EFFECT OF INCOME DIVERSIFICATION ON HOUSEHOLD FOOD SECURITY: THE CASE OF RICE FARMERS IN THE NORTH TONGU DISTRICT OF GHANA

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ADMINISTRATION

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DECLARATION

I, Eddico Prince Ntrie, the author of this thesis do hereby declare that except for the references which have been duly cited and a plagiarism report presented in Appendix F, the work presented in this thesis, "**EFFECT OF INCOME DIVERSIFICATION ON HOUSEHOLD FOOD SECURITY: THE CASE OF RICE FARMERS IN THE NORTH TONGU DISTRICT OF GHANA"** was entirely done by me at the Department of Agricultural Economics and Agribusiness, University of Ghana, Legon from August 2015 to July 2016.

This work has never been presented either in whole or in part for any other degree in this University or elsewhere.

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This thesis has been submitted for examination with our approval as supervisors

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(Co-Supervisor)

DEDICATION

This write up is gratefully dedicated to Mr. Eric Osei and his wife Mrs. Edith Osei who were the main pillars I leaned on while pursuing this programme.

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ABSTRACT

This study assesses the effect of income diversification of rice farmers on household food security in the North Tongu District of the Volta Region of Ghana. By income diversification, the study implies the different combination of activities that rice farmers indulge in to earn income. Information on personal as well as household characteristics was obtained from 204 rice farmers in the North Tongu District by the use of semi-structured questionnaires. Depending on their income portfolios, rice farmers (the respondents for this study) were classified into 4 groups; 'Rice income only' (no diversification), 'Rice and other agricultural incomes', 'Rice and non-agricultural incomes' and 'Rice plus other agricultural and non-agricultural incomes'. The Multinomial Logit Model was used to estimate the factors affecting the choice of income strategies. Being a household head, household size, the employable skills of the respondents and household expenditure on food were among factors found to be statistically significant determinants of diversification. Respondents' household food security was measured using the household dietary diversity score (HDDS). The mean dietary diversity score for the sample was 5.81, implying consumption of nearly 6 out of the reference 12 food groups by the sampled households. Majority of the households had moderate dietary diversity with scores between 5-7. Dietary diversity was significantly correlated with per capita food expenditure and farmer income, both of which are also indicators of food security. The Poisson Regression was used to model the effect of income diversification on food security, measured as dietary diversity. All the 3 diversification strategies had a positive and significant effect on household dietary diversity. However, engaging in 'Rice and non-agricultural' activities had the most pronounced effect. The study concluded that income diversification indeed had a positive effect on food security and that attainment of high food security was associated with diversification into non-agricultural activities. The study recommends that farmer-field workshops should be organized periodically in the area to train farmers to equip them with non-farm skills so they can explore other opportunities outside of farming. Also, farmer awareness on the need for crop diversification and livestock production should be intensified in the area.

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LIST OF ACRONYMS

CERGIS	Centre for Remote Sensing and Geographic Information Systems
DFID	Department for International Development
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
GHS	Ghana Cedi
GLSS	Ghana Living Standard Survey
GSS	Ghana Statistical Service
HDD	Household Dietary Diversity
HDDS	Household Dietary Diversity Score
IFAD	International Fund for Agricultural Development
ISSER	Institute of Statistics, Social and Economic Research
MDG	Millennium Development Goal
MOFA	Ministry of Food and Agriculture
MT	Metric Tonnes
OLS	Ordinary Least Squares
SDG	Sustainable Development Goal
SRID	Statistics, Research and Information Directorate
UN	United Nations
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
USDA	United States Department of Agriculture
VIF	Variance Inflation Factor
WFP	World Food Programme
WHO	World Health Organisation
WIAD	Women in Agricultural Development

CHAPTER ONE

INTRODUCTION

1.1 Background

Improving food security remains a key objective of most African countries. Participating countries at the 1996 World Food Summit renewed their pledge to fight against poverty and hunger (Food and Agriculture Organization (FAO), 1996). Even though several interventions have been rolled out to ensure food security in Africa over the years, food insecurity is still prevalent in the continent. In a recent work by FAO (2014), it was found that some 226.7 million people in the continent are still undernourished. An earlier report by World Food Programme (WFP) (2009) indicated that about 1.2 million people in Ghana, representing about 5% of the population were food insecure and another 2 million people would be vulnerable to food insecurity should there be an unexpected shock in the food system.

According to the FAO, food security exists when all persons, at all times, have physical and economic access to adequate, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, 1996). Emphasis is made on not just the household but more importantly, the food security of the individual members within the household. The above definition highlights the four pillars of food security: availability, access, utilization and stability. Food availability in this context refers to the "supply side" of food security as determined by the level of food production, stock levels and net trade. Access implies the household or better still, the individual's economic and physical access to the food since food available at the global or national level might not necessarily translate into household/individual food security. The utilization domain addresses concerns of nutritional status of individuals whereas the last pillar

refers to the stability of the other three dimensions over time. Stability thus answers the question of whether the individual's food security will not be affected by adverse events in the future (Tweeten, 1999; FAO, 1996). When any of the above conditions is not met, the individual could be said to be food insecure.

One major factor that contributes to food insecurity in Ghana is poverty (Hjelm & Dasori, 2012). The Millennium Development Goal (MDG) on hunger called for the proportion of hungry people across the globe to be halved by the end 2015 (Gill et al., 2003). The second of the new Sustainable Development Goals (SDGs) of the FAO has even targeted an end to global hunger and ensuring that all persons everywhere especially the poor and vulnerable have access to food all year round by 2030 (Loewe & Rippin, 2015). World Food Program (2009) and Demi et al. (2013) identified farming households in Ghana to be more vulnerable to poverty than those of other sectors, with about 46% falling below the poverty line.

The prevalence of climate change and variability has also compounded the issue of food insecurity. The threat that climate change and variability pose have been evident in many ways with peasant farmers feeling the most impact. Jennings and Magrath (2009) noted that changes in cropping seasons due to climatic changes have made it difficult for farmers most especially smallholders in developing countries to discern the best time to cultivate their crops. Bailey et al. (2011) also argued that climate change has the tendency to increase the frequency and severity of weather extremes such as high temperatures, draughts and floods which can destroy farmers' entire harvest. Meanwhile, these complex changes in global environment are already having serious bearings on human wellbeing (The United Nations Environment Programme (UNEP), 2012). A study by

Lobell et al. (2011) suggested that the rise in temperature between 1980 and 2008 has already caused a reduction in global production of major staple foods. FAO (2008a) report projected that if agricultural production in Asian and African developing countries is badly affected by the changing climatic conditions, the livelihoods of the rural poor will be put at risk and they will become even more vulnerable to food insecurity.

In the midst of all these challenges, farmers would rationally adopt strategies to cope with their vulnerabilities to climate change and food insecurity. Even though agriculture is the main source of livelihood of most developing country farmers, the problem of food insecurity cannot be solved within the agricultural sector alone. It is for this reason that income diversification is crucial. Minot et al. (2006) defined income diversification as switching from one crop to a combination of food crops or high value cash crops (crop diversification) or moving from farming into non-farm ventures (non-farm diversification). Ellis (1999) and Ellis et al. (2003) as cited by Asfaw et al. (2015) viewed diversification in rural context as a dynamic adaptation process through which farmers respond to threats and opportunities as well as manage risk and gain extra income thereby securing their livelihoods and improving their standard of living. For this study, income diversification is the process of combining rice farming with other income sources (farm or non-farm) in order to improve living standards.

Literature suggests that farmers in developing countries employ different coping measures which include engaging in both on-farm and non-farm activities to earn some additional income (Arun & Keshav, 2006). By diversifying their income sources, farmers either lessen risk or supplement their main income activities (Barrett et al., 2001). Gordon and Craig (2001) argued that the growing

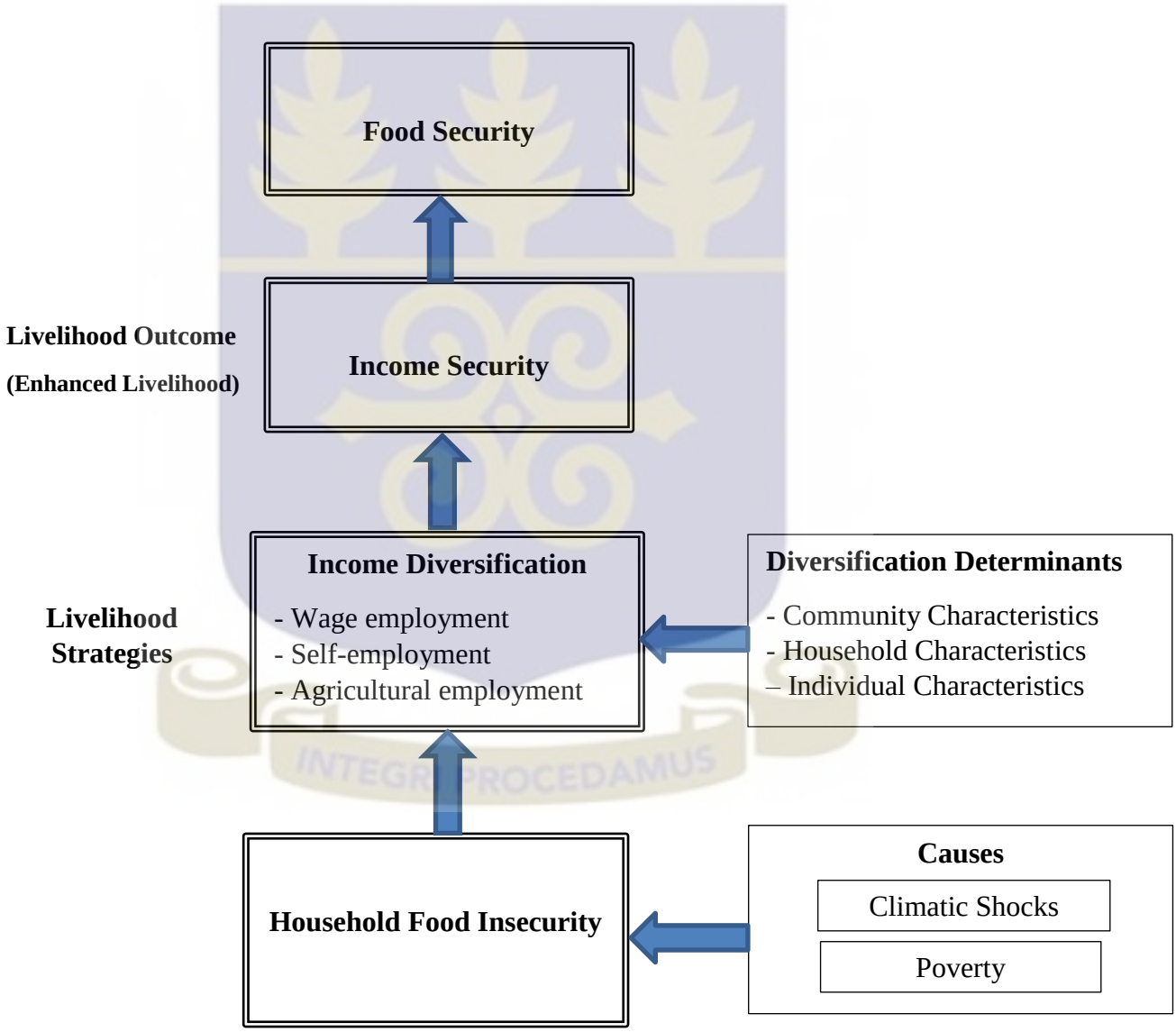
attention given to non-farm rural income hints at its importance among rural folks than previously thought. Babatunde and Qaim (2010) even associated participation in income diversified activities with better food access and nutrition hence improved food security.

This study was conducted on rice farmers in the North Tongu District of the Volta Region. According to Ghana Statistical Service (GSS) (2014a), about 60% of the populace in North Tongu live in rural areas with agriculture being their main source of livelihood. Rice, maize and cassava are among the main crops cultivated in the area. Other existing means of livelihood in the area include fishing and petty trading. With the existence of commercial farms in the area, farmers can augment their incomes by seeking wage employment as well.

