983).

Dabalen et al. (2004)'s study of the returns to participation in the non-farm sector in rural Rwanda finds that education is a significant determinant of participation into the non-farm sector, in particular, in non-farm wage employment. They also find that for both men and women, higher levels of education are positively associated with higher probability of participating in the non-farm sector. They further find that having some form of education is associated with a greater chance of participating in self-employment for men, while only post-primary education matters for women's participation. Education is even more strongly correlated with wage employment for both men and women. This correlation increases with education level with the strongest effect coming from having secondary education or further education. Similarly, studies by De Janvry and Sadoulet (2001) in Mexico and by Ruben and Van den Berg (2001) in Honduras observed that education plays a major role in accessing better remunerated non-farm employment activities. Household assets are also important for non-farm income diversification. In the African context Reardon (1997) showed that household wealth has a positive relation with income from non-farm

sources. In Burkina Faso, Reardon et al. (1992) found that prior wealth is important for income diversification.

Other reasons for households to adopt diversified portfolios as highlighted by (Ellis, 1998; Ellis, 1999; Ahmed, 2012) include; poverty, food insecurity, risk considerations; consumption smoothing, labour allocation smoothing, credit market failures and shock coping strategies. Non-farm income generating activities play an important role in breaking the vicious cycle of poverty by significantly increasing the income of rural population, help smooth income fluctuations and improve the food security status of rural dwellers; (Ellis, 1998; Ellis, 1999; Ellis, 2000b). Diversification is therefore seen to be associated with desperate struggle for survival in declining economies (Ellis, 1998). Some scholars contend that diversification can sometimes be tailored towards livelihood security under improving economic situations among the rural rich.

In general, off-farm labour supply decisions of farm households depend on household specific characteristics, farm attributes, local labour market conditions and local and overall economic conditions of a given country. However, there is no consensus on how such factors affect off-farm labour supply decisions of farm households in a particular area. It is possible that a given factor can have different impact over time and across households (Ellis, 1998). Some of the basic determinants of off-farm employment participation decisions that have been documented in the literature are discussed below:

Agricultural activities in developing countries rely heavily on weather conditions that make agricultural output seasonal and risky. Risk averse individuals tend to diversify their portfolio holdings to minimize seasonality effects and risks associated with agricultural productivity. As a result, poor households are expected to diversify more as risk aversion decreases with increase in wealth (Ellis, 1998). However, entry barriers and lack of off-farm wage employment opportunities do not allow poor households to diversify their portfolio holdings as desired (Ellis, 1998; Reardon et al., 2001; Woldehanna and Oskam, 2001). Using data from Ethiopia, Barrett et al. (2001) showed that households with relatively higher income are associated with more diversification away from crop production suggesting entry barrier constraints for poor households.

Some studies suggest that risk mitigation cannot be a significant factor in explaining the existing income diversification patterns in Africa (Barrett et al., 2001). However, the effect of risk on income diversification is not conclusive in the case of Ethiopia. The study by Dercon and Krishnan (1996) suggests that risk is not a significant factor in explaining household income diversifications in Ethiopia and Tanzania. They argue that location; differences in ability and access to credit are more important factors than risk. But, the finding from Barrett et al. (2001) indicates that increased perception of risk is associated with subsequent diversification. On the other hand, using quality of land as an indicator of risk, Lemi (2006) shows that poor land quality, in other words higher risk, is associated with less off-farm employment participation. He justifies this by arguing that households with poor land quality need to spend more time on the farm to secure food for subsistence. His result, could also suggest that return from off-farm income is not satisfactory relative to farm income in rural areas. The inconclusive result on the effect of risk on income diversification could be due to the use of different variables as indicator of risk in these studies.

Negative income shocks are documented as important factors in affecting off-farm labour supply of farm households. Empirical studies in developing countries show that farm households' labour supply into labour markets increases in response to idiosyncratic negative income shocks (Skoufias, 1993; Kochar, 1999; Rose, 2001; Barrett et al., 2001). Similar results are also found in the case of developed countries. Using data from the United States, Kwon et al. (2006) show that off-farm labour supply for wives increase following idiosyncratic adverse income shocks to their farm income.

Theoretically, the probability of off-farm labour supply of farm households is expected to increase with education. Several studies find strong evidence that education is among one of the factors which determine off-farm labour supply of farm households, particularly for female household members. Empirical evidence from developed countries suggests a significant positive relationship between education and off-farm labour supply of farm households (Sumner, 1982; Huffman and Lange, 1989; Tokle and Huffman, 1991; Chang and Mishra, 2008). Similar results are also found in some developing countries (Abdulai and Delgado, 1999; Reardon et al., 2001).

However, contrary to expectations, a study by Beyene (2008) suggests that although other human capital variables such as health and training on handicraft skills have a significant positive effect on off-farm employment, education of farm household members has no effect on the probability of off-farm employment in Ethiopia. He argues that this could be the case since most off-farm activities in rural Ethiopia do not require formal education. The result is consistent with findings from previous studies in Ethiopia (Maertens, 2000; Woldehanna and Oskam, 2001). These studies give an important insight as they show that a given factor could have different effects on different types of off-farm employment activities in the country. The study by Maertens (2000) in particular shows that education has a significant positive effect only for off-farm employment in skilled labour and trade sectors while it has a significant negative impact on agricultural wage-employment in Ethiopia.

Local output and labour market conditions are also important factors that affect off-farm employment participation of farm households. A study by Tokle and Huffman (1991) shows that off-farm labour supply decisions of farm households in the USA increases with expected decline in farm output price and decreases with high unemployment rate. Woldehanna and Oskam (2001) show that an increase in farm output significantly increases the probability of off-farm self-employment while significantly decreasing labour supply into wage employment. In contrast, low farm income is positively associated with diversification into wage employment. The authors suggest that in the presence of credit market constraints farm households use profit from farm output to overcome liquidity constraints to start a new business (self-employment). But, increase in farm output increases an individual's reservation wage and their demand for leisure (assuming leisure is a normal good) which leads to lower wage employment. In Ethiopia, diversification of poor households into off-farm wage employment is also restricted due to a lack of local market employment opportunities (Shiferaw et al., 2004).

Furthermore, availability of credit, transfer income and infrastructure are also important factors, particularly in the case of developing countries. Availability of credit and infrastructure increase the likelihood of off-farm employment of farm households (Abdulai and Delgado, 1999; Abdulai and CroleRees, 2001; Reardon et al., 2001; Maertens, 2000; Beyene, 2008). Diversification into off-farm self-employment needs some kind of initial capital. Therefore, a binding credit constraint

is expected to have a significant negative impact on off-farm self-employment as entry barriers are high for self-employment (Woldehanna and Oskam, 2001; Ellis, 1998; Barrett et al., 2001). In the case of Ethiopia, Maertens (2000) shows that being a member of credit organization increases the probability of off-farm self-employment (crafts and trade) significantly while it does not affect the probability of participation in other types of off-farm employment activities. The above findings suggest that although there could be an incentive for a given farm household to diversify income because of various reasons, the development and functioning of local output, credit and labour markets are important factors in determining the capacity of diversification for a given household.

Household asset holdings, composition and size of household demographic characteristics are also suggested as important determinants of family labour supply of farm households. In most developing counties family labour is an important and easily available disposable resource for poor farm households to maximize their utility. In this regard, the probability of participation in off-farm employment is expected to increase with family size and decrease with number of dependents in a household. On the other hand, more farm assets are expected to decrease the probability of participation in off-farm employment. Using sample households from the Northern part of Ethiopia, Woldehanna and Oskam (2001) show that large family size and small land size significantly increase labour supply into off-farm wage employment.

In general, the empirical results from previous studies in Ethiopia suggest that farm size, livestock holding, composition and size of household demographic characteristics are the main factors that determine the decision to participate in off-farm employment in rural areas (Lemi, 2006; Maertens, 2000; Woldehanna and Oskam, 2001). Households with small land size and large family size participate more in off-farm employment. On the other hand, education level of household members has little significant effect on the probability of participation in off-farm employment. The significance of household demographics could suggest that family labour is the only available disposable resource for farm households in rural Ethiopia.

Farm-based households pursue non-farm strategies because they lack access to sufficient agricultural land and because they seek additional income sources to diversify risks (De Janvry and Sadoulet, 2001; Buchenrieder et al., 2010).

2.3 Definition and Measurement of Dietary Diversity

Food security is still one of the global concerns and its measurement may facilitate the development of policies on the improvement of health (Hinrichs, 2012 ; Lo et al, 2012). Several studies have shown that ingesting a more varied diet is associated with a higher quality diet and proper nutrition around the world. Therefore, the diversity of the diet is an indicator of health related to the quality of the diet and a useful instrument to measure food security (Azadbakht & Esmaillzadeh, 2012 ; Mirmiran et al, 2006). Households have food security when they have access throughout the year to the quantity and variety of safe foods that its members require to lead an active and healthy life. At home, food security means the ability to ensure the availability of foods, either because the family produces or buys them, in order to satisfy the needs of all its members (FAO, 2010). This is why methodological tools have been developed to allow the identification of dietary diversity in the households and individually, such as the Household Dietary Diversity Score (HDDS) elaborated by the FANTA Project (Food and Nutrition Technical Assistance) (Swindale & Bilinsky, 2006). The HDDS is a qualitative methodology that has been validated in different countries as an approximate measure of energy consumption per capita of the household (Kennedy et al., 2010 ; De Cock et al., 2013 ; Legwegoh & Hovorka, 2013 ; Maxwell et al., 2014 ; Tsiboe et al., 2016 ; Nyantakyi-Frimpong et al., 2016). It also allows to identify the population's food deficiencies or excesses and it works as a baseline to implement interventions that improve the food consumption in households (Swindale & Bilinsky, 2006). This indicator assesses the number of different food groups consumed in the household during a defined reference period, such as the last 24 or 48 hours or the last 7 or 14 days (De Cock et al., 2013 ; Legwegoh & Hovorka, 2013 ; Jones et al., 2014).

A diversified diet is linked to the economic ability of a household to access a variety of foods by obtaining a number of different food groups consumed during a determined period (FAO, 2013). A varied, nutritional and balanced diet prevents the lack or excess of nutrients in the diet and reduces the malnutrition rates in the population (WHO, 2015). However, malnutrition is still high in rural populations and they have higher risk of food and nutritional insecurity, mainly where indigenous population prevails (FAO et al., 2015).

Dietary diversity refers to an increase in the variety of foods across and within food groups (WHO/FAO, 1996) capable of ensuring adequate intake of essential nutrients that can promote

good health (Ruel, 2002). Ruel (2003) yet again defined dietary diversity as the number of individual food items or food groups consumed over a given period of time. Since no single food can contain all nutrients, Labadarios et al. (2011), noted that the more food groups included in daily diet the greater the likelihood of meeting nutrient requirements. With that background, Kennedy et al. (2009) argued that, a diet which is sufficiently diverse may reflect nutrient adequacy. Thus far, dietary diversity can be viewed as a proxy measure of food security (Hoddinott, 2002).

Food security on the other hand entails three important aspects (availability, access and utilization) in the relationship between man and food, necessary to ensure that nutrition plays its optimum role in human health (Leyna et al., 2010; Ajani, 2010). However, dietary diversity has been positively linked with these three pillars of food security (Hillbrunner and Egan, 2008; Bernal and Lorenzana, 2003; Steyn et al., 2006). Eating a large variety of foods, across and within major food groups has therefore been recommended in most dietary guidelines (Jeanene et al., 2006), since it is associated with a number of improved outcomes such as nutrient adequacy, anthropometric indices and improved haemoglobin concentrations (Swindale and Bilinsky, 2006).

Dietary diversity, is considered an outcome measure of food security (Hoddinott, 1999) mainly at the level of individual or household food access, but also can provide information about food availability in the community and reflect seasonal changes in dietary patterns, an aspect of the sustainability of the food supply.

A diverse diet, rare among poor populations in developing countries, proves especially important for infants and young children who need essential micronutrients and energy for rapid physical and mental development (Torlesse et al., 2003; PAHO and WHO, 2003; Arimond and Ruel, 2004). Indicators of dietary diversity, derived from the recall of the number of foods or food groups consumed over a given time period, have gained increased attention in both the nutrition and food security communities in recent years (Ruel, 2002). Dietary diversity indicators prove popular in part because the data are fairly easy to collect and are associated with dietary quality, energy intake, and food security (Arimond and Ruel, 2004; Ruel, 2002). The use of dietary diversity indicators holds promise as a powerful tool for effective needs assessments and targeting, as well as efficient program monitoring and evaluation.

Many studies have linked household dietary diversity indicators to improved nutrient intake in developed and developing countries (Arimond and Ruel, 2004; Kant, 1996; Savy et al., 2005; Steyn et al., 2006; Kennedy et al., 2007). Though less frequently explored in peer-reviewed literature, household dietary diversity holds promise as a food security indicator as well. The underlying principle is simple; as poor households gain additional income they are better able to regularly access foods needed for a healthy life, thus increasing food security. Poor households often use additional income to purchase additional non-staple foods, thus increasing household dietary diversity (Torlesse et al., 2003; Behrman and Deolalikar, 1989; Ruel et al., 2004).

2.3.1 Experiences with Measurement of Dietary Diversity

At household level, Vakili et al. (2013) suggested that, dietary diversity can be used as a proxy measure of food access and the socio-economic level of the household while at individual level as a reflection of nutritional or dietary quality of an individual's diet. Also, when measured at household level, dietary diversity scores reflect the economic ability of a household to consume a variety of foods (Swindale & Bilinsky, 2006) and are considered good proxy measures of household energy availability (Hoddinott and Yohannes, 2002; Ruel, 2002). When measured at the level of an individual, the scores reflect adequacy of energy and other nutrients (FAO, 2008a).

Dietary diversity is usually measured using two indicators: the food variety score and the dietary diversity score (Kant et al., 1993; Ruel, 2003; Swindale and Bilinsky, 2006; FAO, 2011b). The food variety score is a simple count of the different food items consumed during the recall period. This is a useful indicator for nutritional assessments within one setting. The dietary diversity score is the number of food groups consumed by the household during the recall period.

There is no international consensus on which food groups to include in the calculation of dietary diversity scores. Many studies classify all foods consumed into 12 groups (Swindale and Bilinsky, 2006; FAO, 2011b), an approach that is followed for the analysis. The following 12 food groups are included to calculate household dietary diversity scores: fruits; vegetables; pulses, dry; nuts and seeds; cereals and cereal products; starches; meat, meat products and fish; milk and milk products; oils, fats and spices; beverages; sweets and sugars; outside foods and drinks. However, research has shown that the last three food groups contribute little to the micronutrient density of the diet, so that—depending on the purpose—there are also studies that have calculated dietary

diversity scores only based on the remaining nine food groups (Arimond et al., 2010; FAO, 2011b). Dietary diversity scores only including the nine more healthy food groups is used in a sensitivity analysis.

2.3.1.1 Measurement of Dietary Diversity in Developed Countries

Common measures of dietary diversity used in developed countries include measures based on a simple count of foods (Krebs-Smith et al., 1987) or food groups (Krebs-Smith et al., 1987; Lowik et al., 1999), while others take into consideration the number of servings of different food groups in conformity with dietary guidelines. Examples of this latter approach include the dietary diversity score developed by Guthrie and Scheer (1981), which allocates equal weights to each of the four food groups consumed in the previous 24 hours: milk products and meat/meat alternatives receive two points for each of two recommended servings, and fruits/vegetables and bread/cereals receive one point for each of four recommended servings (total = 16 points).

A modification of this approach developed by (Kant et al., 1991; Kant et al., 1993) evaluates the presence of a desired number of servings from five food groups (two servings each from the dairy, meat, fruit, and vegetable groups and four servings from the grain group) over a period of 24 hours. This score, called the serving score, allocates a maximum of four points to each food group for a total score of 20. The authors also use a simple five-point scale called the food group score, which is a simple count of food groups consumed in one day (using the same five food groups).

Finally, (Krebs-Smith et al., 1987) used and compared three different types of dietary diversity measures (which they refer to as dietary variety): (1) an overall variety score (simple count of food items), (2) a variety score among major food groups (six food groups), (3a) a variety score within major food groups, counting separate foods, and (3b) a variety score within major food groups, counting minor food groups. All dietary measures are based on a three-day recall period.

2.3.1.2 Measurement of Dietary Diversity in Developing Countries

Single food or food group counts have been the most popular measurement approaches for dietary diversity in developing countries, probably because of their simplicity. The number of servings based on dietary guidelines was not considered in any of the developing country studies reviewed. In China, Taren and Chen (1993), Ethiopia, Arimond and Ruel (2002), and Niger, Tarini et al. (1999), researchers used food group counts, while in studies in Kenya, Onyango et al. (1998), and in Ghana and Malawi Ferguson (1993), they used the number of individual foods consumed. Studies in Mali, Hatloy et al. (1998), and Viet Nam, Ogle et al. (2001) used both single food counts (called Food Variety Score [FVS]) and a food group count (called Dietary Diversity Score [DDS]).

Studies done at household level also used dietary diversity indicators that included either individual foods or food groups (Hoddinott and Yohannes, 2002; Hatloy et al., 2000). A study in Mozambique used a weighting system, which scored foods and food groups according to their nutrient density, the bioavailability of the nutrients they contain, and typical portion sizes (Rose et al., 2002). For example, foods that were usually consumed in small amounts (e.g., condensed milk) were given a lower score than foods with similar nutrient content that were consumed in larger amounts (e.g., fluid milk).

2.4 Factors Determining Dietary Diversity in Rural Farm Households

Clausen et al. (2005) found that older adults in Botswana consume a low variety of food, with inadequate dairy products, fruits, and vegetables (35.2%, 59.3%, and 22.4% respectively). Another cross-sectional study among elderly respondents in Sharpeville, South Africa comparing a low mean dietary diversity score (3.41 +/- 1.34) and food variety score (4.77 +/- 2.2) with poverty parameters confirmed household food insecurity (Oldewage-Theron & Kruger, 2008). However, an earlier study found that respondents in the older age group had a higher mean intake for all nutrients compared to their younger counterparts (Holcombe, 1995). Married people tend to consume a greater variety of food, perhaps because responsibility for other family members leads to a wider variety of dietary items in the household (Liu et al., 2014).

Education is positively correlated to high dietary diversity. That is, the more educated households are, the more likely they are to attain a high dietary diversity (Taruvinga et al., 2013). A cross-sectional study in a semi-rural setting in Louisiana found that intake of cereals/breads, dairy products, fruits/100%, fruit juices, and vegetables was higher in subjects with more than 12 years of education (Deshmukh-Taskar et al., 2007).

Dietary diversity was shown to be strongly associated with household socioeconomic status (Hulshof et al., 2003). Families with greater incomes and resources tend to have more diverse diets, but they are also likely to have better access to health care and better environmental conditions. Evidence from a multi-country analysis suggests that household-level dietary diversity (DD) is strongly associated with household per capita income and energy availability, suggesting that dietary diversity could be a useful indicator of food security.

Households, especially those in rural areas, own farmland where they can grow vegetables and raise livestock to replace or supplement purchased food (Liu et al., 2014). Dietary diversity is slightly but significantly higher among farm households than among non-farm households at the sample mean, although non-farm households are significantly richer and could therefore afford a more diversified diet (Ecker et al., 2012). It suggests that the direct access to food through farming can indeed contribute to an improved diet.

Ferguson and colleagues also made reference to differences in dietary diversity between households from different socioeconomic status groups among preschool Ghanaian and Malawian

children (Ferguson et al., 1993). There are no significant differences in the dietary diversity between market-oriented and subsistence farm households on average, although market-oriented farm households have substantially higher income levels (Ecker et al., 2012).

Food prices and income levels have a strongly determinative effect on dietary quality as agricultural products reach consumers through food supply chains, and each link affects the availability, affordability, and nutritional quality of foods. This is because, as incomes increase, individuals buy non-staple plant foods (lentils, fruits, vegetables) and animal products, which are denser in bio-available vitamins and minerals than staple foods (Ruel, 2003).

The importance of animal-source foods for macro- and micronutrient intakes in developing countries is addressed by Murphy and Allen (2003), and the functional importance of micronutrients for human growth and cognitive function is discussed by Rivera et al. (2003) and Black (2003), respectively. The importance of animal-source foods as one component of dietary diversity is highlighted in studies in Mexico and Peru (Allen et al., 1991; Marquis et al., 1997).

In a study conducted in Peru, animal-source foods were not significantly associated with length of the child at 15 months as a main effect, but significantly interacted with overall dietary diversity in multivariate models (Marquis et al., 1997). The specific contribution of animal-source foods to dietary diversity depends to a large extent on the definition of dietary diversity. For example, in a study conducted in Mali, the dietary diversity score was composed of eight food groups, half of which were animal product groups such as eggs, meat, milk, and fish, which were all treated as separate categories (Hatloy et al., 1998). In Vietnam, however, animal products contributed only three of the twelve food groups (fish/seafood, meat, and eggs) and thus, could account for no more than 25% of the total food group diversity score (Ruel, 2006).

A home garden is a place where one should be able to find a large variety of foods (fruits, vegetables, herbs, condiments, etc.). Diversity of plants in the garden leads to diversity of family diet (Ajah et al., 2013). Home gardening provides a means to access a variety of foods that may not be available in the market through cultivation of fruits, vegetables, and other crops. Home gardens provide easy access to fresh plants and animal– source foods in both rural and urban areas (Galhena et al., 2013). A study done in Nepal concluded that home gardens contain high levels of species diversity. The value of home gardens for household dietary diversity and health is well

recognized (Gautam et al., 2006). Additionally, homestead food production, e.g. in home gardens, has a direct and positive impact on dietary diversity and, consequently, the dietary quality of the homestead occupants (Olney et al., 2009). This has been shown, for example, by the homestead food production program introduced by Helen Keller International in Bangladesh about two decades ago in which the increase in production and consumption of diverse micronutrient rich foods played a major role (Iannotti et al., 2009).

There was a clear association between having a home garden and a more varied diet, and dietary diversity scores were significantly higher among children living in households with gardens (Cabalda et al., 2011). Access to a home garden was positively correlated to high dietary diversity and negatively related to low dietary diversity (Taruvinga et al., 2013). Their study indicated that rural households with access to home gardens are more likely to move from a medium dietary diversity status into a high dietary diversity status. A possible explanation is that home gardens normally provide a variety of micronutrient-rich horticultural crops like vegetables, fruits, and tubers.

In Bangladesh, Khondker et al. (2013) attempted to examine whether availability of credit influences households' food security status and dietary diversity. Food security was proxied by daily per capita food consumption in calorie terms and access to credit was represented by a dummy variable which takes the value of 1 if any member of the household has reported to have borrowed money and zero, otherwise. OLS estimates revealed that, credit plays a significant role in household food consumption and a household with credit tends to consume around 60 calories more per capita on a daily basis than an otherwise similar household without credit. Per capita calorie consumption also appeared to be higher for male headed households with smaller household size. In addition, households with greater number of literate adults have significantly higher probability to consume more calories and therefore, tend to have greater level of food security. It is interesting to find that, rural as opposed to urban households are more food secure and more aged household heads tends to have greater consumption. In addition to OLS, while following Wooldridge (2002) this analysis also applied an alternative methodology for controlling selection bias. Both OLS as well as the alternative method revealed that, credit has positive and significant effect on household's food security. Similar analysis with OLS and the alternative method for explaining food security was conducted with their primary survey data which also

provided evidence in favour of the positive and significant contribution of credit on household food security status. In addition to these two methods, this analysis also employed the IV method to test for any plausible endogeneity of credit variable but the results showed no sign of endogeneity.