1.2 Conceptual framework

The main problem at hand is household food insecurity. It is caused by poverty and climatic shocks along with failing harvests which are encountered by farmers in Ghana, majority of whom are smallholders (Demi et al., 2013; World Food Program, 2009). The prevalence of food insecurity in the household (or in an attempt to prevent its incidence altogether) 'pushes' the rice farmer who is a major bread winner for his household to adopt livelihood strategies to increase or smoothen his fluctuating farm income. The farmer does this by engaging in multiple income-generating activities either through crop diversification, seeking of agricultural wage-employment or exploring non-farm activities in order to earn additional income. The choice of which particular strategy or combination of livelihood strategies to adopt is dependent on the community characteristics (such as the kind of opportunities available in the community), the household characteristics (such as the household size and number of persons within the working-age in the

household) and the also the individual characteristics (such as the educational level of the farmer and his skills) (Malek & Usami, 2009). The above-mentioned factors are known as the determinants of diversification. The outcome of income diversification is enhanced livelihood or income security which leads to better access to food. This will be more or less reflected in a higher dietary diversity for the household which is an indicator of household food security (Kennedy, 2009; Hoddinott & Yohannes, 2002). Figure 1.1 illustrates this from a bottom up direction.



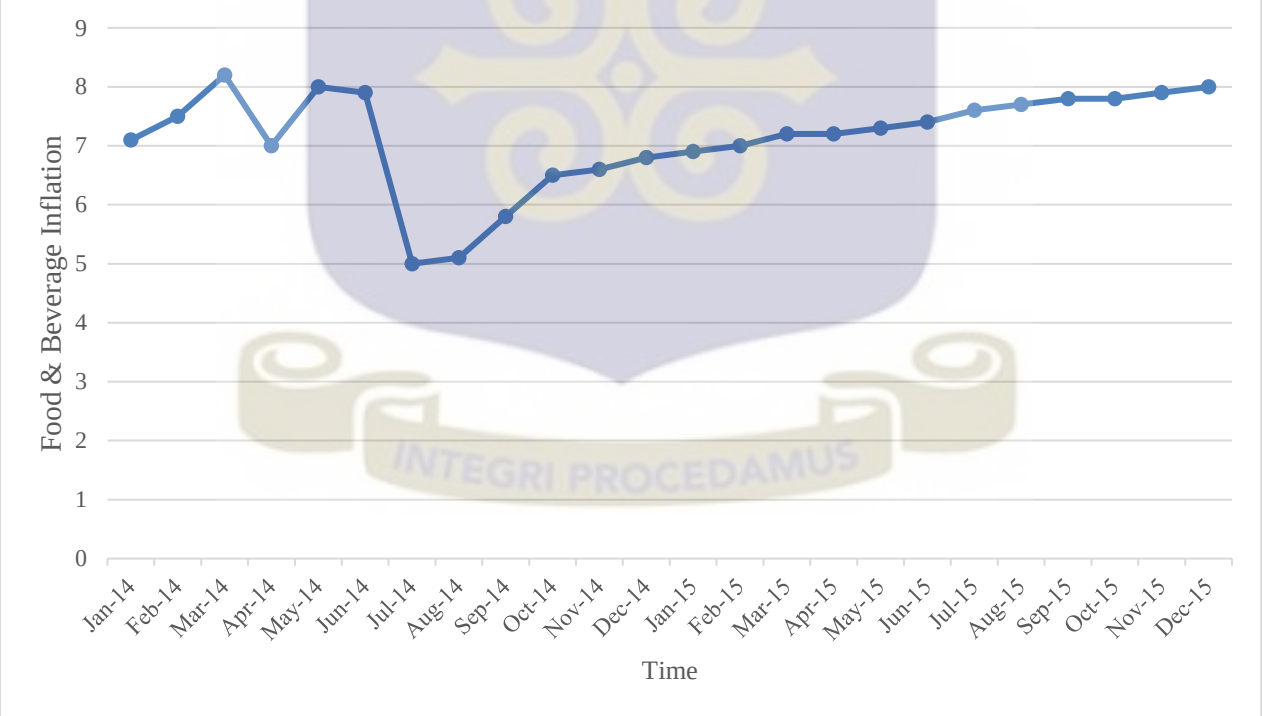
Adapted from Scoones (1998) and DFID (1999).

Figure 1.1: Conceptual framework: Effect of income diversification on household food security

1.3 Problem statement

According to the GSS (2014a), smallholder farmers with less than a hectare on the average are predominant in the North Tongu District. Smallholders are more likely to run out of food and be forced to buy in the lean season when market prices are usually at their peak (Hjelm & Dasori, 2012). Non-participation in alternative livelihood activities could therefore worsen the plight of these farmers.

Farmers do not depend on what they produce alone to meet their food needs and the needs of their households but they also buy as well. Official figures from the Ghana Statistical Service indicate an increasing trend in prices of food and non-alcoholic beverages in Ghana between July 2014 to December 2015 as can be seen in Figure 1.2. ISSER (2016) further argued that whereas the share



Source: Ghana Statistical Service (2015) as reported by ISSER (2016)

Figure 1.2: Monthly food & non-alcoholic beverage price inflation for 2014 & 2015

of non-food inflation decreased from an average of 23.9% in 2014 to 23.33% in 2015, the contribution of food and non-alcoholic beverage inflation to overall consumer price inflation rose from 6.8% in December 2014 to 8% in the year 2015. This rise in food prices is a source of concern for poor farming households since it has a toll on their purchasing power, thereby hindering their access to food.

Another challenge farmers face is the usual low prices for their farm produce. This places agricultural incomes among the lowest in the country, leaving poor farmers and their households more vulnerable to food insecurity (Nyanteng & Asuming-Brempong, 2003). Even in periods of bumper harvest, farmers are still likely to receive low prices for their produce because the abundance of produce in the market will drive the market prices downwards. These low prices farmers receive could have dire consequences for their food security especially those without alternative livelihood source.

Though the agricultural sector continues to play a key role in job creation, these jobs have largely been in the rural areas. ISSER (2014) reported that majority of farmers in Ghana live in rural areas. Even though food is usually produced in rural areas, rural dwellers are more vulnerable to food insecurity than their counterparts in the urban areas due to low purchasing power (Gill et al., 2003). The Ghana Statistical Service District Analysis Report indicates that majority of farmers in North Tongu District are rural dwellers thus making them vulnerable to food insecurity (GSS, 2014a).

The standard of living among persons in the Volta Region is one of the lowest in the country. The Ghana Living Standards Survey 6 (GLSS 6) indicated that behind the three Northern regions, Volta

Region recorded the highest prevalence of absolute poverty with 9.8% of adults in the region being extremely poor. The report further stressed that household heads who are farmers are not just the poorest in Ghana, but also contribute the most to Ghana's poverty. Although the relative poverty level in the region was 33.8 in 2012/2013 (down from 37.8 in 2005/2006), this figure is still above the national average by some 9.6 percentage points. Whilst some regions showed remarkable progress with respect to equality in the welfare distribution, the Volta Region recorded a worsening distribution of welfare between 2005/06 and 2012/13 (GSS, 2014b). In a study to assess the spatial distribution of deprivation and income poverty among children using the fifths and sixth rounds of GLSS data, Kofinti and Annim (2015) found children in Volta Region to be the poorest in Ghana. These findings confirm the need for an improvement in the welfare situation for inhabitants of the region since poverty can limit the amount of resources available to a household and ultimately hamper their access to food. It is for these reasons that this study is carried out to access the effect of diversified income generating activities as a means of addressing food insecurity among farmers in the North Tongu District of the Volta Region.

Rice farmers are of interest in this study because of the important role rice can play in raising people out of poverty. Asuming-Brempong and Osei-Asare (2007) suggested that not only is rice an important staple food in Ghana but it is also possibly the most important cash crop in the communities where it is cultivated. The study contributes to the body of knowledge needed to address the problem of food insecurity by answering the question: Does income diversification influence household food security? The specific research questions are:

1. What factors affect rice farmers' choice of income diversification strategy in the North Tongu District?

2. What is the household food security status of rice farmers in North Tongu?
3. What effect does farmer's income diversification have on household food security?

1.4 Objectives of the study

The main objective of the study is to examine the effect of rice farmers' income diversification on their household food security. To achieve this, the following specific objectives were set out:

1. To determine the factors influencing the choice of income diversification strategy by rice farmers in the North Tongu District
2. To estimate the food security status of rice farmers' households
3. To estimate the effects of rice farmers' income diversification on household food security

1.5 Relevance of the study

Several factors influence a farmer's decision to diversify his income but the relative importance of each factor differs from one area to the another. Those factors found to be statistically significant in the study deserve particular attention due to their importance in the area since they play some role in the growth of rural income and hence farmer wellbeing. Findings from this study will therefore give policy makers a focal point. If farmers derive their income largely from crop diversification, then research into the limitations that prevent some farmers from diversifying deserves better attention. And if non-farm diversification in particular leads to better food security, then helping farmers explore the non-farm opportunities in the area through initiatives like business training should be a priority.

Food security status can be used as an indicator of individual wellbeing. Therefore, knowing the food security status of rice farmers' households can help policy makers to measure the effectiveness of programmes put in place to address welfare needs of these farmers. This can be achieved by comparing the food security status of households before and after the specific intervention.

1.6 Organization of the thesis

The rest of the thesis is organized as follows: Chapter two reviews literature on related studies. Chapter three presents the methodology and it covers a profile of the study area, sampling procedure, theoretical framework and methods of analysis of the specific objectives. The fourth chapter is devoted to the results of the data analysis and the discussion of the results. Chapter five summarizes the key findings from the study, draws conclusions and gives policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on studies conducted in the field of income diversification and food security that are of relevance to this study. The first part deals with the evolution of food security as a concept and how it is measured. The second section deals with the concept of livelihood diversification, highlighting the approaches of diversification reported in literature. Also found in this chapter are empirical studies on determinants of income diversification as well as an overview of econometric model for estimating the determinants of diversification.

2.2 Evolution of the concept of food security

As a concept, the definition and operationalization of food security has varied over time because of its multi-sectoral and multi-disciplinary nature. According to Jones et al. (2013), measuring food availability at the national level existed as far back as the post-world war 1 era long before the concept of food security even came into being. The quantity of food available to a country then was estimated on the supply-side by measuring kilocalories of all food stuffs both produced within a country and that imported. The term food security was birthed in the 1970s with food availability as its fundamental component. Sen (1981) argued that food availability alone was not enough for measuring food security and that under adverse conditions, poorer folks in a country might not be able to afford food in spite of its sufficiency at the national level. It was for this reason that the 1974 definition of food security which focused on food availability was revised in 1983 to include both economic and physical access to food (FAO, 1983).

The scope of food security kept evolving as contentions arose over unequal food distribution and access to food not just within countries, but also in individual households. Around the same time, eliminating primary micro nutrient deficiency gained importance hence shifting attention from caloric intake to diet quality. Utilization therefore became a third component of food security (Jones et al., 2013). Utilization addresses the differences in food allocation within households, the dietary quality of the food, and disparity in the level to which the different nutrients in food are absorbed and processed by the different persons in a household (Jones et al., 2013). It was on this premise that the 1996 World Food Summit came out with what has now become widely accepted definition of food security; when everyone has physical and economic access to adequate and safe food all the time in order to meet their nutritional and dietary needs so they can live a healthy life (FAO, 1996). The definition above encompasses the four domains of food security; 'availability', 'access', 'utilization' and 'stability'.