Climate change could also have an impact on food security by affecting calorie consumption: recent empirical evidence suggests that climate-related shocks (particularly droughts) impact dietary diversity and reduce overall food consumption with long-term detrimental effects on stunting (Silventoinen, 2003; Gitau et al., 2005; IPCC, 2007).

CHAPTER THREE

METHODOLOGY

3.1 Data and Sources

The extraction and analysis of data in this research study was based on three comprehensive waves of household level data gathered by the Uganda National Panel Survey from 2009, 2010 and 2011 and implemented by the Uganda Bureau of Statistics. The UNPS is a stratified survey of a nationally representative sample of 3123 households drawn from 322 enumeration areas (villages) distributed over 54 districts in Uganda. The sampling design was representative at the national and district level, as well as for rural and urban areas, enabling the survey to provide reliable estimates for each of these areas. Data were collected for three main modules: the household module (socio-economic module), the agricultural module and the community module. The household module captured data on employment and income of each member of the household, education, household asset holdings, consumption expenditure, and access to services. The agricultural survey collected data on agricultural production (agricultural inputs, and technologies), land availability and land use, shocks and uncertainties, and agricultural extension services. After data cleaning and due to missing data, the sample size for each year reduced to 2491 households. Similarly, after running the Panel Ordered Logit Model, the number of observations reduced to 7296 households for the three years of study.

3.2 Data Analysis

The database was cleaned thoroughly before the actual statistical analyses were carried out with the STATA software package. Descriptive, statistical and econometric methods were used to analyse the secondary data through examining the socio-economic characteristics of respondents. These techniques included means, frequencies and percentages and were used to catalogue and categorize households by socio-economic characteristics. Descriptive methods such as measures of averages (mean), standard deviations and percentages; and statistical methods such as two-sample (student) t-test were used to compare the level of Household Dietary Diversity between participants and non-participants in non-farm income generating activities.

To achieve objective one on the trends in participation in non-farm income sector among rural farmer households in Uganda, the study employed descriptive statistics (percentages). The study described the socio-economic characteristics of the respondents, the trends in non-farm income participation from the years 2009 to 2011.

To achieve objective two on determining and comparing the level of household dietary diversity between participants and non-participants in the rural non-farm sector in Uganda, a Student T-test was computed for the years 2009, 2010 and 2011 to compare the level of household dietary diversity between participants and non-participants in the rural non-farm sector. Participation in non-farm sector was defined as a binary variable, taking only two values, 1 if the household participated in non-farm income generating activities, and 0 if not.

Objective three: "The effect of farmer participation in non-farm income activities on household dietary diversity in rural Uganda" was analysed using the Panel Ordered Logit Model. The study's methodological approach drew heavily on both theoretical and empirical literature that seeks to explain the linkage between market access and livelihoods of farm households (defined as dietary diversity in this study). The study measured household dietary diversity following the approaches in standard literature (Drewnowski et al., 1997; Swindale and Bilinsky, 2006; Kennedy et al., 2013 and Food and Agricultural and Organisation, FAO, 2011a), in which HDD is defined as the number of unique foods consumed by household members over a given period[6]. In this research study, household dietary diversity was measured by summing up the number of food groups consumed over a seven day recall period. Household dietary diversity was categorised into three terciles: low HDD (1-4 food groups consumed); medium HDD (5-8 food groups consumed) and high HDD (9-12 food groups consumed). Since household dietary diversity is ordered with more than two categories (low, medium and high HDD) and the values of each category have a meaningful sequential order where a value is indeed 'higher' than the previous one, I chose the panel ordered logit model. The Household Dietary Diversity Score is meant to provide an indication of household

[6] Dietary diversity is usually measured by summing the number of foods or food groups consumed over a reference period. The reference period usually ranges from one to three days, but seven days is also often used, and periods of up to 15 days have been reported (Kennedy et al., 2013)

economic access to food, thus items that require household resources to obtain, such as condiments, sugar and sugary foods, and beverages, are included in the score. In this research study, only twelve food groups are proposed for the household dietary diversity score and certain food groups in the questionnaire are aggregated as seen in Table 1 below.

3.3 Model Specification

3.3.1 Theoretical Model

The theoretical framework for determining the effects of farmer participation in non-farm income activities on Household Dietary Diversity has its roots in the threshold theory of decision making. In this theory, a reaction occurs only after the strength of the stimuli increases beyond the individual's reaction threshold (Hill and Kau, 1973). The decision to participate in NFAs (Non-Farm Activities) is therefore dichotomous between two mutually exclusive alternatives: either to participate or not to participate. The probability that an individual makes a particular choice is influenced by a vector of explanatory variables. A particular choice is made when the combined effect of the vector of the explanatory variables reaches the critical level (breaking point). Thus, a decision to participate in NFAs will occur only when the combined effect of the explanatory variables $(Xi'\beta)$ reaches a certain unobservable critical value Yi^*. So that:

$$\mathbf{Yi = 1 \text{ if } Xi'\beta > Yi^* \quad OR \quad Yi = 0 \text{ if } Xi'\beta < Yi^*} \tag{1}$$

Where Yi^* is a latent variable and represent the unobserved level of participation in NFAs. By the application of probability theory, the probability that a given individual participates in NFAs is given by:

$$\mathbf{P = Prob(Yi=1) = f(Xi'\beta)} \tag{2}$$

and the probability that a given individual does not participate in NFAs is given by:

$$\mathbf{1 - P = Prob(Yi=0) = 1 - f(Xi'\beta)} \tag{3}$$

Participation in non-farm sector is not randomly distributed between the participants and non-participants since households make individual decisions on whether or not to participate. In this case, participants and non-participants may have systematical differences in both observable and non-observable characteristics, which affect both the probability of participation in non-farm sector and dietary diversity. Thus estimating the effect of non-farm income participation without accounting for this potential selection bias could lead to inconsistent estimates of the effect.

3.3.2 Estimation Procedure

As our dependent variable, household dietary diversity which is the number of food groups consumed by a household in the last seven days, is a non-negative count variable with integer values from 1 to 12, the application of standard ordinary least-squares regression (which assumes a continuous dependent variable) is not appropriate since this may produce biased and inconsistent estimates (Coxe et al., 2009; Greene, 2012). Household dietary diversity is measured by a three-point scale (1-4 for low dietary diversity; 5-8 for medium dietary diversity and 9-12 for high dietary diversity) (Suneetha & Rahul, 2012) and thus has a categorical and ordinal nature. Since three classes are distinguished instead of two, standard approaches such as ordinary least squares regression method cannot be applied. Instead, the panel ordered logit model is used as an analytical model here.

Many logistic regression models have been developed for analyzing ordinal response variable. In situations where there are many response variables, a multivariate approach is considered, but for this research paper only one response variable is considered with more than two explanatory variables, so the ordered logistic regression is considered.

The panel ordered logistic regression fits via maximum likelihood the random-effects ordered logistic models. The actual values taken on by the dependent variable are irrelevant, although larger values are assumed to correspond to "higher" outcomes. The conditional distribution of the dependent variable given the random effects is assumed to be multinomial with success probability determined by the logistic cumulative distribution function.[7]

[7] If one uses cross-sectional data, the observed relationship between household dietary diversity and the regressors could be biased because of omitted variables. Typically, the use of panel data models makes it possible to minimize

To assess the effect of participation in non-farm income activities on household food dietary diversity in rural Uganda, a panel ordered logit model was applied in this research study. The model has been used widely by (Greene & Hensher, 2009; Elias et al., 2015). The dependent variable household dietary diversity was initially measured by summing up the number of food groups consumed in the seven days preceding the recall. However due to insufficient variability in the dependent variable, the analysis was conducted using a three point scale (categories). Suppose that the values of Y represent the ordered items. Let Y_i be the level of household dietary diversity, defined as:

$$Y_{it} = \begin{cases} 0: \textit{Low dietary diversity (1-4 food groups)} \\ 1: \textit{Medium dietary diversity (5-8 food groups)} \\ 2: \textit{High dietary diversity (9-12 food groups)} \end{cases} \quad (4)$$

Y is not a continuous value but categorical thus a larger value means a higher dietary diversity. In this case, there exists a known natural number (m). y_i has M possible outcomes $y_i = m$ for $m = 1,\ldots M$. Natural ordering (ie, $m + 1$ is in some sense ''better'' than m) such that:

$$P[y_{it} \epsilon \{ 0,1,2...m\}] = 1 \quad (5)$$

This type of data is usually modelled via latent (unobserved) variable model given by:

$$Y_{it}^{*} = \alpha + X'_{it}\beta + \varepsilon_{it} \qquad \text{for } i = 1,\ldots., N,\ t = 1,\ldots..T \quad (6)$$

Where, Y_{it}^{*} = Latent (unobserved) measure of household dietary diversity, X_{it} = A vector of explanatory variables, α, β = coefficients to be estimated, and ε = a random error term (assumed to follow a standard normal distribution for logistic distribution).

omitted variable biases (Cameron and Trivedi, 2010) and help to control for unobserved effects such as for example household's attitudes to risks (Dimova and Sen, 2010).

The observed or defined categorical household dietary diversity variable Y_{it} is determined from the model as follows:

$$Y_{it} = \begin{cases} 0: \textit{Low dietary diversity if } Y^{*}_{it} \leq 0 \\ 1: \textit{Medium dietary diversity if } 0 < Y^{*}_{it} \leq \boldsymbol{\mu}_i \\ 2: \textit{High dietary diversity if } Y^{*}_{it} > \boldsymbol{\mu}_i \end{cases} \quad (7)$$

Where $\boldsymbol{\mu}_i$ is a set of thresholds of the dietary diversity gap to be estimated with parameter β and α.