The main emphasis of the 'access' pillar of food security is that individuals should be able to get socially and culturally acceptable food in an acceptable manner. Jones et al. (2013) referred to the first three pillars (availability, access and utilization) as the necessary conditions for food security while the last one (stability) which stresses on the need for these three conditions to be met at all times is the sufficient condition. If any of the above pillars is unmet, then food insecurity exists. The FAO (2008b) report indicated that food insecurity is sometimes classified as chronic or transitory, though time frames for these two extreme categories of food insecurity have not been clearly defined (Hart, 2009). Between these two classes of food insecurity lies a third, known as seasonal food insecurity. The decision to use the term 'food security' rather than 'food insecurity'

in discussions depends on the point from which one is arguing and the manner in which the metrics and scales chosen are constructed (Jones et al., 2013).

2.3 Measuring food security

A search through the literature reveals that over the years, food security measures have focused on availability, access, utilization of food or the stability of food security in itself over time, or a blend of some of these pillars. Depending on the kind of data set available, be it national, regional, household or individual, the metrics have varied from one indicator to another. At the round table on measurement of hunger at the FAO headquarters in Rome in 2011, the Committee on World Food Security (CFS) recommended a set of indicators of food insecurity (FAO, 2016a). These indicators cut across all the dimensions of food security and have been used by various organizations of the United Nations including the WHO, UNICEF and the FAO. Examples of these indicators classified according to the four domains of food security as reported by FAO (2016a) are presented below:

Availability: Average protein supply, average dietary energy supply adequacy and average value of food production

Access: Percentage of paved roads over total roads, domestic food price index as well as prevalence of food inadequacy.

Stability: Domestic food price volatility, per capita food supply variability as well as cereal import dependency ratio.

Utilization: Percentage of children under 5 years who are underweight and prevalence of anaemia among pregnant women.

In order to build a comprehensive food security information system to facilitate comparison of the food security situation across countries/regions, the FAO hosts data on these indicators in a single database on their website.

The decision on which tool to choose depends on the intended purpose of the study and an understanding of the underlying constructs the tool in question measures (Webb et al., 2006). Jones et al. (2013) suggested that choosing a wrong tool comes with its own consequences such as measuring a wrong domain, measuring different domains together which are ambiguous and so difficult to interpret, collecting data that is irrelevant to the intended audience or selecting a metric which requires so much resources than the study can support.

2.3.1 Country-level metrics

Jones et al. (2013) and FAO (2001) suggested that country level measurement tools more often than not focus on food availability at the national level. A typical example is Food Balance Sheet, a tool that measures food availability by aggregating the supply and utilization of food to a nation. Supply in this context refers to the quantity of food both imported and the quantity produced domestically while utilization refers to quantity of food exported, fed to livestock as feed, processed as food and for non-food uses, lost in the process of storage/transport as well as what is used as seed. FAO (2001) reckoned that food supply and utilization are helpful when it comes to estimating food shortages and making projections at the national level with a strong assumption that the mean distribution of calorie consumed by the entire population matches the average supply of dietary energy. That assumption is not practicable since no reliable data on food losses and food distribution are usually available especially in the context of developing countries. Even in

developed countries like the USA where records are comparatively available, there have been big differences between the number of households estimated to be insecure estimated using the food balance sheet and the estimates made by USDA using projected calorie consumption estimates of different income groups in addition to the aggregated food supply data (Barrett, 2010; Shapouri et al., 2009).

National level estimates of food security are very useful when comparing the food security situations of different countries but Jones et al. (2013) argued that the type of data and reliability of data sources as well as the assumptions underlying the computation of the food security will tell the accuracy of the estimates. It is for this among other reasons that the FAO nowadays issues a set of indicators alongside its estimates of prevalence and undernourishment data. These tools measure variations of the dietary energy supply and undernourishment (such as share of energy supply obtained from cereals and roots/tubers) in addition to information on food prices making use of country-level data on food deficits, inflation rates and purchasing power parities (FAO, WFP & IFAD, 2012). In order to address the reliability and other challenges associated with comparing food security data across countries, the FAO, collaborating with the World Bank came up with ADePT-Food Security Module (FSM) which is a stand-alone software that helps the consistency and quality of food security data obtained from Household Budget Surveys and National Household Surveys (FAO, 2016b).

2.3.2 Household level metrics

As argued by Sen (1981), food availability at the national level might not necessarily translate into food security at the household and individual level hence the need for metrics that suitably capture

the households access and utilization in addition to availability. Household Consumption and Expenditure Surveys (HCES) is one such tool that is suited to estimating household level food security. In HCES, information on food expenditures are usually based on the monetary value of the quantity of food the household has acquired. HCES usually works with the assumption that the quantity of food acquired by a household equals the quantity of food the household consumes (Jones et al., 2013). Though HCES are relatively easy to obtain and also less time-consuming, the above assumption could be problematic as not every food acquired by the household might be consumed. Some of the food acquired might be given to livestock as feed while others might be given out as gifts to non-household members or even wasted.

One indicator that is often used by the World Food Programme to assess food security level in regions is the Food Consumption Score (FCS). It is a composite score that is based on dietary diversity, food consumption frequency and relative nutritional relevance of different food groups over a 7-day recall period (Kennedy et al., 2010). Studies conducted in different parts of Africa proved a positive correlation between FCS and daily per capita kilocalorie consumption, total household expenditure on food as well as asset indices (World Food Programme, 2007). However, one challenge with the use of FCS is that even though the food group weights and food consumption group thresholds are standardized, they are based on some intrinsically subjective choices. Jones et al. (2013) argued that regardless of the fact that the standardization of cutoffs and weightings in the FCS makes it easier to directly compare the score across different settings, these same weightings may conceal essential national or regional dynamics. For instance, in areas where vegetables and fruits are relatively difficult to access by some households, consumption of these food groups may reflect better economic access to food and consequently food security. However,

the relatively small weight assigned to fruits and vegetables in the FCS computation may mask this very fact.

Yet another metric that has gained momentum over time is the Household Dietary Diversity Score (HDDS). In their respective studies, Kennedy (2009) as well as Hoddinott and Yohannes (2002) emphasized the importance of dietary diversity as an important outcome measure of food security at the individual or household level. Dietary diversity is a qualitative measure of food consumption that tells a household's access to a variety of foods (Kennedy et al., 2013). It is a reflection of both food availability and food access in the sense that a household will consume a variety of food groups when there is the means to acquire them (Kennedy et al. 2010; Swindale and Bilinsky, 2006). An increase in dietary diversity has proven to be associated with socio-economic status and household food security (Hoddinot & Yohannes, 2002; Hatloy et al., 2000). When used to measure the individual dietary diversity rather than that of the entire household, the score reflects nutrient adequacy (Kennedy et al., 2013). The HDDS as a tool is simple to use and requires relatively less capital investment plus minimal enumerator training. One challenge with the use of HDDS has to do with the recall period. Critiques have raised concerns that the frequently used 24-hour recall period is too short. In a validation study on the HDDS as an indicator for food access however, Kennedy (2009) dispelled such doubts as the author found no significant difference in the scores while using both the 1-day and 7-day recall periods. The author observed that the 1-day recall brought more accurate results since the possibility of recall bias was relatively minimal.

2.3.2.1 HDDS versus the Daily Caloric Method

Jones et al. (2013) argued that while providing vital information, the caloric measurement is quite time-demanding and requires high enumerator capacity since data on the actual quantities are needed for that. There is also a high possibility of recall bias as respondents will generally find it difficult to recall exactly how much food was consumed over the recall period. While the HDDS takes into consideration all kinds of foods consumed, the recommended daily calorie approach ignores some food groups consumed as it usually deals with a few staple foods.

2.3.2.2 HDDS correlation with other indicators of food security and socio-economic variables

A number of studies have been conducted in different places to validate the dietary diversity score as a tool for measuring food security by comparing the scores with other socioeconomic indicators of food security. Rah et al. (2010) and Thorne-Lyman et al. (2010) found dietary diversity to be associated with household food and non-food expenditures. Hoddinott and Yohannes (2002) also reported a positive association between dietary diversity and per capita daily calorie available. Anzid et al. (2009), Rashid et al. (2006) as well as Hatloy et al. (2000) all argued in favour of a positive relationship between dietary diversity and household assets, education and the total income of the household. A study in Mali by Torheim (2003) revealed a positive relationship between dietary diversity and education. Kennedy (2009) also reported household asset index to have a positive association with dietary diversity in Lao People's Democratic Republic.

2.4 The concept of livelihood diversification

According to Ellis (2000), livelihood diversification is a process by which rural households create more and more varied set of assets and activities so as to survive and improve upon their standard of living. Though related, income diversification and livelihood diversification do not mean the same thing. Ellis (1998) argued that livelihood refers to a relatively broader concept, comprising of income (both cash and in-kind), the social institutions, gender relations, and property rights that are needed to maintain a sustained standard of living. Income however is comparatively narrower in scope as it refers only to a household or an individual's earnings, be it cash or in-kind that can be valued at a market price. Thus, income diversification is a subset of livelihood diversification. Ellis (1998) again distinguished income diversity from income diversification. He argued that whereas income diversity refers to the composition of a household/individual's incomes at a given time, income diversification is an active social process whereby households/individuals are observed to engage in different sets of activities over time.

2.5 Approaches to livelihood diversification

Three approaches to the conceptualization of livelihood diversification have been identified throughout the literature; asset approach, activity approach and income approach.

2.5.1 Asset approach

Assets in this context are the resources an individual/household owns. They can come in the form of capital, land or machinery which could either depreciate or appreciate with time. Barrett et al. (2001) argued that assets could be productive or unproductive. Whereas productive assets refer to human capital and land that are deployed to generate income, unproductive assets are luxuries not

used in income generation. Thus, the disadvantage of using the asset approach is that not every asset can be put into productive use. Barrett et al. (2001) and Reardon et al. (1998) further contended that finding the true value of some assets can be difficult if not completely impossible because the secondary asset markets in developing countries are not properly developed.

2.5.2 Activity approach

The activity approach looks into the manner in which the productive assets are put into use. For instance, as an asset, a fishing boat can either be used for fishing or for water transport to generate income. Using the asset approach also comes with some challenges. Barrett and Reardon (2000) pointed out that the activity to which assets are employed could be difficult to value. Also, there is the tendency to ignore the outcomes of unearned income sources.

2.5.3 Income approach

Unlike the other approaches discussed earlier, the income approach provides a more direct measure of diversification due to its clear interpretation as a welfare outcome. It has therefore been used in several studies on livelihood strategies (Idowu et al., 2010; Babatunde & Qaim, 2009; Lerman, et al., 2008). One reason why the income approach is widely used is due to the fact that for any activity or venture, income is the outcome. Barrett et al. (2001) and Ellis (2000) were both of the view that the primary motive behind diversification to a large extent is to maximize and/or stabilize incomes. Hence, it is relatively straightforward to measure diversification in income terms since payments in-kind can easily be converted into their equivalent monetary values.

2.6 Categories of income sources

Different studies have categorized income sources in different ways. Saith (1992) grouped income sources into 3; farm, on-farm and off-farm. Barrett et al. (2001), Barrett et al. (2000) and Barrett and Reardon (2000) however argued that though not appropriate, many studies have used these terminologies synonymously and hence called for some form of standardization of the terms. Barrett et al. (2001) recommended the use of standard national accounting sectoral classifications to address this confusion. On that basis, they proposed classification of income sources by sector, by function (wage employment versus self-employment) and by space (local versus migratory).

Based on the classification by sectors, income sources can be categorized into agricultural/farm incomes and non-agricultural/non-farm incomes. According to the Barrett et al. (2001) sectoral approach, agricultural/farm incomes are incomes earned from within the agricultural sector. It includes incomes from crops and livestock both in-kind and in cash as well as wages earned by working on other people's farms. Non-farm/non-agricultural income sources on the other hand are incomes earned from outside the agricultural sector such as non-farm wage employment and non-farm self-employment.

2.7 Reasons for diversification

Ellis (1998) reported that among other reasons, people diversify because of the seasonal nature of farming and in their attempt to reduce risks. Besides, Barrett et al. (2001), Barrett et al. (2000) and de Janvry and Sadoulet (1996) suggested that an individual or a household's decision to allocate resources into any non-farm venture depends on two variables; the 'incentive' to diversify as well as the 'capacity' to do same.

2.7.1 Capacity to diversify

Reardon et al. (2006) held the view that diversification may be as a result of the individual or household having the capability to draw incomes from multiple sources. By capacity, Reardon et al. (2006) referred to the capital assets like human, social, financial and political capital that an individual or a household may possess. These capital assets may come at the regional/community level (such as electricity, roads, market and other public goods) or at the individual level (which includes assets like land and other physical assets that a person may own).

2.7.2 Incentives to diversify

A search through the literature revealed incentive variables could be either 'push' or 'pull' factors. As suggested by Reardon et al. (2006) and Barrett et al. (2001), 'pull' factors could arise from the comparative advantage non-farm activities have over agriculture due to better technology. They include the relatively lower risks associated with non-farm activities and the higher returns these activities have over agriculture which draw persons to invest their resources in the non-farm sector in order to raise their incomes.

On the other hand, households/persons can be 'pushed' into diversifying outside of agriculture even if the ventures they are moving into have lower returns as long as they have relatively lower risks compared to agriculture. Reardon et al. (2006) named factors such as seasonal drops in farm income, agricultural credit market failures, pest/disease outbreak and unreliable rainfall pattern to be among factors that can 'push' farmers to consider going into non-farm ventures.

2.8 Determinants of income diversification

A search through the literature reveals individual, household, community and institutional factors among others influence a person's decision to diversify or adopt an income strategy. In a study to find factors that determine level of non-farm income diversification among households in Nigeria, Awoniyi and Salman (2011) found farm size, age of the household head, having formal education as well as being a male as significant factors. In analysing determinants of livelihood diversification choices using climatic, household socio-economic as well as community and institutional variables, Asfaw et al. (2015), found female-headed households, household size, level of education and wealth index to positively affect diversification. They however found credit access to be inversely related to income diversification.

While investigating the determinants of income diversification among farming households in Borno State, Nigeria, Ahmed (2012) reported that age, educational level of household head and ownership of assets influenced income diversification while household size, access to loan and marital status did not. Babatunde and Qaim (2009) found that households in rural Nigeria with little productive assets and those who were disadvantaged in terms of education and infrastructure were constrained in their ability to participate in more lucrative off-farm activities.

Using a Tobit regression model, Teshome and Edriss (2013) found that family size, extension visit and educational level had a positive and a significant effect over income diversification in Ethiopia whereas age of the household head, farm size and average distance from market had negative effect on decision to diversify. In another study by Idowu et al. (2014) in the Ogun State of Nigeria, the authors used crop diversification as a proxy for income diversification. They found that higher

educational level, larger farm size, household size, and farmers' participation in social group were drivers of income diversification.

From the above, one theme stands out; that these determinants of diversification and the manner in which they affect diversification vary from place to place. This present study therefore seeks to explore the factors that influence rice farmers' choice of diversification strategy in the study area as well as the effects of these strategies on their household food security.

2.9 Econometric model for determinants of income diversification

Depending on the scope of diversification that the study focused on, different studies have used different econometric models to estimate determinants of income diversification. Using the Probit model, Babatunde and Qaim (2009) estimated the determinants of participation in different off-farm activities. The authors disaggregated off-farm employment into agricultural wage employment, non-agricultural wage employment and self-employment, treating each of these activities as a dummy and then regressed the determinants of diversification on them in three different Probit models. Even though determinants of engaging in individual employment activities can be measured using the above approach, one notable shortfall is that the determinants of combining two or more activities (for instance self-employment with agricultural wage employment) cannot be ascertained using that method. As much as some respondents may be diversifying into just one of those activities, there are others who would have been engaged in multiple of these activities as their income portfolio. The factors that affect engaging in a combination of these activities might be different from those that drive engaging in one particular activity.

Man (2009) used Binary Logit model to measure the relationship between the decision to participate in off-farm activities and the determinants of participation. The use of the Logit model in the above study required that all activities that the individual engages in to constitute diversification irrespective of the sector be pooled together. This does not bring to light the factors that affect participation in some sectoral specific activities. It can be argued that factors that drive participation in agricultural related activities might not necessarily be the same as those that influence participation in non-agricultural activities hence the need for some form of disaggregation.

The use of the Multinomial Logit model has the advantage of addressing the above shortfall since the various strategies (whether single or combination of different activities) can be assigned separate categories. Therefore, determinants of activities within one sector or a combination of sectors can be ascertained since all possible strategies can be assigned separate categories. This approach was used by Wanyama et al. (2010) to assess the determinants of income diversification strategies in maize-farming households of Kenya.

The Multinomial Logit Model

Assuming Q_i is a random variable which represents an individual's choice among different alternatives, the assumption is that the individual is confronted with a set of discrete choices, all of which are mutually exclusive. This choice among other factors is dependent on characteristics of the community in which the person dwells, the person's household characteristics as well as the individual characteristics of the person making the choice (Malek & Usami, 2009). In dealing with

choice among several different alternatives, Greene (2000) suggests the use of Multinomial Logit model which specifies the probability associated with choosing option Q_i given the set of explanatory variables X_i. The model is specified as:

$$\Pr ob(Q_i = j) = \exp(x\beta_j / \left[1 + \sum_{k=1}^{J} (\exp x\beta_j) + \omega, j = 0,1,...,J\right] \quad 2.1$$

In the above equation, β_j denotes corresponding coefficients of the different explanatory variables X_i and ω is the random error term. Model 2.1 is normalized to address indeterminacy in the model. This can be done by assuming that $\beta_0 = 0$. The associated probabilities can be represented as

$$\Pr ob(Q_i) = j / x_i = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=1}^{J} e^{e\beta_k' x_i}}, j = 1.2...., J, \beta_0 = 0 \quad 2.2$$

Equation 2.2, when estimated, gives the *j* log-odds ratio

$$Ln\left[\frac{P_{ij}}{P_{ik}}\right] = x_i'(\beta_j - \beta_k) = x_i'\beta_j, if\ k = 0 \quad 2.3$$

Thus, the dependent variable becomes the log of any of the alternatives relative to the base. Greene (2000) holds the view that associating β_j with the *jth* outcome could be misleading. Also, since the estimated coefficients of the Multinomial Logit model are usually difficult to interpret, Greene (2000) suggested that the marginal effects which are the probabilities of the explanatory variables are rather interpreted. The marginal effect can be derived as follows:

$$\delta_j = \frac{\partial P_j}{\partial x_i} = P\left[\beta_j - \sum_{k=0}^{J} P_k \beta_k\right] = P_j(\beta_j - \bar{\beta}) \quad 2.4$$

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The methodology used in this study is presented here. The chapter includes an overview of the study area, the sampling procedure, the theoretical framework and the analytical techniques used to achieve the specific objectives.

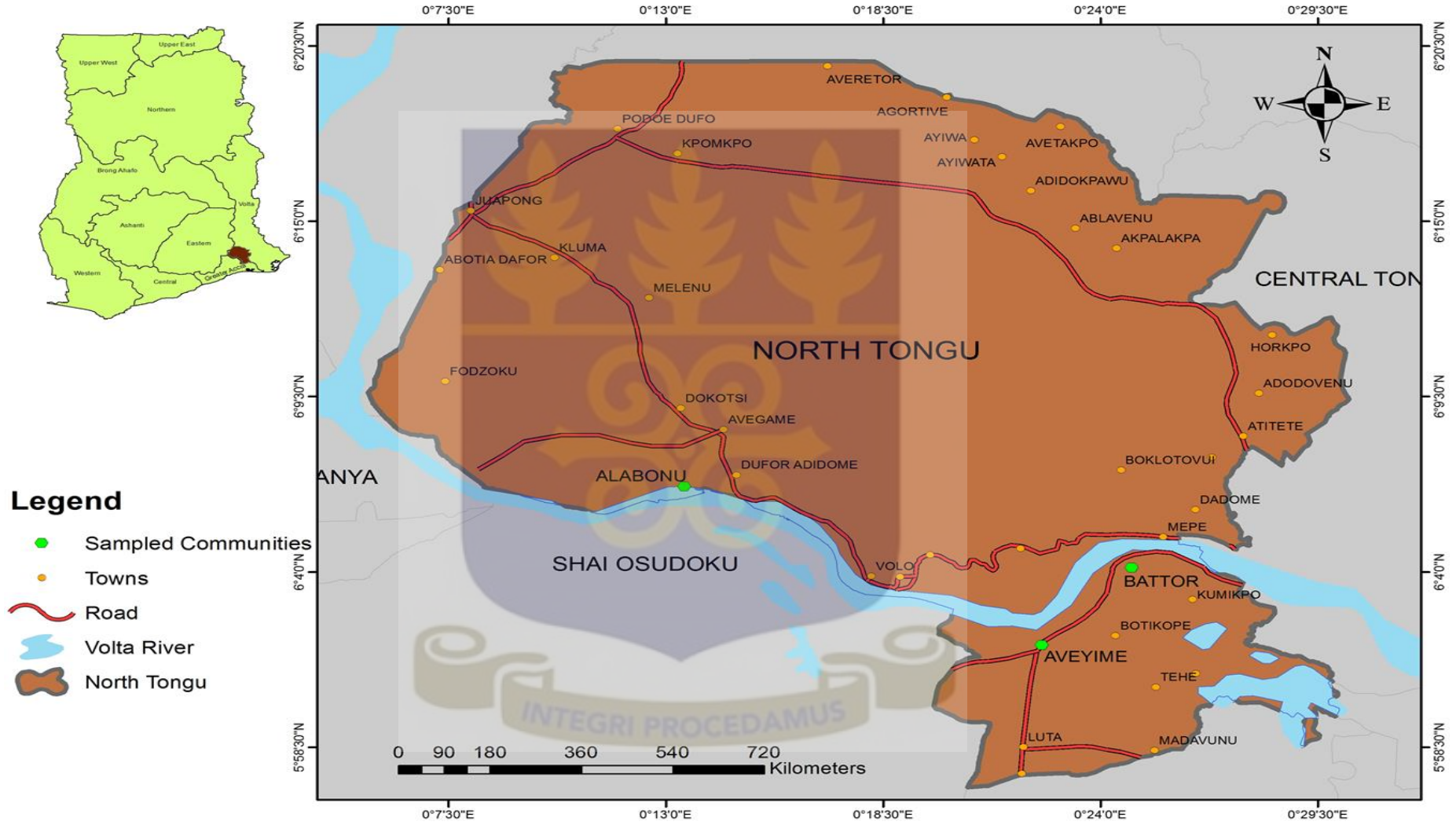
3.2 The Study Area

The North Tongu District is a new district carved out of the then North Tongu District which is now Central Tongu in 2012. It has a population of 89,777 with 52.7% of them being females. The district contributes 4.2 percent of the total population of the Volta Region and 0.4 percent of the total population of Ghana. Up to 55.7 percent of population are within the economically active age with more than 95 percent of them employed. The district is considered as more rural as around 60 percent of the inhabitants therein dwell in rural areas (GSS, 2014a).

Located in the Coastal Savannah belt, it experiences a bimodal rainy season leading to two main cropping seasons. Agriculture (mostly crop farming) is the mainstay of the district with more than 64 percent of households actively involved in it. Maize, cassava, groundnuts, cowpea, sugar cane, vegetables, oil palm, rice and mangoes are the main crops cultivated in the area. The district is endowed with vast land suitable for agriculture and continues to attract private investors into farming. Notable commercial farms operating in the area include Praire Volta Limited, Cassi Farms, Freshfields Farms Limited and VegPro Ghana Limited. These farms produce for the local market or for export and serve as a key source of employment for the people in the area through

direct employment or by engaging them as out-growers. The Aveyime area is particularly known to be suitable for rice production and plays host to Prairie Volta Limited and MOFA's Irrigation Development Authority (IDA) Project where rice is grown by individual farmers under an irrigation scheme (GSS, 2014a).