The probability associated with the coded responses of an ordered probability model is as follows:

$$Pr(Y_i = j) = Pr(\boldsymbol{\mu}_{j-i} < Y^{*}_{it} \leq \boldsymbol{\mu}_j) = Pr(\boldsymbol{\mu}_{j-i} < [\alpha + \beta_{it}X_{it} + \varepsilon] \leq \boldsymbol{\mu}_j) \quad (8)$$

Where, j represents the ranked value of household dietary diversity. The random error 'ε' is such that:

$$Pr(Y_i = j) = Pr(\boldsymbol{\mu}_{j-i} < Y^{*}_{it} \leq \boldsymbol{\mu}_j) = F(\boldsymbol{\mu}_j - \alpha - \beta_{it}X_{it}) - F(\boldsymbol{\mu}_{j-i} - \alpha - \beta_{it}X_{it}) \quad (9)$$

In a simplified form,

$$\begin{cases} Pr(Y_i = 0) = F(\alpha - \beta_{it}X_{it}) \\ Pr(Y_i = 1) = F(\boldsymbol{\mu}_i - \alpha - \beta_{it}X_{it}) - F(\alpha - \beta_{it}X_{it}) \\ Pr(Y_i = 2) = 1 - F(\boldsymbol{\mu}_i - \alpha - \beta_{it}X_{it}) \end{cases} \quad (10)$$

In ordered logit, F(Y*)* is specified as the logistic distribution function given by:

$$F(Y_{ijt}) = \frac{\exp(x)}{[1+\exp(x)]} \quad (12)$$

In an ordered logistic regression model, the outcome variable has more than two levels. It estimates the probability being at or below a specific outcome level given a collection of explanatory

variables.[8] The ordered logistic regression model can be expressed in the logit form (Liu, 2009; Long, 1997: Long and Freese, 2006) as follows:

$$\text{In}(Y) = \text{logit}[\pi(x)]$$

$$\text{In}\,(Y_{ijt4}) = In(\frac{\pi(x)}{1-\pi(x)})$$

$$\text{In}\,(Y_{ijt}) = \alpha_j + (-\beta_1 X_1 - \beta_2 X_2 - \ldots - \beta_p X_p) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

Where $\pi_j(x) = \pi(Y \leq j \mid x_1, x2, \ldots, x_p)$ is the probability of being at or below category j, given a set of predictors, j =1, 2, …, J−1, α_j are the cut points and $\beta_1, \beta_2, \ldots, \beta_p$ are logit coefficients. When there are j categories, the Proportional odds model estimates J-1 cut points. This Proportional odds model assumes that the logit coefficient of any predictor is independent of categories, i.e., the coefficients for the underlying binary models are the same across all cut points. The equal logit slope or the proportional odds assumption can be assessed by the Brant test (Brant, 1990), which estimates logit coefficients for underlying binary logistic regressions, and provides the chi-square test statistics for each predictor and the overall model in Stata. To estimate the In (odds) of being at or below the jth category, the proportional odds model can be rewritten as the following form:

$$logit[\pi(Y \leq j \mid X1, X2, \ldots, Xp)]$$

$$= In(\frac{\pi(Y \leq j \mid X1, X2, \ldots, Xp)}{\pi(Y > j \mid X1, X2, \ldots, Xp)})$$

$$= \alpha_j + (-\beta_1 X_1 - \beta_2 X_2 - \ldots - \beta_p X_p)$$

Thus, this model predicts cumulative logits across J−1 response categories. The cumulative logits can then be used to calculate the estimated cumulative odds and the cumulative probabilities being at or below the jth category. Different software packages may estimate parameters differently and the ordered logistic regression model can be expressed in different forms (Liu, 2009). For example, Stata follows the above form with a negative sign before the logit coefficients. SAS, however, uses a different form when estimating the cumulative odds of being at or below a particular category using the ascending option.

[8] Ordered logistic regression and ordered logit model are used interchangeably.

3.4 Measurement of Household Dietary Diversity

We examined household dietary diversity and assumed that households distribute food equitably to optimize the diet of each member according to the total of foods available (Thorne-Lyman et al., 2010; Jones et al., 2014). According to Thorne-Lyman et al. (2010), dietary diversity scores are increasingly used as measures of food security and as proxies for nutrient adequacy because the collection of reliable household expenditures data is relatively time consuming and rather complex.

Dietary diversity was measured using the household dietary diversity score (HDDS), a proxy measure of household food access and it reflects the economic ability of a household to consume a variety of foods. HDDS which is the number of different food groups consumed in the seven days preceding the recall, is an attractive proxy indicator for the following reasons (Hoddinott and Yohannes, 2002). A more diversified diet is an important outcome in and of itself and it is therefore associated with a number of improved outcomes in areas such as birth weight, child anthropometric status, and improved haemoglobin concentrations. Additionally, a more diversified diet is highly correlated with such factors as caloric and protein adequacy, percentage of protein from animal sources (high quality protein), and household income. Even in very poor households, increased food expenditure resulting from additional income is associated with increased quantity and quality of the diet.

To better reflect a quality diet, the number of different food groups consumed is calculated, rather than the number of different foods consumed. Knowing that households consume, for example, an average of four different food groups implies that their diets offer some diversity in both macro- and micro-nutrients. This is a more meaningful indicator than knowing that households consume four different foods, which might all be cereals. The Household Dietary Diversity Score was developed to measure household food access, one of the levels of food security. HDDS reflects the economic ability of a household to consume a variety of foods whereas individual dietary diversity score (IDDS) aims to capture nutrient adequacy. Measurement of dietary diversity is a rapid, user-friendly and cost effective approach which measures changes in the dietary quality of a household. Previous research has shown that dietary diversity is related to food security. However, the validity of the HDDS in the form developed by the Food and Nutrition Technical

Assistance (FANTA) project 12 food groups, 24-hour recall and most frequently used by development organizations and non-governmental organizations has never been verified (Vellema et al., 2016).

In this research study, the key variable is dietary diversity, which is a proxy variable for food security in nutrition surveys, and corresponds to various anthropometric measures (Pellegrini and Tasciotti, 2014; Moursi et al., 2008; Ruel, 2003). Dietary diversity is found positively associated with the intake of adequate nutrients and energy (Jones et al., 2014; Steyn et al., 2006), and is usually measured using two indicators – food variety score and dietary diversity score (Jones et al., 2014; Swindale & Bilinsky, 2006; Ruel, 2003; Drewnowski et al., 1997; Kant et al., 1993). While the former is a simple count of the unique food items consumed (Drewnowski et al., 1997), dietary diversity score as defined earlier is the number of food groups consumed over a given recall period by the household (Ruel, 2003; Kant et al., 1993).

In this case, household dietary diversity score was computed (Pellegrini & Tasciotti, 2014; FAO, 2007b). Different studies use different number of food groups for estimating the dietary diversity score. For example, Jones et al. (2014), Pellegrini & Tasciotti (2014) and Keding et al. (2012) categorized food items into 12-14 groups, respectively.

We therefore used a scale of twelve food groups which include: (i) fruits; (ii) vegetables; (iii) pulses, dry; (iv) nuts and seeds; (v) cereals and cereal products; (vi) starches; (vii) meat, meat products and fish; (viii) milk and milk products; (ix) oils, fats and spices; (x) beverages; (xi) sugar and sweets; and (xii) outside foods and drinks in assessing the dietary diversity of rural farm households in Uganda since dietary diversity in terms of food groups better predicts diet quality than that based on individual food items (Ruel, 2003). The outcome variable, Household Dietary Diversity (HDD), was derived following guidelines by the Food and Agriculture Organization (FAO, 2007a) for measuring household and individual dietary diversity. The index was constructed by recompiling all the food items into 12 food groups and attributing one point for each food group consumed in the last seven days. The set of 12 food groups with food items and food categories used to calculate household dietary diversity is listed in Table 1 below. Dietary diversity was obtained by summing the number of food groups. The total score was calculated and

this ranged from 0-12. Three terciles of dietary diversity were created, based on household dietary diversity score: low HDD (1–4 food groups consumed), medium HDD (5–8 food groups consumed) and high HDD (9–12 food groups consumed) (Suneetha & Rahul, 2012). These cutoffs were used due to lack of national and international guidelines on which to base cut-offs (FANTA, 2013).

Table 1: Definition of Food groups and Food Items Used in the Analysis to Calculate Household Dietary Diversity

Food Group Point	Food Group	Food Items
1	Fruits	Passion fruits, sweet bananas, mangoes, oranges, pineapples, pawpaws and other fruits.
2	Vegetables	Onions, tomatoes, avocado, cabbages, dodo, carrots, pumpkins, eggplants, green pepper and other vegetables.
3	Pulses, dry	Fresh and dry beans, dry peas.
4	Nuts & Seeds	Shelled, unshelled and pounded groundnuts.
5	Cereals & Cereal Products	Simsim, maize cobs, maize grains, maize flour, sorghum, millet, rice, bread, wheat and other grains.
6	Starches	Plantains, fresh and dry sweet potatoes, fresh and dry/flour cassava, irish potatoes and matooke.
7	Meat, Meat Products & Fish	Fresh and dry/smoked fish, beef, pork, goat meat, eggs, chicken and other meat.
8	Milk & Milk Products	Fresh milk and infant formula milk.
9	Oils, Fats & Spices	Salt, cooking oil, ghee, margarine and butter.
10	Beverages	Tea, coffee, soda and beer.
11	Sweets & Sugars	Sugar, sugarcane, sweets and other sugar products.
12	Outside Foods & Drinks	Cigarettes, expenditure in restaurants on food, soda and beer, other juices, other alcoholic drinks, other tobacco, other food etc.

Source: Adapted from FAO (2007).

The explanatory variables to be included in the model are drawn from related empirical literature (e.g. Taruvinga et al., 2013). Table 2 provides the details of the explanatory variables and the expected signs.

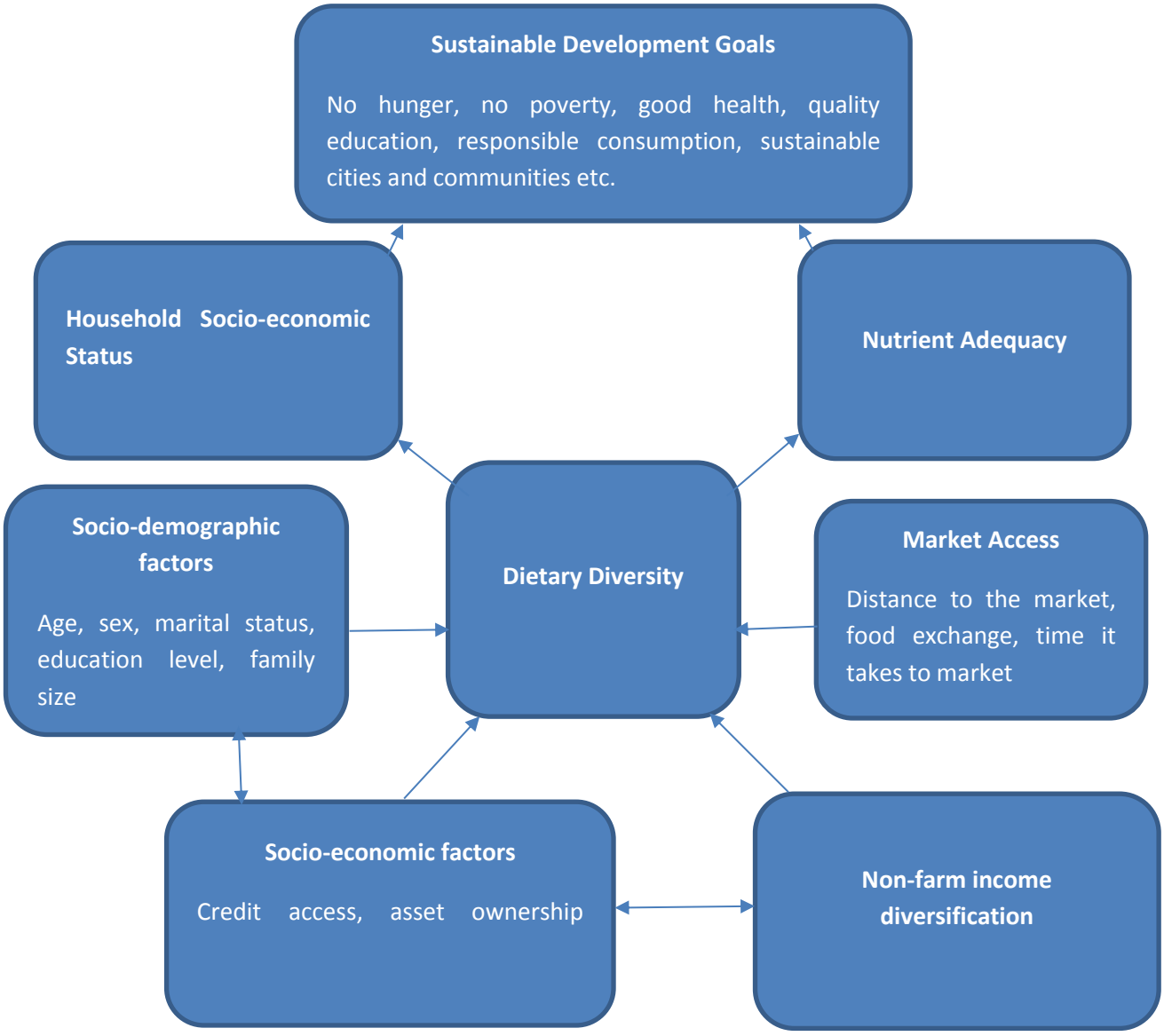
Table 2: Definition and Measurement of Variables and the Hypothesized Signs