Sand winning in and around the Volta River which passes through the district is also an important means of livelihood for some inhabitants of North Tongu. Also present in the district is Volta Star Textile factory located in Juapong (GSS, 2014a). Figure 3.1 is a map of the study area.



Source: CERGIS, University of Ghana

Figure 3.1: Map of North Tongu District

3.3 Data collection approach

A cross-sectional data for major cropping season of 2015 (which covered March through to August) was collected from the selected rice farmers (who were respondents in this study) by administering a well-structured questionnaire in the area through the help of well-trained enumerators. The data covered information on income portfolios of the respondents, personal and household socio-economic characteristics as well as household food consumption. A pilot survey preceded the actual data collection to test for the reliability and appropriateness of the questions and expected responses. A revised form of the questionnaire after the pilot survey was used as the data collection instrument for this study.

Sampling procedure and sample size

Multistage sampling technique was used to obtain the sample of rice farmers for the study. It first of all involved the selection of Volta Region as the focal area. The region was purposively selected because aside the three Northern regions, Volta Region had the highest absolute poverty rate in the 6th round of the GLSS. Also, the region recorded a worsening welfare distribution (GSS, 2014b). Besides, studies on food security in Ghana have largely focused on the three Northern regions. The next stage involved the purposive selection of rice farmers as the target group. Besides being an important staple food in Ghana, Asuming-Brempong and Osei-Asare (2007) argued that rice is perhaps the most economically important cash crop within the communities where it is cultivated. Rice can therefore be an important crop in moving people out of poverty.

Next was the purposive selection of North Tongu District. North Tongu was selected because it is a key rice growing district in the region with evidence of presence of vibrant farm and non-farm

sectors which farmers can explore to improve their livelihoods. After this stage, the three-leading rice growing communities in the district (Battor, Aveyime and Alabonu) were purposively selected. A list of rice farmers was compiled from IDA project office in the area, out-growers of Prairie Volta Limited (a commercial rice farming company in the study area) as well as a Farmer Based Organization (FBO) in Alabonu. From a population of 464 rice farmers compiled, a sample size of 215 was computed using the formula $n = \frac{N}{1+N(e^2)}$ proposed by Yamane (1967), where n = Sample size; N = size of the population; e= significance level (0.05 for this study)

Finally, a simple random sampling technique was used to select 215 rice farmers within the 3 selected communities. The number of respondents selected from each community was based on the proportion of rice farmers from the community in the list compiled; 54 respondents from the Alabonu area and 161 from the Battor-Aveyime area. The study however ended up with 204 respondents for the analysis as some questionnaires had to be taken out during data cleaning for the purposes of data quality.

3.4 Theoretical framework

Applying the Random Utility models tradition as used by Train (2003) and Babulo et al. (2008), the rice farmer's activity choice model assumes that farmers maximize their utility. Assume a rice farmer. n (n=1,..., N) has to make a choice among J different strategies. Let U_{nj}, j = 1,..., J represent the utility that farmer n obtains from alternative strategy j. The farmer will choose alternative j if and only if he derives a relatively higher utility from that strategy. This can be mathematically represented as $U_{nj} > U_{ni}$, $V_j \neq i$. Based on the Random Utility Theory, the utility (U_{nj}) that a farmer attains from alternative j can be decomposed into two components V_{nj} and ε_{nj}, where V_{nj} is that

aspect of U_{nj} resulting from the observed characteristics of the alternative strategies, labelled X_{nj} $\forall j \neq i$, and some household specific attributes, H_n, while ε_{nj} is a random error term which reflects innately random choice behaviours, specification or measurement error as well as attributes of the alternatives that affect the utility (U_{nj}) that are unobserved but are not captured in V_{nj}. The utility function can be expressed as follows as:

$$\left.\begin{aligned} U_{nj} &= V_{nj} + \varepsilon_{nj} \forall j \\ &= V(X_{nj}, H_n) + \varepsilon_{nj} \end{aligned}\right\} \qquad 3.1$$

Since there are 4 alternatives of income strategies in this study, let P_{nj} (j=1-4) represent the probability associated with the choice of income strategy farmer n makes with j=1 if the farmer chooses 'R strategy' (no diversification), j=2 if the farmer chooses the 'RA strategy' (Rice and other agricultural incomes strategy), j=3 if the farmer chooses the 'RN strategy' (Rice and non-agricultural incomes) and j=4' if the farmer chooses 'RAN strategy' (Rice plus other agricultural and non-agricultural incomes) as his means of livelihood. The probabilities associated with choosing either of the above income strategies can be estimated using the Maximum likelihood estimation method.

3.4.1 Method of analysis of the factors influencing the choice of income diversification strategy by rice farmers

By income diversification, this study implies engaging in other income-generating activities in addition to the rice farming in order to earn extra income. While some farmers may depend entirely on only one enterprise for their income, others might be earning their incomes from a combination of various sources. Thus in estimating the determinants of choice of income diversification strategy among rice farmers, the respondents were grouped into four categories based on their choice of

income strategy using Barrett et al. (2001) sectoral approach: Those who get all their incomes from rice farming only (R strategy); those that obtain their incomes from rice farming as well as other farm/agricultural-related activities (RA strategy); those that jointly combine their rice farm incomes with non-agricultural income sources (RN strategy); and those that rely on a combination of all the above sources for their incomes - agricultural and non-agricultural sources to augment their rice farm income (RAN income strategy). A detailed explanation of the four income portfolios is presented below.

Income strategies adopted by rice farmers

Rice farm income only (R Strategy): This group comprises farming households that rely solely on rice farming for income and neither grow other crops nor engage in other livelihood activities aside rice farming. Farmers who chose this income portfolio did not diversify their incomes.

Rice farm income plus other agricultural sources (RA Strategy): This group of rice farmers derive their livelihood from within the agricultural sector. Included in this group are rice farmers who combine all or any of the following income-generating activities in addition to their rice cultivation: Growing other crops; keeping livestock; fishing and/or investing in fishing-related activities (such as renting out fishing equipment for income); seeking farm wage employment either in commercial farms or farms belonging to other persons to gain income.

Rice farm plus Non-agricultural income (RN Strategy): This group of respondents are those who in addition to their rice farming engage in other income-generating activities not within the agricultural sector. This includes non-agricultural wage employment, non-agricultural self-employment of any kind, owning a shop, engaging in trade, and earnings from artisans among others.

Rice farm plus other agricultural and non-agricultural incomes (RAN Strategy): This category is made up of rice farmers who simultaneously earn incomes from all the above sources thus, within the agricultural sector as well as the non-agricultural sector.

Multinomial Logit model

The Multinomial Logit model can be used to estimate the probabilities associated with choosing each income strategy. Multinomial Logit model is deployed when the response variable is categorical and for which there are more than two categories just as in this study. The unordered multinomial logit model is appropriate because the different income strategies deployed by rice farmers in the study are nominal in nature and do not have any natural order. Assuming identical and independent distribution of the unobserved portion of the utility across all the options and following Babulo et al. (2008), the Multinomial Logit can be represented by:

$$P_{nj} = \frac{e^{(\beta' X_{nj} + \gamma' H_{nj})}}{\sum_{j=1}^{4} e^{(\beta' X_{jj} + \gamma' H_{nj})}} \qquad 3.2$$

Setting the β's and γ's to zero for 'Rice income only' strategy (R) which will be used as the base category, the Multinomial Logit for each strategy (j≠ strategy R) can be represented as

$$P_{nj, j\neq 1} = \frac{e^{(\beta' X_{nj} + \gamma' H_{nj})}}{1 + \sum_{j=2}^{4} e^{(\beta' X_{nj} + \gamma' H_{nj})}} \quad (j=2,3,4) \quad \text{and} \qquad 3.3$$

$$P_{n1} = \frac{1}{1 + \sum_{j=1}^{4} e^{(\beta' X_{nj} + \gamma' H_{nj})}} \qquad 3.4$$

The above equation can be estimated using maximum likelihood method. The H_n and X_n are pooled together under broad 'asset-based' variables.

The explicit form of the model is specified as below

$$P_{ij} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots + \beta_{13} X_{13} + \varepsilon \quad 3.5$$

$$P_{ij(j=2,3,4)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots + \beta_{13} X_{13} + \varepsilon \quad 3.6$$

where P_i = Probability of a farmer choosing income strategy j and 'j' is any of the four (4) available income strategies a rice farmer can choose.

β_0 = constant term

β_k = coefficients

X_i = the set of independent variables hypothesized to affect the choice of income diversification strategy and are explained in the Table 3.1

ε = error term

In determining the factors influencing choice of income diversification strategy, the "Rice income only" category (R strategy) will be set as the base category for the analysis since this group did not participate in income diversification. Rice farmers in all the other three categories diversified their incomes.

Table 3.1: Apriori expectation of variables used in the Multinomial Logit model

Variable	Description	Measurement	A priori Sign
X_1	Age of rice farmer	Years	+/-
X_2	Educational background of farmer	Years of education	+
X_3	Gender	1=male 0=female	+/-
X_4	Whether respondent is household head or not	1=Household head 0=otherwise	+
X_5	Household size	Number of persons	+
X_6	Rice farm size	Hectares	+/-
X_7	Rice farm income	GHS	-
X_8	Income saved	GHS	+
X_9	Perceptive availability of opportunities in the area	1= yes 0=no	+
X_{10}	Employable skills	1= yes 0=no	+
X_{11}	Access to rice farm credit	1= yes 0=no	-
X_{12}	Assets owned	GHS	+
X_{13}	Total household expenditure on food	GHS	+

3.4.2 Justification of independent variables used in the Multinomial Logit Model

Age (X_1): Respondents' age was measured in number of years and it is a continuous variable. Ability to take up an additional job can be influenced by the age of the farmers. There are arguments on either side. Lay and Schuler (2008) reported a positive relationship between age and diversification. Older farmers, in their quest to meet the needs of their relatively larger household sizes would more likely partake in additional jobs to supplement their income than younger farmers who generally have a relatively smaller household size. Newman and Canagarajah (2000) on the other hand argued that as an individual advances in age, he is less likely expected to diversify. The authors were of the opinion that younger farmers are more enthusiastic and energetic in terms of adoption and so will more likely engage in extra income-generating activities than older

farmers who are more or less tied to their traditional ways of farming, therefore, slow to try new things. As a result, this variable could either be positive or negative.

Educational status (X_2): This variable was measured in number of years spent in formal education. Formal education opens up opportunities for an individual to participate in both farm and non-farm activities (Yunez-Naude & Taylor, 2001). Lay and Schuler (2008) also found correlation between primary/secondary education of household heads and partaking in local non-farm activities. According to Jolliffe (2004), schooling has a negative effect on income from agricultural self-employment, although it has a positive impact on entire income and income earned from off-farm activities. Barrett et al. (2001) also reported a positive relationship between education and non-farm income. This study therefore expected a positive association between income diversification and education.

Gender (X_3): Gender was measured as a dummy; males were scored '1' while females were assigned '0'. The kinds of economic opportunities and assets that are available to men and women are not often the same (Quisumbing, 2010). Consequently, men are more likely to participate in certain activities than women and the vice versa. Demi et al. (2013) found that the relatively higher proportion of dependent individuals in female-headed households affects their households' ability to allocate labour to on-farm or other off-farm income-generating activities. Relatively limited skills and low level of education of women can limit their chances of getting some income generating activities outside the circles of agriculture. Hjelm and Dasori (2012) however argued that females usually do not have access to larger farm lands and that this will more likely compel them into engaging in other non-farm income generating activities so that they can keep up with

the food needs of their households. Therefore, the gender variable could yield either a positive or a negative response.

Household head (X_4): This study defined a household head by the GSS (2014a) criteria as the person who has economic and social responsibility for the household. Being a household head implies additional responsibility of having to cater for the needs of the household members. Farmers who are heads of their respective households are therefore expected to diversify their incomes by engaging in extra income-generating activities. Hence, a positive relationship with diversification was expected for this variable.

Household size (X_5): Household size was measured by counting the number of persons living in the household with the same household head. Large household size means increased food requirement which will in turn compel the farmer to diversify his income sources in order to meet these needs. Also, Joshi et al. (2004) argued that households with more working-age persons participate in income-generating activities more. Bigger households are more likely to contain more persons who are within the working-age and who engage in altogether different activities implying diversification at household level. This variable is therefore expected to yield positive relationship with income diversification.

Rice farm size (X_6): Farm size is a continuous variable measured in hectares. Farm size can be an indicator of social status of the respondents. Rahman (2013) found it to be positively related to participation in off-farm income-generating activities. Man (2009) on the other hand argued that because larger farm sizes reflect good asset holding and social status, persons with larger rice farm

size are less likely to engage in income diversification. For that reason, a positive or negative relationship is likely.

Rice income (X_7): The amount of income a person earns from growing rice can influence the decision to pursue other sources of income or not. If a farmer makes high returns from rice farming, it could be a motivation to intensify the rice cultivation and not diversify. On the other hand, low incomes from rice farming could also serve as a 'push' factor that will lead the farmer to try other non-farm activities. A negative or positive relationship is therefore possible for this variable.

Income saved (X_8): The study took data on the amount of money saved by the farmers during the major season of 2015. Savings can serve as capital to enter into non-farm ventures. In the absence of credit, a farmer who has saved some substantial amount will be able to draw upon his savings to invest in other enterprises. A positive relationship with income diversification is therefore hypothesized.

Perceptive availability of opportunities in the area (X_9): The perceived availability of paid job and other income-generating opportunities in an area can influence the decision of the people to exploit it. For example, if one perceives that there are firms operating within the area, he will be more likely to seek wage employment there to augment their income than a person who perceives otherwise. This variable was measured based on individuals' perception; '1' for respondents who perceive there are paid job and other opportunities in the area and '0' for otherwise.

Employable skills (X_{10}): This variable was measured by asking the respondents whether they possessed any special skills that could earn them employment or help them to exploit other income-generating activities apart from farming. The amount of skills a person is endowed with can either create employment for him/her or make him/her eligible to access opportunities. These skills can either be acquired from birth or may be learned from schooling or by other means. For instance, a person who can drive a car is more likely to take up an additional job of driving alongside his farming. Any individual who has employable skills has a high tendency to put his skills to use by seeking additional wage employment or self-employment aside the rice farming. A positive relationship is expected for this variable.

Access to rice farm credit (X_{11}): If a farmer receives credit to invest in his rice farm, then he will most likely intensify his rice cultivation rather than diversify. Access to rice farm credit was measured using a dummy; "1" when the household received a formal credit in the last cropping season for his rice farm and "0" if otherwise. A negative relationship was thus expected for the rice farm credit variable.

Ownership of assets (X_{12}): The assets available to a farmer can determine his ability to enter into farm or non-farm income diversification. For instance, the ownership of an outboard motor powered boat implies that the farmer has the capacity to diversify. He can earn additional income by deploying it for water transport. Babatunde et al. (2010) also opined that household productive assets have a positive relationship with participation in off-farm work. Bryceson (1999) indicated that even though households with less assets can allocate a vast share of their times to off-farm activities, they earn relatively low wages from these activities. The opposite is true for the upper

income strata households who make relatively higher shares of their total income from off–farm activities. A positive relation with income diversification was the expectation.

Total expenditure on food (X_{13}): The amount of money a household spends on food monthly can influence the decision to engage in other income-generating activities. The expectation here is that a farmer whose household spends more on food would be willing to explore other income-generating avenues so as to meet the food needs. Therefore, a positive relationship is expected.

Hypotheses

a) H_o: Educational background of a rice farmer has no effect on the choice of income diversification strategy.

   H_a: Educational background of a rice farmer has a positive effect on the choice of income diversification strategy.

This hypothesis will be repeated for the following variables: Age; Gender; Household size; Household head; Rice farm size; Income saved; Perceptive availability of opportunities in the area; Employable skills; Total expenditure on food; and Asset base

b) H_o: Access to rice farm credit has no effect on a rice farmer's choice of income diversification strategy.

   H_a: Access to rice farm credit has a negative effect on a rice farmer's choice of income diversification strategy.

This hypothesis will be repeated for Rice farm income variable.

3.5 Methods of analysis of the other specific objectives

In estimating the food security status of the respondents' households, the household dietary diversity scores (HDDS) was used. Then, the effects of income diversification on household food security was explored using the Poisson regression.

3.5.1 Estimating the food security status of rice farmers' households

Considering the direct link between income and economic access to food, the study focused on the 'access' pillar of food security as this study is on income diversification. Food security of rice farmers' households of was measured using the Household Dietary Diversity Score (HDDS). Developed by the Food and Nutrition Technical Assistance (FANTA) Project, the HDDS serves as a proxy indicator for household access to food by measuring food consumption qualitatively. Dietary diversity can be used to collect information either at household or individual level. According to Swindale and Bilinsky (2006), the household dietary diversity score reveals in a glimpse a household's economic access to food variety while the individual dietary diversity score (IDDS) reflects an individual's nutrient adequacy. According to Kennedy (2009), decision on which level to collect information (whether individual or household) rests on the purpose and objectives of the study. This study chose to collect data on household level because of the belief that the food security of the farmer is dependent on the food security situation of his household. Also, since household members are likely beneficiaries of the farmer's production through cash and/or direct food produce contribution, it is appropriate to collect data on the household level even though the primary focus of the study is the individual farmer's livelihood strategy.

Collecting data on dietary diversity is fairly straightforward, requiring less complicated training of field staff. There is also less possibility of recall bias on the part of the respondent since the

reference period is only 24 hours. Hoddinot and Yohannes (2002) argued that household dietary diversity is a preferred proxy indicator because a more diversified diet is known to be very much correlated with factors like caloric and protein adequacy, consumption of high quality protein (animal source protein), as well as household income. Furthermore, an increase in food expenditure as a result of rising incomes (even in the case of poor households) is associated with increase in both diet quantity and quality. A more diversified diet is also associated with a number of improved outcomes in areas such as birth weight, child anthropometric status, and improved haemoglobin concentrations.

The respondents were asked to describe the different food items (meals and snacks) they or any member of their households had consumed over the recall period. This included all foods prepared at home and consumed either at home or outside home but excluded foods that were bought and consumed outside home. Respondents were also asked to provide information on the different ingredients used to prepare composite foods (mixed dishes which contain ingredients belonging to different food groups). Small quantities of food items consumed were captured because the HDD score is designed to reflect economic access to food. As such, even small quantities of a food item reflect some ability to purchase since household resources were used to acquire them.

The score was constructed by counting the different food groups consumed by the household or an individual over the preceding 24 hours. The FAO has a preferred list of 12 reference food groups used for computing the household dietary diversity scores. In generating the scores, the expanded set of food groups (used in the questionnaire) were combined back into the original 12 FAO food groups. The reference food groups used are presented in Table 3.2.

Table 3.2: Food groups used to compute the household dietary diversity scores

Group Number	*Food group*[1]	Description/Examples of *food items*[2]	Question Number(s)
1	Cereals	Maize, rice, wheat, sorghum, millet or any other grains or foods made from these (such as bread, noodles, porridge)	1
2	Pulses/legumes	Dried beans, dried peas, groundnuts, nuts, seeds or foods made from these	12
3	Vegetables	Tomato, onion, carrot, leaves	3,4,5
4	Fruits	All fruits including 100% fruit juice	6,7
5	Roots and tubers	Cassava, yam, cocoyam	2
6	Meat and poultry	Beef, chicken	8,9
7	Eggs	Poultry eggs	10
8	Fish and seafood	Fresh or dried fish or shellfish, oyster, lobster	11
9	Milk and milk products	Milk, cheese, yogurt or other milk products	13
10	Oils and fats	Oil, fats or butter added to food or used for cooking	14
11	Sweets	Sugar, honey, sweetened juice drinks, sugary foods (chocolates, candies, cookies and cakes)	15
12	Condiments[3], spices	Spices, condiments (soy sauce, hot sauce), coffee, tea	16

Source: Kennedy et al. (2013)

[1] **Food group** is a group of food items with similar nutritional and caloric qualities.

[2] A **food item** cannot be separated further into distinct foods. That notwithstanding, *fish* or *poultry* and other generic terms are considered to be food items for sake of this analysis.

[3] **Condiments** denote foods that are usually consumed in very small quantities for instance for the purpose of flavour such as a teaspoon of milk in coffee or a 'pinch' of curry powder.
Source: World Food Programme (2007)

Following the recommendation of Swindale and Bilinsky (2006) along with the approach by Birhane et al. (2014), tertiles were created using the mean HDDS for the sample and standard deviation. The results are presented using tables and graphs and tables. Cross-tabulations were also done to bring out some further meaning.

3.5.2 Estimating the effects of rice farmers' income diversification on household food security

3.5.2.1 Theoretical background

The relationship between income diversification and food security falls in the domain of Sustainable Livelihood Framework. The Sustainable Livelihood Framework by Scoones (1998) and DFID (1999) shows how sustainable livelihoods can be realized in different contexts through access to a diverse livelihood resources (natural, economic, human and social capitals). Different livelihood strategies can be pursued by combining these resources to yield sustainable livelihood outcomes. The choice of livelihood strategy is influenced by certain organizational and institutional factors that affect a household/individual's access to resources.

The Sustainable Livelihood Framework by DFID (1999) identifies food security as an outcome of livelihood strategy because the household's access to food depends on its ability to generate income. Many studies in the context of developing countries have reinforced the importance of income generation in determining access to food. Even subsistence farming groups in developing African countries are known to be net purchasers of food, highlighting further the significant role income generation plays in determining food access (Benson et al., 2008). As incomes rise, poor households spend more on food (albeit proportionately less than the corresponding rise in income).

These households purchase a more diverse variety of foods, and shift to higher quality foods with greater nutritional value (Hoddinot & Yohannes, 2002). Hence, we can say that food security depends on the choice of income strategy adopted.

Applying the above to this study, the relationship between food security and income strategy can be represented mathematically as:

$$Food\ \ Security = f(Income\ strategy)$$

The income strategies of the farmers can thus be regressed on their household food security using an appropriate econometric model in order to estimate the effects of income diversification on household food security.

3.5.2.2 Model specification

In modeling the effects of income diversification on household food security, the Poisson regression model was used. The number of different food groups consumed represented by the HDDS is the measure used for household food security in this study (dependent variable). Since it is a discrete variable, it is appropriate to use a model for count data based on a Poisson distribution. Following Fontana et al. (2006) along with Greene (2000), the study defines y_i as the number of food groups consumed by the household i in the past 24 hours leading to the survey (where i=1,2,…,12). The variable y_i is assumed to be distributed as a Poisson distribution with parameter λ_i given as:

$$P(Y_i = y_i) = \frac{e^{-\lambda} \lambda_i^{yi}}{y_i!} \qquad 3.7$$

where λ_i can be specified by a vector of covariates X_i that includes the variables in Table 3.3.

More often than not, λ_i is log linear function which assumes the form:

$$\ln \lambda_i = \beta_i x_i \quad 3.8$$

The log linear model guarantees that the number of food groups consumed by the household is a non-negative integer and is given as:

$$E(y_i \mid x_i) = \lambda_i = e^{\beta_i x_i} \quad 3.9$$

The empirical model is given as:

$$\lambda_i = E(y_i \mid x_i) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_{11} X_{11} + \varepsilon \quad 3.10$$

Where y_i is the number of food groups consumed by household i over the reference period, β_0 is the constant term, β_i are the coefficients, X_i is the set of explanatory variables in Table 3.3 and ε is the error term

Generally, two main issues arise when dealing with Poisson models. The first usually arises when the data contains 'excess zeros'. This occurs under distributional assumptions when the data generating process has a large number of zeros. A data set is said to have 'excess zeros' when the sample contains observations with an actual score of zero and also observations of non-occurrence. For example, if a random sample of 100 students who took a particular test in Econometrics is to be drawn from the entire student population of University of Ghana, there is the possibility that the sample might contain students who did not take the said test at all and as such be assigned a score of zero. If there are students who took this test but had an actual score of zero, the data set will contain two kinds of zeros; those who took the test but scored zero and those who did not take the test at all because they did not offer that course. In situations like that, the zero-inflated Poisson and the zero-inflated negative Poisson are the preferred models since they handle these two kinds of zeros separately. This is not the case of this study since the HDD scores ranges from 1 to 12.