Variable specification	**Measurement**	**Expected Signs**	
Dependent variable		**LHDD**	**HHDD**
Household dietary diversity	Household dietary diversity score (12 food groups)		
Explanatory variables		**Explanatory variables**	
Participation in non-farm income activities	1 if the household participated in non-farm income activities, and 0 if not.	-	+
Age of the household head	Age at time of interview in completed years	+/-	+/-
Sex of the household head	1 if male and 0 otherwise	-	+
Level of education	Years of schooling	-	+
Possession of special skill	1 for those with transferable skill, 0 otherwise	-	+
Marital status	1 if married, 0 otherwise	+/-	+/-
Household size	Number of household members	-	-
Land ownership	1 if yes, 0 otherwise	-	+
Land size	Total land owned in acres	-	+
Farm size	Total area under cultivation in acres	-	+
Tenure security	1 if the household has fear of losing land, 0 otherwise.	-	+
Livestock holding	Total number of livestock owned	-	+
Credit access	1= Access 0= No access	-	+
Electricity	1 if the village has electricity, 0 otherwise	-	+
Distance to the nearest market in kilometres	1 if close by 1km to the town, 0 otherwise	-	+
Distance to the main road in kilometres	1 if close by 1km to the main road, 0 otherwise	-	+

3.5 Conceptual Framework

The conceptual framework of dietary diversity and its associated factors is illustrated in Figure 1. Dietary diversity is believed to be influenced by market access: distance to the main road, food exchange and time it takes to reach the market; non-farm income diversification; socio-economic factors such as access to credit, land ownership and asset ownership and socio-demographic factors such as age, sex, marital status and education level of the household head and family size. These factors could have a positive or negative effect on dietary diversity.

Figure 1: Conceptual Framework: Dietary Diversity and Associated Factors



3.6 Limitations of the Model

The ordered logit model is one of the most popular methods for analyzing ordinal outcome variables. Unfortunately, experience suggests that the assumptions of the ordered logistic regression model are frequently violated (Long & Freese, 2014). Researchers have then typically been left with a choice between staying with a method whose assumptions are known to be violated or switching to a method that is far less parsimonious and more difficult to interpret, such as the multinomial logit model which makes no use of information about the ordering of categories.

The use of an ordered logit model when its assumptions are violated creates a misleading impression of how the outcome and explanatory variables are related. Further, keep in mind that these are simple bivariate models. When there are multiple explanatory variables, the situation can get much more complicated. For example, there could be a dozen variables in a model, 11 of which meet the parallel lines/proportional odds assumption and only one of which does not. Nonetheless, the one problematic variable could cause the entire model to fail the Brant test. We would then want a more flexible model that can deal with situations like the above, a model whose assumptions are not violated but at the same time does not include a lot of extraneous and unnecessary parameters such as a multinomial logit model might. Perhaps even more critically, we would want the model to yield substantive insights that the ordered logit model does not.

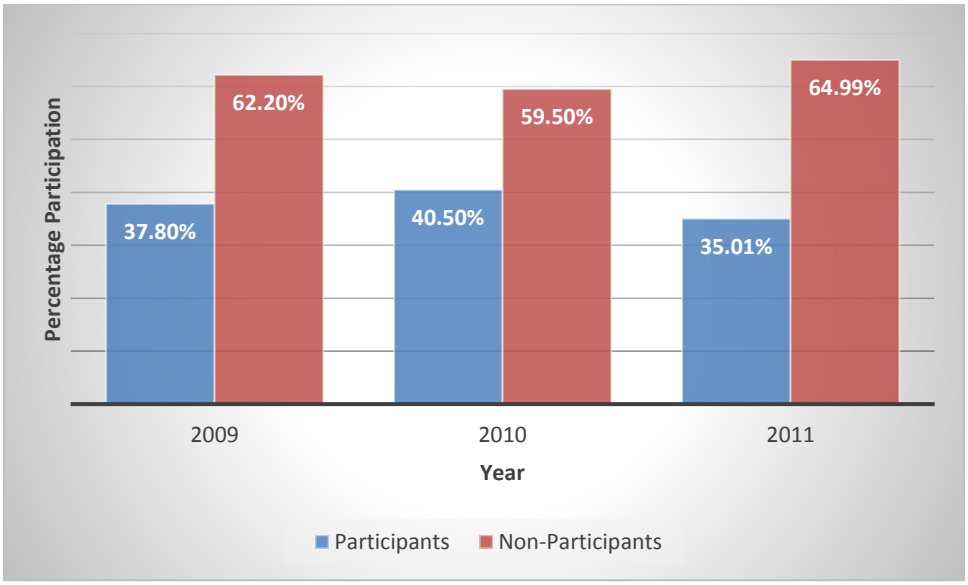
CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Participation in Non-farm Income Activities

To address objective 1 on the trends in participation in the non-farm income sector among rural farmer households in Uganda, we generated descriptive statistics. The results are presented in Figure 2 and discussed in what follows. This section presents descriptive results of the trends in non-farm income participation in the years 2009, 2010 and 2011. We present the percentages for both participants and non-participants in non-farm income generating activities. Figure 2 compares trends of participation in non-farm income activities in the years 2009, 2010 and 2011. As can be discerned from the figure, the level of participation in non-farm income activities significantly increased from 37.80% in 2009 to 40.50% in 2010, and then fell to 35.01% in 2011. The fall in non-farm income participation in 2011 could have been brought about by the reduction in economic activity in the country from a GDP growth rate of 6.7% in 2010 to 3.2% in 2011 (UBOS, 2013).

Figure 2: Trends in Non-Farm Income Participation, 2009 to 2011



Source: Survey data

4.2 Non-farm Income Participation and Household Dietary Diversity

We computed Student T-tests for the years 2009, 2010 and 2011 to compare the level of household dietary diversity between participants and non-participants in the rural non-farm sector so as to answer objective 2; determine and compare the level of household dietary diversity between participants and non-participants in the rural non-farm sector in Uganda. Results split by years and participation are presented in Table 3 and discussed in what follows. The table lists the different years and their respective household dietary diversity scores (mean HDD) and T-statistics which indicates that the difference of means in household dietary diversity between participants and non-participants in non-farm income activities were statistically significantly different from zero. Therefore, I reject the null hypothesis of no difference in HDD between the two categories and conclude that participants in non-farm income activities have higher household dietary diversity than their non-participating counterparts.

Table 3: Non-farm Income Participation and Household Dietary Diversity

Year	Group	All households (n=2491)	Mean (HDD)	Standard Deviation	Degrees of freedom	T-statistic	P-value
2009	**Participants**	937	8.20	2.381	2478	-5.1947	0.0000
	Non-participants	1,543	7.70	2.268			
2010	**Participants**	980	8.32	2.675	2417	-6.1557	0.0000
	Non-participants	1,439	7.67	2.447			
2011	**Participants**	847	8.76	2.394	2416	-9.1384	0.0000
	Non-participants	1,571	7.83	2.389			

Source: Survey data

The average HDDS across the years was 8.43 and 7.73 for participants and non-participants respectively. These results are generally high and different from the ones found by De Cock et al. (2013) in Limpopo province, South Africa. They reported that the households had an average HDDS of 4.5, whereas Harris-Fry et al. (2015) in their research performed with women from the rural area of Bangladesh reported an average of 3.8 food groups. However, what the HDDS means

in terms of public health is not clear, since there is no specific cut points (Swindale & Bilinsky, 2006; Kennedy et al., 2013).

For all the years 2009, 2010 and 2011, household dietary diversity was higher for participants in non-farm income activities than non-participants with an average household consuming 8.20 food groups in 2009, 8.32 food groups in 2010 and 8.76 food groups in 2011. Household dietary diversity score is thus seen improving significantly from 8.20 in 2009 to 8.32 in 2010 and to 8.76 in 2011. This implies that on average, participating households consume food from more than eight different food groups per week. However, household dietary diversity score for non-participants in non-farm income activities reduced from 7.70 food groups 2009 to 7.67 food groups in 2010 and then prominently increased to 7.83 food groups in 2011.

Significant differences based on the t-tests were observed between participants and non-participants in non-farm income activities. The outcome variable (household dietary diversity) was found to be statistically different between participants and non-participants in the rural non-farm sector at $p>0.000$ level. This means that the household dietary diversity of participants and non-participants in non-farm income generating activities are different statistically based on their t-ratios.

These results provide statistically significant evidence that participants in non-farm income activities have a higher food dietary diversity compared to non-participants. This is consistent with the findings of Babatunde and Qaim (2010), that indicated that non-farm income has a positive and significant effect on dietary quality. Implying that, when non-farm income increases, it results in not only more food in general, but also more higher-value food is consumed. Our results are also consistent with the findings of Owusu et al. (2011) who reported diversified households to be more food secure in Ghana.

4.3 Summary of Other Socio-economic and Demographic Characteristics of the Households

This section looks at some descriptive statistics for the variables of interest. Table 4 presents the summary statistics (means) of some of the variables included in the model for the effect of non-farm income participation on household dietary diversity. Summary statistics show a general increase in most of the variables between 2009 and 2011. For instance, results show an increase in size of households from 6 members in both 2009 and 2010 to about 7 members in 2011, representing a 1% increment. The average age of the household head increased from 45.7 in 2009 to 46.4 in 2010 and 47.2 in 2011. Households that actively participated in groups also increased from 13.6% in 2009 to 14.1% in 2009 and 19.1% in 2011 leading to increased socio capital. The size of land owned by a household on average increased by 2.869 acres between 2009 and 2011. Similarly, the household heads' average number of years spent in school increased from 6.2 in 2009 to 6.4 in 2010 and to 6.6 in 2011. However, the proportion of male headed households decreased from 72.3% in 2009 to 69.8% in 2010 and to 69.7% in 2011. Also, the proportion of households that received credit decreased from 17.6% in 2009 to 14.5% in 2010 and to 10.6% in 2011. Similarly, statistics show a decrease in access to extension services. About 82.4% of the households were not visited by an extension worker in 2011 as compared to 75% in 2009; however, 62.5% of the households were visited in 2010. The percentage of married household heads decreased from 74.8% in 2009 to 74% in 2010 and slightly increased to 74.4% in 2011. The number of livestock owned by the household decreased from 857 in 2009 to only 13 animals in 2011. On the other hand, literacy of the household head increased from 70.7% in 2009 to 84.6% in 2010 and later fell to 71.9% in 2011. Lastly, the proportion of households that had access to electricity increased from 11.1% in 2009 to 11.3% in 2010 and to 12.4% in 2011.