Another potential problem has to do with the general assumption underlying Poisson distributions; that the variance of the response variable is equal to the sample mean, otherwise known as equi-dispersion. If the variance is greater than the sample mean, then we have a situation known as over-dispersion. If on the other hand the variance is less than the sample mean, there is under-dispersion. Cameron and Trivedi (1998) suggested that when the count data are not equi-dispersed, the Poisson Maximum Likelihood estimated coefficients are not bias, however, the standard errors are. The biased standard errors can however be corrected by generalizing the White-heteroskedastic consistent estimates of standard errors from OLS to the Poisson. The way out in addressing the problem of over-dispersion is through the use of the negative binomial regression model.

The set of explanatory variables used in the study are those that have been theoretically and empirically identified as influencing both household food security and household dietary diversity presented in Table 3.3. To determine the effect of income diversification on food security, three out of the four income strategies farmers used (RA, RN and RAN income strategies) were included as dummies. 'Rice income only' strategy was not included for two reasons; first, so as to avoid the dummy variable trap and also because respondents who chose this strategy did not participate in income diversification.

Table 3.3: Apriori expectation of variables included in the Poisson model

Variable	Description	Measurement	A priori sign
X_1	Number of contributors to household food	Number of persons	+
X_2	Education of rice farmer	Years of schooling	+
X_3	Household size	Number of persons	-
X_4	Land tenure	1=Owner 0=Otherwise	+
X_5	Monthly household food expenditure per capita	GHS	+
X_6	Rice farm size	Hectares	+
X_7	Rice yield	kg/ha	+
X_8	Income saved	GHS	+
	Effects of income diversification strategies		
X_9	Rice farm plus other agricultural income sources	1=Rice farm plus other agricultural income sources (RA) 0=otherwise	+/-
X_{10}	Rice farm plus non-agricultural income sources	1=Rice farm plus other non-agricultural income sources (RN) 0=Otherwise	+
X_{11}	Rice farm plus other agricultural plus non-agricultural income sources	1=Rice farm plus other agricultural income plus non-agricultural income sources (RAN) 0=otherwise	+

3.5.2.3 Explanation of variables included in the Poisson model

Number of contributors to household food (X_1): An increase in the number of household cash contributors to food expenditure with a constant household size implies a rise in the available household per capita income for food. This means that more money is now available to the household hence more variety of foods can be purchased for consumption. Also, high number of non-working household members puts pressure on the food and non-food resources of the household which increases the household food insecurity (Ojogho, 2010). Conversely, a high

number of income contributors to food implies relatively less pressure on food resources. A positive relationship is therefore hypothesized for this variable.

Education of the rice farmer (X_2): This variable was measured by the number of years spent in school. As argued by Yunez-Naude and Taylor (2001), formal education has the tendency to open up opportunities for an individual to participate in both farm and non-farm activities which will likely lead to increased income. This will almost invariably reflect in better food security for both the farmer and his/her entire household. A positive relationship with household food security is thus expected for attainment of higher level of education.

Household size (X_3): Household size is the number of persons living under the same roof with one household head. Muche et al. (2014) reported a negative relationship with household food security. They explained that large family sizes create more pressure on household food security as expenditure on both food and non-food increases with household size. This is especially the case when most of the family members are within the economically inactive age group and as such are entirely dependent.

Land tenure (X_4): Land tenure was measured as a dummy; '1' for rice farmers who own their lands and '0' for otherwise. Land in itself is an economic asset which can be cultivated or rented out for money. Kyaw (2009) reported incidence of food insecurity and poverty is usually prevalent among the landless poor in rural areas. Land ownership is therefore expected to have a positive effect on food security status

Monthly household food expenditure per capita (X_5): This variable was gotten by dividing the total monthly food expenditure of the household by the number of persons in the household. When households increase their food expenditure allocation without an increase in the household size, the outcome is an increase in food access. An increase in the food expenditure per capita means that households can purchase a variety of food items which will almost invariably lead to a higher food security. A positive effect is thus expected.

Rice farm size (X_6): Size of rice farm cultivated was measured in hectares. We expected larger farm sizes to have higher output hence households of farmers with larger farm sizes are more likely to be food secured than those with smaller rice farm size. The expected relation with dietary diversity and food security is therefore positive.

Rice Yield (X_7): Yield from the rice farm was measured in metric tonnes per hectare. Babatunde et al. (2007) found own production to be positively related and statistically significant with food security of farming households. Thus, the higher a farmer's rice yield, the more likely his household will be food secure since it will translate into food at the household's disposal or more income from sale. Hence a positive relationship is hypothesized for yield.

Income saved (X_8): Personal savings can always serve as income security during adverse circumstances. Due to the risky nature of farming, one can always draw from his previously saved income from successful seasons to meet the food and other needs of his household when there is harvest failure. We expect savings to have a positive effect on food security.

Effects of income diversification strategies (X_9, X_{10} and X_{11}): Diversifying one's income sources through participation in other agricultural or non-agricultural activities is expected to have a positive relationship with household food security. This is because it allows farmers to minimize the risks of food shortage in the unexpected event of crop failures (Mannaf & Uddin, 2012). From this perspective, the study attempted to see any significant difference(s) existing amongst households of farmers who relied on only rice farm income (no diversification); those that combined their rice farm income with other agricultural sources; those that relied on non-agricultural income in addition to their rice farming; and households that combined all three sources of income (rice farm plus agricultural income plus non-agricultural income). The effect of each of these income strategies on household food security was the subject of focus for this study. Being in any of these category of variables (X_9 -X_{11}) is mutually exclusive. Hence each of the variables was measured as a dummy with a score of '1' for the respective variable of interest and '0' if otherwise. For instance, farmers who were growing rice as well as other crops (RA strategy) were assigned '1' while all others had a score of '0' for variable X_9 during the analysis. This was repeated for variables X_{10} and X_{11} but this time using strategies RN and RAN respectively.

Hypothesis

a) H_o: Number of income contributors to household food has no effect on the food security status of a rice farmer's household

   H_a: Number of income contributors to household food has a positive effect on a rice farmer's household food security.

The same hypothesis was repeated for all the other variables in Table 3.3 with positive apriori expectation.

b) H_o: Household size has no effect on household food security

H_a: Household size has a negative effect on the household food security status

3.6 Statistical Application

STATA version 13 was used for the data analysis. Results are presented in tables and graphs in the next chapter.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the discussions on the findings of the study beginning with some socio-economic characteristics of the respondents.

4.2 Socio-economic characteristics

The socio-economic characteristics have been divided into socio-demographics, farm-related characteristics and income and household expenditure.

4.2.1 Socio-demographic characteristics

4.2.1.1 Gender of the respondents

Out of the 204 rice farmers interviewed, only 40 of them representing 19.6 percent were females while the remaining 164 (80.4 percent) were males as shown in Table 4.1. The male dominance could possibly be due to strenuous and capital intensive nature of rice cultivation as females are relatively disadvantaged in that regard.

4.2.1.2 Educational level

The modal educational level was SHS/A Level/Vocational with 40.2 percent of the respondents sampled as presented in Table 4.1. Only 4.4 percent of the respondents interviewed had no formal education. The fact that majority of the respondents interviewed had some form of formal education puts them in a position to participate in income diversification because attaining a high level of education enhances one's skills and increases the chances of securing a non-farm job. This

corresponds with Ackah (2013) who was also of the view that attainment of at least primary education increases the chances of getting a non-farm job.

4.2.1.3 Household head

Majority of the respondents reached (83.8%) were heads of their respective households. This underlines the centrality of the economic activities of rice farmers in North Tongu to their household because being a household head also means bearing the economic responsibility of the entire household as per GSS (2014a).

4.2.1.4 Primary occupation

The main jobs in the study area were rice farming, trading, agricultural wage employment, self-employment and non-agricultural salaried work. The modal primary occupation among the respondents was rice farming; 69.6 percent of the respondents reported it as their primary occupation (Table 4.1). Even though some of them cultivate other crops in addition to the rice, none of them reported growing other crops as their primary occupation. That the farmers perceive rice as a more lucrative cash crop to grow compared to the other crops like maize, chilli and cassava grown in the study area explains this. This substantiates the argument by Asuming-Brempong and Osei-Asare (2007) who were of the view that rice is the most economically important cash crop in communities in Ghana where it is cultivated. Up to 13.7 percent of the respondents reported agricultural wage employment as their main occupation. This group of rice farmers were mainly those who were employed by the commercial farms such as Prairie Volta Limited, Musa Hamat Farms, Golden Exotic Farms, among others operating in and around the study area. About 8.8

percent of the respondents were involved in non-agricultural salaried work such as teaching as their main livelihood in addition to the rice farming.

4.2.1.5 Age distribution of the respondents.

The age of the respondents ranged between 22 to 70 years with an average of 47.25 for the sample. The age distribution implies that majority of the farmers are within their economically active times and as such can engage in multiple income-generating activities. Table 4.1 has the age distribution in the study area. It shows that majority of the rice farmers are above the age of 40 years, further confirming the existing concern of ageing farmers in Ghana. In a study by Vigneri (2007), the author attributed this observation to the continuous departure of young farmers from rural areas to urban centers in search for greener pastures.

4.2.1.6 Distribution of household size of rice farmers

Majority of the farmers (74.5) lived in households with 5 to 9 members. The mean for the sample was 5.8 persons, which is well above the average household size of 4.2 and 4.4 persons recorded for the region and entire nation respectively in the 2010 population and housing census (GSS, 2014a). A large household size can mean more pressure on household food and non-food resources hence the need for farmers to adopt livelihood strategies to help meet these needs.

Table 4.1: Socio-demographic characteristics

Variable	Frequency	Percent	Mean	Minimum	Maximum
Gender					
Female	40	19.6			
Male	164	80.4			
Educational level					
None	9	4.4			
Primary	30	14.7			
JHS	68	33.3			
SHS/A Level/Vocational	82	40.2			
Tertiary (Training college/HND)	11	5.4			
Tertiary (First degree/Masters)	4	2.0			
Household head					
Otherwise	33	16.2			
Household head	171	83.8			
Primary occupation					
Rice farming	142	69.6			
Other crops	0	0			
Agricultural wage employment	28	13.7			
Trading	3	1.5			
Non-agricultural salaried worker	18	8.8			
Self employed	13	6.4			
Age (years)			47.3	22	70
≤30	16	7.8			
31-40	40	19.6			
41-50	75	36.8			
51-60	50	24.5			
≥61	23	11.3			
Household size			5.8	1	12
≤4	44	21.6			
5-9	152	74.5			
≥10	8	3.9			
Total	204	100.0			

Source: Field survey (2016)

4.2.2 Farm-related characteristics

Distribution of rice yield

The average rice yield in the area of 4.5 metric tonnes (MT) per hectare was well above the national average yield of 2.54 tonnes per hectare reported by Statistics, Research and Information Directorate (SRID) (2013) even though this figure was still short of the achievable yield of 6.5 MT/ha. A bulk of the farmers recorded yields between 4.1-5 tonnes per hectare. More than a quarter of the farmers had yields in the excess of 5 MT/ha as is reported in Table 4.2. These figures emphasize the potential of North Tongu area as an important rice growing area which must be explored if local rice production in Ghana is to be increased and imports reduced.