Table 4: Descriptive Statistics of Household's Socio-economic Attributes, 2009-2011

Socio demographic and economic characteristics	2009 (n= 2,491)	2010 (n= 2,491)	2011 (n= 2,491)
Gender of the household head (1=male, 0=female)	0.723 (0.448)	0.698 (0.459)	0.697 (0.460)
Age of the household head (in years)	45.750 (15.105)	46.375 (15.108)	47.243 (14.894)
Marital status of the household head (1=married, 0=unmarried)	0.748 (0.434)	0.740 (0.438)	0.744 (0.437)
Education of the household head (No. of years of schooling)	6.229 (3.224)	6.411 (3.356)	6.630 (3.450)
Literacy of the household head (1=literate, 0=illiterate)	0.707 (0.455)	0.846 (0.376)	0.719 (0.449)
Household size (Number of household members)	6.271 (3.280)	6.912 (3.428)	7.589 (3.796)
Land size (Total land owned in acres)	1.543 (2.156)	4.328 (16.109)	4.412 (8.388)
Livestock holding (Number of livestock owned)	856.918 (23723.68)	16.463 (36.855)	12.978 (41.563)
Credit access (1=Access, 0=No access)	0.176 (0.381)	0.145 (0.352)	0.106 (0.308)
Access to extension services (1=visited by ext. agent, 0=otherwise)	0.250 (0.433)	0.625 (0.485)	0.176 (0.381)
Socio capital (1=member participates in a group, 0=otherwise)	0.136 (0.342)	0.141 (0.348)	0.191 (0.393)
Distance to the main road (in kilometres)	3.226 (7.036)	2.710 (4.336)	2.857 (6.559)
Electricity access (1=Access, 0=No access)	0.111 (0.314)	0.113 (0.317)	0.124 (0.329)

Source: Survey data **Note:** Standard deviation in parenthesis

4.4 Socio-economic and Demographic Characteristics of Participants and Non-participants in Non-farm Income Generating Activities in Uganda

This section presents percentages of the various demographic characteristics for participants and non-participants in non-farm income generating activities in Uganda in the year 2009, 2010 and 2011. Table 5 depicts various demographic characteristics for participants and non-participants in non-farm income generating activities.

Table 5: Socio-economic and Demographic Characteristics of Participants and Non-participants in Non-farm Income Generating Activities, 2009-2011

Variable		**Participants (%)**			**Non-Participants (%)**		
Year		**2009**	**2010**	**2011**	**2009**	**2010**	**2011**
Gender	Male	38.77	41.29	35.41	61.23	58.71	64.59
Marital Status	Married	37.86	41.28	35.64	62.14	58.72	64.36
Region	Rural	30.52	33.19	28.32	69.48	66.81	71.68
Literacy	Literate	41.87	81.82	39.87	58.13	18.18	60.13
Extension	Extension access	32.28	34.41	29.82	67.72	65.59	70.18
Credit	Credit access	64.86	66.87	82.30	35.14	33.13	17.70
Electricity	Electricity access	66.91	72.73	68.79	33.09	27.27	31.21

Source: Survey data

Results in Table 5 indicate that most of the participants in non-farm income activities were males, however, their percentage participation increased from 38.77% in 2009 to 41.29% in 2010 and then decreased to 35.41% in 2011. The largest percentage of participants were married and their percentage participation increased from 37.86% in 2009 to 41.28% in 2010 and decreased to 35.64 in 2011. The percentage of participants who live in the rural region increased from 30.52% in 2009 to 33.19% in 2010 and slightly fell to 28.32% in 2011. The study revealed that majority of the

participants were literates and their percentage participation significantly increased from 41.87% in 2009 to 81.82% in 2010 and then greatly fell to 39.87% in 2011.

Similarly, the majority of participants had access to extension services and their percentage participation increased from 32.28% in 2009 to 34.41% in 2010 and decreased to 29.82% in 2011. The largest percentage of participants had access to credit and their percentage participation increased from 64.86% in 2009 to 66.87% in 2010 and then greatly increased to 82.30% in 2011.

Likewise, the largest percentage of participants had access to electricity and their percentage participation increased from 66.91% in 2009 to 72.73% in 2010 and then decreased to 68.79% in 2011. These results therefore indicate that majority of non-farm participants were males, married, literates who had access to electricity, credit and extension services and stayed in urban regions.

4.5 Dietary Diversity and Non-Farm Income Participation within the Last Seven Days, 2009-2011

This section presents the Household Dietary Diversity Score (HDDS) in terciles and participation in non-farm income activities in the years 2009, 2010 and 2011 as seen in Table 6 below. When the HDDS results were divided into terciles, the lowest HDDS being represented by 1–4 food groups, medium HDDS by 5-8 food groups and the highest HDDS by 9 or more food groups.

Results in Table 6 indicate that in the year 2009, majority of participants in non-farm income activities consumed food from the medium HDDS food group category (46.86%) while 44.73% were in the higher HDDS food group category and 8.41% in the lower HDDS food group category.

Whereas in the year 2010, majority of the participants were in the higher HDDS food group category (48.32%), 43.25% were in the medium HDDS food group category and 8.43% in the lower HDDS food group category.

Furthermore, in the year 2011, while 56.13% of the participants were in the higher HDDS food group category, 37.97% belonged to the medium HDDS food group category and only 5.9% belonged to the lower HHDS food group category.

Table 6: Distribution of Household Dietary Diversity Score (HDDS) in Terciles and Non-Farm Income Participation, 2009-2011

Tercile	2009		2010		2011	
Participation (%)	**Participants**	**Non-participants**	**Participants**	**Non-participants**	**Participants**	**Non-participants**
Low HDDS	8.41	9.32	8.43	11.40	5.90	8.96
Medium HDDS	46.86	57.09	43.25	53.08	37.97	53.94
High HDDS	44.73	33.59	48.32	35.52	56.13	37.10
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Survey data

4.6 Structure of Household Incomes

This section presents the average composition of household income as can be discerned in Table 7. The amount of income derived from non-farm activities by far exceeds other sources of income followed by farming, remittances and lastly transfers. Income diversification particularly from non-farm activities is increasingly becoming an important component in alleviating poverty and increasing food security among rural households (Muyunda, 2009).

Literature on non-farm diversification in Africa documents a positive correlation between wealth or income of households and participation in non-farm employment, especially with regard to lucrative non-farm activities (Ellis, 1998; Lanjouw et al., 2001; Reardon, 1997; Woldehanna and Oskam, 2001). Table 7 shows how different income sources contribute to overall household incomes. Results indicate that most households derived the largest income share from non-farm activities. This agrees with the findings of Rijikers et al. (2008) who estimated the contribution of non-farm income at more than a quarter of total household income in rural areas of Ethiopia.

Table 7: Average Composition of Household Incomes, 2009-2011

Income Source	2009	2010	2011
	Mean Income in Ugx	**Mean Income in Ugx**	**Mean Income in Ugx**
Farm Income	820,205.10 **(37.49%)**	688,798.60 **(27.50%)**	969,781.60 **(36.07%)**
Non-farm Income	1,238,943.95 **(56.63%)**	1,499,943.88 **(59.89%)**	1,549,640 **(57.63%)**
Transfers	42,956.12 **(1.96%)**	39,931.75 **(1.59%)**	57,554.83 **(2.14%)**
Remittances	85,673.03 **(3.92%)**	275,979.60 **(11.02%)**	111,770.80 **(4.16%)**
Total	**2,187,787.35**	**2,504,498.05**	**2,688,747.23**

Source: Survey data Note: Percentage Income Share in parentheses.

Results in Table 7 above show that more than 50% of the total income of households in rural Uganda is from non-farm income activities. As seen in Table 7, non-farm income accounts for 56.63% in 2009, 59.89% in 2010 and 57.63% in 2011 of total household income which is way more than other income sources. All households derive income from farming, which, however, only accounts 37.49% in 2009, 27.50% in 2010 and 36.07% in 2011 of the total income. About 10% of the total household income (transfers and remittances) is derived from other different off-farm sources. [9] Non-farm income increased from 56.63% in 2009 to 59.89% in 2010 and then decreased to 57.63% in 2011. These percentages are above the average of 35% reported for Africa (Haggblade et al., 2010). Similarly, several studies have reported a substantial and increasing share of non-farm income in total household income (Ruben and Van den Berg, 2001; De Janvry and Sadoulet, 2001; Haggblade et al., 2007). De Janvry confirms this view, noting that non-farm rural

[9]Non-farm income (or non-agricultural income, see Barrett et al., 2001) refers to income earned from non-agricultural sources, either in wage-employment or self-employment.

incomes are necessary for successful income growth in Sub-Saharan Africa (De Janvry, 1994). They are, therefore, critical to the achievement of sustainable livelihoods.

4.7 The Effect of Non-farm Income Participation on Household Food Dietary Diversity in Rural Uganda

To address the third objective on the effect of non-farm income participation on household food dietary diversity in rural Uganda, we estimated a Panel Ordered Logit Model. The results are presented in Table 8 and discussed in what follows.

Household dietary diversity was measured by a three-point scale: low dietary diversity (1-4); medium dietary diversity (5-8) and high dietary diversity (9-12) (Suneetha and Rahul, 2012) and thus has a categorical and ordinal nature. Since three classes are distinguished instead of two, standard approaches such as ordinary least squares regression method cannot be applied. Therefore, the best-fitting statistical model for handling the ordered outcome is an ordered logit model, which was used as an analytical model in this research study.

Table 8: Estimated Marginal Effects from Panel Ordered Logistic Regression of the Effect of Non-farm Income Participation on Household Food Dietary Diversity in Rural Uganda, 2009-2011

Explanatory variable	Low HDD (dy/dx)	Medium HDD (dy/dx)	High HDD (dy/dx)
Non-farm income participation (1=participates, 0=otherwise)	-0.0162***	-0.0286***	0.0448***
	(0.0041)	(0.0073)	(0.0114)
Age of the household head (years)	0.0009***	0.0016***	-0.0024***
	(0.0001)	(0.0002)	(0.0004)
Household average education (years of schooling)	-0.0065***	-0.0115***	0.0180***
	(0.0005)	(0.0009)	(0.0013)
Gender of head of household (1=male, 0=female)	0.0082	0.0146	-0.0228
	(0.0052)	(0.0091)	(0.0143)
Household size (No. of persons)	-0.0045***	-0.0080***	0.0125***
	(0.0006)	(0.0010)	(0.0015)
Remittance (dummy)	-0.0096	-0.0169	0.0265
	(0.0080)	(0.0142)	(0.0222)
NAADS member (1=member in NAADS, 0= otherwise)	-0.0164**	-0.0291**	0.0456**
	(0.0073)	(0.0128)	(0.0200)
Weather shocks (1= affected by weather shocks, 0=otherwise)	-0.0187*	-0.0330*	0.0517*
	(0.0112)	(0.0199)	(0.0311)
Livestock holding (No. of animals)	-0.0274***	-0.0485***	0.0759***
	(0.0045)	(0.0080)	(0.0123)
Distance to main road (km)	0.0020***	0.0036***	-0.0056***
	(0.0003)	(0.0006)	(0.0009)
Land size (acres)	-0.0013***	-0.0024***	0.0037***
	(0.0003)	(0.0005)	(0.0008)
Marital status of household head (1=married, 0=unmarried)	-0.0293***	-0.0519***	0.0812***
	(0.0056)	(0.0098)	(0.0153)
Credit access (1=household received credit, 0=otherwise)	-0.0375***	-0.0665***	0.1041***
	(0.0075)	(0.0131)	(0.0204)
Extension visits (1= visited by extension workers, 0=otherwise)	-0.0085	-0.0151	0.0237
	(0.0061)	(0.0108)	(0.0168)
Urban region (1=stayed in the urban region, 0=stayed in the rural region)	-0.0525***	-0.0931***	0.1456***
	(0.0055)	(0.0092)	(0.0143)
Central region without Kampala	-0.0050	-0.0186	0.0236
	(0.0089)	(0.318)	(0.0407)
Eastern region	0.0202**	0.0587*	-0.0788*
	(0.0093)	(0.0323)	(0.0415)
Northern region	0.0572***	0.1209***	-0.1781***
	(0.0098)	(0.0319)	(0.0413)
Western region	0.0700***	0.1339***	-0.2039***
	(0.0103)	(0.0318)	(0.0413)

Source: Survey data Note: Standard errors in parentheses.

A very large Wald $\chi 2$ of 1085.06 combined with a low P-value of 0.0000 (1% level of significance) implies that the model generally fits the data and the explanatory variables chosen explain the variation in household food dietary diversity. This further implies that the explanatory variables were fit for the model hence all together influence the level of household food dietary diversity in rural Uganda.

Non-farm income participation is significantly associated with household food dietary diversity (1% level). All other variables constant, households participating in non-farm income activities are significantly more likely to attain higher levels of dietary diversity (4.48%) but significantly less likely to attain low dietary diversity (1.62%) or medium dietary diversity (2.86%). These results imply that participation in non-farm income activities is associated with better food access and nutrition. This would be explained by the fact that non-farm households have supplementary income from non-farm activities which increases their chances of access to diverse foods from the market. This is consistent with the findings of Owusu et al. (2011) who reported diversified households to be more food secure in Ghana. Similarly, Ecker et al. (2012) found out that non-farm households in Ghana are significantly richer and could therefore afford a more diversified diet. This finding is also consistent with the widely held view in the literature that income from non-farm enterprise activities plays a vital role to smoothen household consumption and in improving their food security status (Quinn, 2009).

Conversely, all other variables constant, younger household heads are significantly more likely to achieve a higher dietary diversity (0.24%) while older household heads are significantly more likely to achieve low dietary diversity (0.09%) or medium dietary diversity (0.16%) at 1% level. Specifically, younger household heads have a higher dietary diversity as compared to older household heads. This can be explained by the fact that younger people are more energetic and can take on any kind of business activity thus increasing household cash earnings which in turn increases their access to diverse foods. These results are comparable with those of Clausen et al. (2005) who found that older adults in Botswana consume a low variety of food, with inadequate dairy products, fruits, and vegetables (35.2%, 59.3%, and 22.4% respectively). Another cross-sectional study among elderly respondents in Sharpeville, South Africa comparing a low mean dietary diversity score (3.41 +/- 1.34) and food variety score (4.77 +/- 2.2) with poverty parameters confirmed household food insecurity (Oldewage-Theron & Kruger, 2008). However, an earlier

study found that respondents in the older age group had a higher mean intake for all nutrients compared to their younger counterparts (Holcombe, 1995).

Household average education is statistically significant (1% level). Educated household heads are significantly more likely to attain a higher dietary diversity (1.8%) but significantly less likely to attain low dietary diversity (0.65%) or medium dietary diversity (1.15%) while keeping all other variables constant. This is consistent with the findings of Taruvinga et al. (2013) who argued that education of the household head enhances food dietary diversity, since it is expected that educated people will be more concerned about nutritional balance in the household. Similar comparable findings were suggested by several authors who noted that educated households assign a significantly larger proportion of their household food budget to food groups that are nutritionally rich in micronutrients (Smith and Haddad, 2000; Smith et al., 2003; Block, 2003; Barrett et al., 2001), mainly because of greater awareness and understanding of their nutritional health benefits (Smith, 2004). This finding also suggests that education is a crucial factor for increasing household dietary diversity in rural Uganda, as was found for Tanzania (Abdulai & Aubert, 2004), Malawi (Snapp & Fisher, 2015) and Bangladesh (Rashid et al., 2011). In Uganda, about 4 in 10 children born to mothers with no education (37%) are stunted compared with 1 in 10 (10%) of children born to mothers with more than a secondary education (UBOS & ICF, 2017).

Household size, an indicator of potential labour, is statistically significant (1% level) which indicates that more labour increases household dietary diversity. All other variables constant, a household with many members is significantly more likely to attain a higher dietary diversity (1.25%) but significantly less likely to attain low dietary diversity (0.45%) or medium dietary diversity (0.8%). This result is expected because households with many members are expected to be more endowed with higher quality family labour for both agricultural and non-agricultural production which results in an increased production and/or increase in their income by paid labour. These findings correspond with those of Jones et al. (2014) in Malawi who found out that a household with many family members attains a higher farm production diversity thus household dietary diversity.

NAADS member (National Agricultural Advisory Services) is statistically significant (5% level). All other variables constant, a household head that is a member in NAADs is significantly more likely to attain a higher dietary diversity (4.56%) but significantly less likely to attain low dietary diversity (1.64%) or medium dietary diversity (2.91%). Community members that participate in NAADS, have a higher nutrition knowledge compared to non-participants. These members more so the women are usually taught the role of care-giver confidence in feeding young children and adults, and ideas of nutritional balance when introducing complementary foods to young children. As a consequence, participatory community-based nutrition education for members improves household dietary diversity.

Livestock holding is statistically significant at 1% level. All other variables constant, a household with a larger livestock holding is significantly more likely to attain a higher dietary diversity (7.59%) but significantly less likely to attain low dietary diversity (2.74%) or medium dietary diversity (4.85%). Livestock ownership improves dietary diversity through both direct consumption of animal products produced on farm like: eggs, milk and meat and through increased consumption expenditure. Therefore smallholder livestock ownership has the potential to enhance food nutritional security through raising incomes of the poor and by increasing the availability of nutrient-dense foods. These findings are comparable to those from Zambia by Jodlowski et al. (2016).

Distance to the main road has a significant effect (1% level) on household dietary diversity. All other variables constant, households that are closer to the main road are significantly more likely to attain a higher dietary diversity (0.56%) while those that are further away from the main road are significantly more likely to attain low dietary diversity (0.2%) or medium dietary diversity (0.36%). Lower costs of accessing a variety of foods is associated with higher dietary diversity. This thus implies that households in remoter regions have lower dietary diversity. This affects the transaction costs for purchasing food, selling output, and for household's access to health and nutrition information. One indicator of market access is the geographical distance from the farm household to the closest market/town where food can be sold or bought. Better market access in terms of shorter distance could therefore contribute to higher dietary diversity.

Land size also has a significant (1% level) impact on household dietary diversity. All other variables constant, a household with larger land holdings is significantly more likely to attain a higher dietary diversity (0.37%) but significantly less likely to attain low dietary diversity (0.13%) or medium dietary diversity (0.24%). This implies that households that have larger land holdings have higher dietary diversity as compared to those that have smaller land holdings. This could be so because they have enough land where they can grow vegetables and raise livestock to replace or supplement purchased food. It also suggests that the direct access to food through farming can indeed contribute to an improved diet. The household's total land area devoted to agricultural production is positively associated with dietary diversity hence more available land improves dietary diversity. Similarly, the greater the proportion of food consumed from a household's own production, the greater the dietary diversity. According to Linderhof et al. (2016), given more land, Ugandan households appear to choose a greater diversity of production and consumption because they are aware that greater crop diversity leads to greater health.

We note a significant (1% level) effect of marital status of the household head on household dietary diversity. All other variables constant, a household with a married household head is significantly more likely to attain a higher dietary diversity (8.12%) but significantly less likely to attain low dietary diversity (2.93%) or medium dietary diversity (5.19%). Married people tend to consume a greater variety of foods, perhaps because responsibility for other family members leads to a wider variety of dietary items in the household (Liu et al., 2014).

Credit access has a significant impact (1% level) on household dietary diversity. All other variables constant, a household with access to credit is significantly more likely to attain a higher dietary diversity (10.41%) but significantly less likely to attain low dietary diversity (3.75%) or medium dietary diversity (6.65%). Results thus imply that credit has a positive contribution towards household food security. Findings reveal that be it from formal, or informal or micro-finance institutions, most of the households avail credit for a wide variety of purposes e.g. for agricultural production, for doing business, purchase of food, to meet educational and health expenditure, for safeguarding themselves in case of income shocks etc. Our findings are similar to those of Khondker et al. (2013) in Bangladesh whose Instrumental Variable (IV) estimates provide evidence in favour of the positive significant effect of credit on household dietary diversity.

The Northern region is significantly more likely to attain low dietary diversity (5.72%) and medium dietary diversity (12.09%) but significantly less likely to attain a higher dietary diversity (17.81%) at 1% level. Similarly, the Western region is significantly more likely to attain a low dietary diversity (7%) and medium dietary diversity (13.39%) but significantly less likely to attain a higher dietary diversity (20.39%) at 1% level. The Eastern region is significantly (1% level) more likely to attain a lower dietary diversity (2.02%). The urban region is significantly more likely to attain a higher dietary diversity (14.56%) but significantly less likely to attain low dietary diversity (5.25%) or medium dietary diversity (9.31%) at 1% level. This seems reasonable since a wide range of different types of foods are available and accessible to households in urban areas as opposed to rural areas. Our findings are comparable to those of Casttebon et al. (1997) who found a higher food variety score to be associated with urban residence in Abidjan, Cote D'Ivoire. Other studies established that urban residents have higher consumption frequencies for all food categories than rural residents (Holcomb, 1995).

Generally, results in Table 8 above indicate that being young, married, educated, a non-farm participant, having access to credit, owning a larger land size with a larger family size and larger livestock holding, part of NAADs and staying in the urban region were positively associated with higher household dietary diversity. This research study largely corroborates similar studies and concludes that participation in non-farm income activities smooths consumption expenditure and improves food security status, and the general wellbeing of the rural households.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusion

This research study used three comprehensive waves of a nationally representative household level data (UNPS 2009/10, UNPS 2010/11 and UNPS2011/12) collected by the Uganda National Bureau of Statistics to examine the effect of non-farm income participation on household food dietary diversity in rural Uganda for the period 2009-2011. The study evaluates household dietary diversity using a scale of twelve food groups of rural farm households. We analyse the impact by employing the panel ordered logit model since the dependent variable household dietary diversity is an ordered and categorical variable from 1-12 food groups consumed by households in the last seven days preceding the recall. Three terciles of dietary diversity were created, based on household dietary diversity score: low HDD (1–4 food groups consumed), medium HDD (5–8 food groups consumed) and high HDD (9–12 food groups consumed). Our analysis leads to several interesting results. First, results show that most households derived the largest income share from non-farm activities which accounts for more than 50% of the total household income. The amount of income derived from non-farm activities by far exceeds other sources of income followed by farming, wages, remittances and lastly transfers. Second, results indicate a statistically significant difference in the level of household food dietary diversity between participants and non-participants in the rural non-farm sector implying that participants in non-farm income activities have a higher household food dietary diversity than non-participants. Results show that the average HDDS of consumption across the years was 8.42 and 7.73 food groups for participants and non-participants in the rural non-farm sector respectively. For all the years 2009, 2010 and 2011, household dietary diversity was higher for participants in non-farm income activities than non-participants with an average household consuming 8.20 food groups in 2009, 8.32 food groups in 2010 and 8.76 food groups in 2011. Household dietary diversity score is thus seen improving significantly from 8.20 in 2009 to 8.32 in 2010 and to 8.76 in 2011. However, household dietary diversity score for non-participants in non-farm income activities reduced from 7.70 food groups 2009 to 7.67 food groups in 2010 and then prominently increased to 7.83 food groups in 2011.

Third, the panel ordered logit model regression results show that participation in non-farm income activities exerts a positive and statistically significant effect on household food dietary diversity and that, a household that participated in non-farm income activities was significantly more likely to attain a higher dietary diversity (4.48%) but significantly less likely to attain low dietary diversity (1.62%) or medium dietary diversity (2.86%). Results further show that being young, married, educated, a non-farm participant, having access to credit, owning a larger land size with a larger family size and larger livestock holding, part of NAADs and staying in the urban region were positively associated with higher household dietary diversity. This study largely corroborates similar studies and concludes that participation in non-farm income activities smooths consumption expenditure and improves food security status, and the general wellbeing of the rural households.

In view of the importance and potential of the rural non-farm economy as part of a diversified income strategy alongside agricultural activities, the challenge for current and future rural development strategies is thus to go "beyond agriculture," so as to identify the adequate elements of an integrated rural strategy that best complement the still pivotal role of a better-linked agricultural sector. So far, relatively little policy efforts have been made to promote the non-farm sector in a pro-poor way and overcome potential constraints in countries of Sub-Saharan Africa. One reason is probably the scarcity of solid and up-to-date information about the driving forces of household income diversification in specific contexts. Based on our results, we can already indicate that promotion of the non-farm income sector in Uganda will lead to a larger diversity of nutrition.

5.2 Recommendations and Policy Conclusions

The findings of this study imply that non-farm activities are one of the options that should be given more emphasis by the relevant authorities in the crafting of poverty eradication programs and reducing food insecurity among rural farmers. These authorities should look into measures that will enable more poor farmers to participate effectively in non-farm activities. They should also look into the factors that are inhibiting some farmers from participating in non-farm activities and assistance should be given to these farmers accordingly. However, it should be noted that not all

non-farm activities are similar in terms of their effectiveness in reducing poverty and food insecurity among farmers. Issues such as cost-effectiveness of the non-farm activities, technical know-how and readiness of the farmers and resources requirement should be taken into consideration when it comes to measure the effectiveness of non-farm activities.

Policies aimed at the rural sector must be oriented toward providing incentives that stimulate households to participate in rural non-farm jobs, as well as the capacity of households to respond to such incentives. It is important to note that several "motors" of the rural non-farm enterprise (such as tourism and urban industry) are determined by demands originating outside the rural sector. A rural development policy that addresses the rural non-farm enterprise (RNFE) must seek to promote the mobilization not only of capital, but also non-rural human and institutional resources, which have the capacities, relationships and knowledge needed to initiate, develop and conduct new types of projects in secondary and tertiary sectors such as tourism, recreation, and environmental services.

It will be crucial for RNFE promotion to remove the strong agricultural bias that characterizes rural development policies, and adopt a position of promoting land-use development and rural economy as a whole. There are no reasons that currently justify exclusive reliance on agricultural development to improve the quality of life in rural areas or to seek to overcome rural poverty. Furthermore, agricultural development itself necessarily requires growth in manufactures and services. In vast rural regions, betting solely on agricultural development means condemning them to conditions of endemic poverty, marginalization and stagnation.

A differentiated treatment must be assumed between the richest and the poorest rural zones. In the former, it is important to reduce the transaction costs faced both by agents that develop investments in RNFE motors, and rural households seeking to participate in non-farm activities. An active role on the part of the public sector is required in promoting conditions to increase the attractiveness of these regions to the private sector (roads, electrification, telecommunications and irrigation), as well as a strong focus of public investment in developing the capacity of rural households to participate in a broader range of paying activities (education, access to credit, activation of land markets, etc.).

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APPENDIX

Figure 3: Panel Ordered Logistic Regression of the Effect of Non-farm Income Participation of Household Food Dietary Diversity in Rural Uganda

```
Random-effects ordered logistic regression      Number of obs      =      7296
Group variable: year                            Number of groups   =         3

Random effects u_i ~ Gaussian                   Obs per group: min =      2414
                                                               avg =    2432.0
                                                               max =      2441

Integration method: ghermite                    Integration points =        12

                                                Wald chi2(19)      =   1085.06
Log likelihood  = -6137.3307                    Prob > chi2        =    0.0000
```

fdc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
agehead	-.0117719	.0017067	-6.90	0.000	-.0151169	-.0084269
hhavgeduc	.0867862	.0065878	13.17	0.000	.0738743	.0996981
sexhead	-.1100162	.0689744	-1.60	0.111	-.2452036	.0251711
hhsize	.060193	.0075712	7.95	0.000	.0453537	.0750323
remitdummy	.1277715	.1071705	1.19	0.233	-.0822788	.3378219
nonfmpart	.2160274	.054903	3.93	0.000	.1084195	.3236354
partNAADs	.2197629	.0968357	2.27	0.023	.0299684	.4095574
weathshocks	.2493087	.1498621	1.66	0.096	-.0444157	.543033
livestockdummy	.3659706	.0597455	6.13	0.000	.2488716	.4830695
distcacetpt	-.0270728	.0045681	-5.93	0.000	-.0360262	-.0181194
land_size	.0179054	.0037567	4.77	0.000	.0105425	.0252683
marriedhead	.3915561	.0739625	5.29	0.000	.2465924	.5365199
credit	.501884	.0991841	5.06	0.000	.3074867	.6962813
extnaccess	.1142598	.0812778	1.41	0.160	-.0450418	.2735614
urban	.7023245	.0703374	9.99	0.000	.5644658	.8401833
region						
Central without Kampala	.1059377	.182418	0.58	0.561	-.2515951	.4634706
Eastern	-.3549536	.18604	-1.91	0.056	-.7195853	.0096782
Northern	-.8251296	.1854637	-4.45	0.000	-1.188632	-.4616275
Western	-.9567945	.1864053	-5.13	0.000	-1.322142	-.5914468
/cut1	-2.049542	.212874	-9.63	0.000	-2.466768	-1.632317
/cut2	.9949819	.2108592	4.72	0.000	.5817054	1.408258
/sigma2_u	.0505243	.0269674			.0177489	.1438236

Figure 4: Marginal Effects for Low Dietary Diversity Outcome

```
Average marginal effects                        Number of obs   =       7296
Model VCE    : OIM

Expression   : Predicted mean (0.fdc), assuming u_i=0, predict(pu0 outcome(0))
dy/dx w.r.t. : agehead hhavgeduc sexhead hhsize remitdummy nonfmpart partNAADs weathshocks livestockdummy distcacetpt
               land_size marriedhead credit extnaccess urban 1.region 2.region 3.region 4.region
```

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
agehead	.0008807	.0001297	6.79	0.000	.0006265	.0011348
hhavgeduc	-.0064927	.0005336	-12.17	0.000	-.0075386	-.0054469
sexhead	.0082306	.0051667	1.59	0.111	-.0018959	.0183572
hhsize	-.0045032	.0005868	-7.67	0.000	-.0056533	-.0033531
remitdummy	-.009559	.0080229	-1.19	0.233	-.0252835	.0061656
nonfmpart	-.0161616	.0041333	-3.91	0.000	-.0242627	-.0080606
partNAADs	-.0164411	.0072684	-2.26	0.024	-.0306869	-.0021953
weathshocks	-.0186515	.0112053	-1.66	0.096	-.0406135	.0033106
livestockdummy	-.0273793	.0045179	-6.06	0.000	-.0362342	-.0185244
distcacetpt	.0020254	.0003448	5.87	0.000	.0013496	.0027012
land_size	-.0013396	.0002837	-4.72	0.000	-.0018956	-.0007835
marriedhead	-.0292934	.0055923	-5.24	0.000	-.0402541	-.0183328
credit	-.0375474	.0075072	-5.00	0.000	-.0522612	-.0228336
extnaccess	-.0085481	.0060859	-1.40	0.160	-.0204762	.00338
urban	-.0525429	.0055084	-9.54	0.000	-.0633391	-.0417467
region						
Central without Kampala	-.0049581	.0088921	-0.56	0.577	-.0223862	.0124701
Eastern	.0201801	.0093489	2.16	0.031	.0018565	.0385037
Northern	.0571769	.0098402	5.81	0.000	.0378904	.0764634
Western	.0700095	.0102895	6.80	0.000	.0498425	.0901765

Note: dy/dx for factor levels is the discrete change from the base level.

Figure 5: Marginal Effects for Medium Dietary Diversity Outcome

```
Average marginal effects                        Number of obs   =       7296
Model VCE    : OIM

Expression   : Predicted mean (1.fdc), assuming u_i=0, predict(pu0 outcome(1))
dy/dx w.r.t. : agehead hhavgeduc sexhead hhsize remitdummy nonfmpart partNAADs weathshocks livestockdummy distcacetpt
               land_size marriedhead credit extnaccess urban 1.region 2.region 3.region 4.region
```

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
agehead	.0015599	.0002273	6.86	0.000	.0011144	.0020054
hhavgeduc	-.0115	.0008582	-13.40	0.000	-.013182	-.009818
sexhead	.0145782	.009138	1.60	0.111	-.003332	.0324884
hhsize	-.0079762	.0009932	-8.03	0.000	-.0099227	-.0060296
remitdummy	-.016931	.0142008	-1.19	0.233	-.0447641	.0109021
nonfmpart	-.0286258	.0072741	-3.94	0.000	-.0428828	-.0143687
partNAADs	-.0291208	.0128152	-2.27	0.023	-.0542381	-.0040034
weathshocks	-.0330359	.0198892	-1.66	0.097	-.072018	.0059462
livestockdummy	-.0484947	.0079602	-6.09	0.000	-.0640965	-.0328929
distcacetpt	.0035874	.0006091	5.89	0.000	.0023936	.0047812
land_size	-.0023726	.0004973	-4.77	0.000	-.0033473	-.0013979
marriedhead	-.0518851	.0098244	-5.28	0.000	-.0711404	-.0326297
credit	-.0665046	.0131073	-5.07	0.000	-.0921944	-.0408148
extnaccess	-.0151406	.0107693	-1.41	0.160	-.0362481	.005967
urban	-.0930649	.0092267	-10.09	0.000	-.111149	-.0749809
region						
Central without Kampala	-.0186351	.0317811	-0.59	0.558	-.0809248	.0436547
Eastern	.0586652	.0322553	1.82	0.069	-.0045539	.1218844
Northern	.1209097	.0319078	3.79	0.000	.0583716	.1834478
Western	.1339396	.0318478	4.21	0.000	.071519	.1963602

Note: dy/dx for factor levels is the discrete change from the base level.

Figure 6: Marginal Effects for High Dietary Diversity Outcome

```
Average marginal effects                        Number of obs   =       7296
Model VCE    : OIM

Expression   : Predicted mean (2.fdc), assuming u_i=0, predict(pu0 outcome(2))
dy/dx w.r.t. : agehead hhavgeduc sexhead hhsize remitdummy nonfmpart partNAADs weathshocks livestockdummy distcacetpt
               land_size marriedhead credit extnaccess urban 1.region 2.region 3.region 4.region
```

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
agehead	-.0024406	.0003515	-6.94	0.000	-.0031295	-.0017517
hhavgeduc	.0179927	.0013154	13.68	0.000	.0154147	.0205708
sexhead	-.0228089	.0142929	-1.60	0.111	-.0508224	.0052047
hhsize	.0124794	.0015479	8.06	0.000	.0094456	.0155131
remitdummy	.0264899	.0222134	1.19	0.233	-.0170475	.0700274
nonfmpart	.0447874	.01135	3.95	0.000	.0225419	.0670329
partNAADs	.0455618	.0200499	2.27	0.023	.0062647	.084859
weathshocks	.0516874	.0310665	1.66	0.096	-.0092018	.1125766
livestockdummy	.075874	.0123267	6.16	0.000	.0517141	.1000339
distcacetpt	-.0056128	.000943	-5.95	0.000	-.0074612	-.0037645
land_size	.0037122	.0007753	4.79	0.000	.0021927	.0052317
marriedhead	.0811785	.0152767	5.31	0.000	.0512367	.1111202
credit	.104052	.0204429	5.09	0.000	.0639846	.1441193
extnaccess	.0236887	.0168443	1.41	0.160	-.0093256	.0567029
urban	.1456079	.0142634	10.21	0.000	.117652	.1735637
region						
Central without Kampala	.0235931	.0406682	0.58	0.562	-.0561152	.1033014
Eastern	-.0788453	.0415312	-1.90	0.058	-.1602449	.0025543
Northern	-.1780866	.0412599	-4.32	0.000	-.2589545	-.0972187
Western	-.2039491	.0413195	-4.94	0.000	-.2849338	-.1229644

Note: dy/dx for factor levels is the discrete change from the base level.