Table 4.2: Distribution of rice yield

Variable	Frequency	Percent	Mean	Minimum	Maximum
Rice yield (MT/ha)			4.5	2.4	6.1
< 3	5	2.5			
3.1-4	35	17.2			
4.1-5	111	54.4			
>5	53	26.0			
Total	**204**	**100.0**			

Source: Field survey (2016)

4.2.3 Income and household expenditure

4.2.3.1 Rice income distribution of the farmers

The income farmers earned from rice cultivation for the 2015 major growing season (Table 4.3) ranged from GHS 400 to GHS 9000 with a mean of GHS 2622.79 for the sampled farmers. More than half of the respondents earned between GHS 2001 – GHS 4000 from rice cultivation for the season.

4.2.3.2 Distribution of total income earned by respondents

The total income of rice farmers for the major season of 2015 is the aggregation of all incomes received by each farmer from all sources (including agricultural and non-agricultural sources as well as remittances) in addition to their rice farm income. The mean for the sample was GHS 4109.75, higher than the mean income from rice farming of GHS 2622.79 as can be seen in Table 4.3. This observation can be attributed to the increase in income that comes with diversifying one's income sources as supported by Barrett et al. (2001). Just like the rice income distribution, the modal income group was GHS 2001 – 4000; nearly half of the respondents which had 42.6 percent of the respondents. Next to this was the GHS 4001 to 6000 income earners who were 27.5 percent of the sample.

Table 4.3: Income of rice farmers

Variable	Frequency	Percent	Mean	Minimum	Maximum
Rice income per season (GHS)			2622.79	400	9000
≤ 2000	74	36.3			
2001 – 4000	110	53.9			
4001 – 6000	13	6.4			
6001 – 8000	6	2.9			
8001+	1	0.5			
Total income per season (GHS)			4109.75	400	15200
≤2000	34	16.7			
2001-4000	87	42.6			
4001-6000	56	27.5			
6001-8000	13	6.4			
8001+	14	6.9			
Total	**204**	**100.0**			

Source: Field survey (2016)

4.2.3.3 Income strategies of the respondents

It should be noted that diversification in the context of this study means cultivating different crop(s) or participating in other farm activity (such as rearing livestock) and/or engaging in non-farm income-generating activities in addition to the rice farming. Whether or not a farmer diversified thus depended on the kind of income strategy he/she used. The 204 respondents were categorized into 4 groups: 'Rice income only' (R); 'Rice income plus other agricultural incomes' (RA); 'Rice income plus non-agricultural incomes' (RN) and; 'Rice income plus other agricultural and non-agricultural incomes' (RAN).

The 'Rice income only' (R) were those respondents that did not diversify in any way at all; they cultivated only rice. They neither grew other crops apart from rice nor engaged in any other non-farm income-generating activity. They made up 22.1 percent of the sample. In the multinomial logit model, this group served as the base category. The next group which happened to be the modal group was those in the 'Rice income plus other agricultural incomes' (RA) portfolio. These respondents diversified within the agricultural sector. They did one or more of the following in addition to their rice cultivation; livestock rearing, participation in agricultural wage employment (working for wages in another person's farm or for a commercial farm), fishing and other crops cultivation. They comprised 40.7 percent of the sample. The third group of respondents, Rice income plus non-agricultural income (RN) were those who diversified outside the confines of agriculture in addition their rice farming by either engaging in self-employment activities (like trading and artisanship) and/or earning non-agricultural wage income by providing services such as teaching. They also consisted of 22.1 percent of the sample. The last group of respondents were those who earned income from all the income sources discussed above, hence their name, 'Rice

income plus other agricultural and non-agricultural incomes' (RAN). They were 31 in number, forming 15.2 percent of the sample. The relatively small number of respondents in the RAN category could be attributed to the herculean nature of engaging in multiple income generating activities simultaneously even though it might have its rewards of high income. The breakdown of income strategies of the 204 respondents interviewed is presented in Table 4.4.

Table 4.4: Income strategies of the rice farmers in the North Tongu District

Income strategy	Frequency	Percent
Rice income only (R)	45	22.1
Rice and other agricultural incomes (RA)	83	40.7
Rice and non-agricultural incomes (RN)	45	22.1
Rice, other agricultural and non-agricultural incomes (RAN)	31	15.2
Total	**204**	**100.0**

Source: Field survey (2016)

4.2.3.4 Distribution of incomes earned by the respondents in the different income strategies

This section presents the income distribution of the different income strategies (Table 4.5). The mean incomes as well as their corresponding standard deviations are also reported in Table 4.6

Rice income only (R strategy): The mean income earned by the farmers in this group was GHS 1887.11 and the standard deviation was GHS 1123.42 (Table 4.6). The incomes of the respondents who used this income portfolio ranged from a minimum of GHS 400 to a maximum of GHS 7000. Out of the 45 persons in the group, up to 64.4 percent earned less than GHS 2000 for the entire season while 33.3 percent earned incomes within GHS 2001 to 4000. Only 1 person earned income between GHS 6001 to 8000.

Rice income plus other agricultural income sources (RA strategy): More than half of respondents (56.6%) who adopted the 'RA strategy' earned between GHS 2001 to 4000 for the

season while 31.3 percent of them received incomes within GHS 4001 to 6000. The mean income for this category was GHS 4047.23 with a standard deviation of GHS 1527.41.

Rice income plus non-agricultural incomes strategy (RN strategy): The mean income of farmers who adopted the RN income strategy was GHS 5506.67 and the standard deviation around the mean was GHS 2920.31. The least earner in this category received GHS 1800 for the season while the highest earner had GHS 15,200. Most of the respondents here earned incomes within GHS 2001 to 4000 and GHS 2001 to 4000. Up to 15.6% of the respondents who adopted the RN income strategy earned incomes in the excess of GHS 8000.

Rice income plus other agricultural plus non-agricultural income sources (RAN): The mean seasonal income of respondents who chose the RAN strategy was GHS 5475.81. The least earner for the season received GHS 2300 while the highest earner had GHS 13,000 as income. More than half (51.6%) of the respondents who adopted this income strategy earned incomes within GHS 4001 to 6000 for the season while 29% of them earned between GHS 2001 to 4000. Similar to the case of those in the RN income strategy, 16.2% of the respondents in the RAN strategy earned more than GHS 8000 from their activities for the season.

Table 4.5: Distribution of incomes earned from the different income strategies

Income (GHS)	Rice income only (R)		Rice & other agricultural incomes (RA)		Rice & non-agricultural incomes (RN)		Rice, other agricultural & non-agricultural incomes (RAN)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
<2000	29	64.4	4	4.8	1	2.2	0	0
2001-4000	15	33.3	47	56.6	16	35.6	9	29
4001-6000	0	0	26	31.3	14	31.1	16	51.6
6001-8000	1	2.2	4	4.8	7	15.6	1	3.2
≥8001	0	0	2	2.4	7	15.6	5	16.2
Total	**45**	**100**	**83**	**100**	**45**	**100**	**31**	**100**

Source: Field survey (2016)

Table 4.6: Mean incomes earned by the different income strategies

Income strategy	Income (GHS)			
	Mean	Standard Deviation	Minimum	Maximum
Rice income only (R)	1887.11	1123.42	400	7000
Rice and other agricultural incomes (RA)	4047.23	1527.41	1500	10650
Rice and non-agricultural incomes (RN)	5506.67	2920.31	1800	15200
Rice, other agricultural and non-agricultural incomes (RAN)	5475.81	2839.03	2300	13000

Source: Field survey (2016)

4.2.3.5 Comparing the mean incomes of the different income strategies

The 2-tailed significance test was used to test for the equality of mean incomes between the various income strategies (results presented in Table 4.7). The test was conducted at 0.05% significance level. The decision rule was that, if the 2-tailed significance value from the test was greater than 0.05, then there was no statistical difference between the mean incomes of the two groups in

question hence, any differences in means could be due to chance. If on the other hand the significance value (2-tailed) was found to be less or equal to 0.05, then the conclusion would be that there was a significant difference between the mean incomes of the two income strategies being compared and the difference observed between the means was not merely due to chance.

The test for equality of means between the "Rice income only" (R strategy) and 'Rice and other agricultural incomes" (RA strategy) was statistically significant since the results for the 2-tailed significance test (0.000) was less than 0.05. This implies that respondents in the "rice and other agricultural incomes" category with mean income of GHS 4047.23 earned more than those in the 'Rice only' category, who did not diversify at all with mean income of GHS 1887.11 (Table 4.6). In other words, diversification within the agricultural sector resulted in higher income than growing only rice (no diversification). The same was true for 'R income strategy' versus the other diversifying income strategies; the mean income of the 'R strategy' was significantly different from each of the other strategies. The mean income earned from growing rice only was actually less than combining rice cultivation with other activities.

This was also the case RA versus RN and RA versus RAN strategies. The mean income received from engaging in multiple activities within the agricultural sector (RA strategy) was less than that from combining rice farming with non-agricultural activities (RN strategy) or combining rice with other agricultural and non-agricultural activities (RAN strategy).

The test however revealed that there was no significant difference in mean incomes earned by respondents who pursued the RN and RAN strategies since the p-value of 0.964 was greater than

the 0.05 significance value. The mean income values of GHS 5506.67 for RN and GHS 5475.81 for RAN strategies respectively were not really different from each other. The apparent difference in mean incomes observed between these two diversification strategies could be attributed to chance. Thus, arranged in order of increasing mean incomes from the least to the highest, will be; R < RA < RN/RAN. This implies that income diversification in general was associated with higher earnings and non-agricultural diversification resulted in the highest income. This finding supports the position of Barrett et al. (2001) who held the view that households participate in income diversification not only to minimize risks but also to increase income.

Table 4.7: Difference in mean incomes from the various income strategies

Pairing of income strategies	t-value	Sig (2-tailed)
R versus RA	-8.34	0.000
R versus RN	-7.76	0.000
R versus RAN	-7.67	0.000
RA versus RN	-3.72	0.000
RA versus RAN	-3.45	0.001
RN versus RAN	0.05	0.964

Source: Field survey (2016)

4.2.3.6 Household expenditure on food

The study was conscious not to overlook the food (in kind) contribution by the farmer and other members of the household to the household's food expenditure. Data on the quantities of each food produce coming from their own farms or otherwise was taken from the respondents and then subsequently converted to their cash equivalent using the prevailing market value. On the average, food produce contributions (in-kind) made up 21.1% of the total monthly household food expenditure for the sample while cash contributions took up the remaining 78.9%. The highest

number of contributors to household food expenditure was 4 persons while the mean number of contributors for the sample was 2 persons. Again, on the average, the rice farmers interviewed bore 85.5% of their households' entire food expenditure for the month through their cash and/or in-kind food contributions. Up to 92 of the respondents interviewed, representing 45.1% of the sample were solely responsible for their entire household food expenditure, binging to light the importance of rice farmer's contribution to food security of a household.

Distribution of household monthly expenditure on food

The minimum household expenditure on food from the sample was GHS 63 while the maximum was GHS 750. The mean monthly food expenditure for the sample was GHS 343.53. Nearly half of the respondents' households spent within the range of GHS 301- 450 on food. Only 1.5 percent of the households spent GHS 150 or less on food for the month. Details are reported in Table 4.8.

Table 4.8: Household expenditure on food

Variable	Frequency	Percent	Mean	Minimum	Maximum
Household monthly food expenditure (GHS)			323.53	63	750
≤150	3	1.5			
151-300	79	38.7			
301-450	93	45.6			
451-600	24	11.8			
>601	5	2.5			
Total	**204**	**100.0**			

Source: Field survey (2016)

4.3 Factors influencing the choice of income diversification strategy by rice farmers

The Multinomial Logit results for the factors affecting income diversification among rice farmers in the study area is presented in this section. The outcome variable of interest, whether or not one

diversifies, is categorical in nature. The reason is because a farmer may either be growing only rice and therefore has no other source of income aside the rice farm (no diversification) and thus be classified into "Rice only category" (R strategy) or may diversify and hence be classified into any of the other three categories of diversification; "rice plus other agricultural incomes" (RA), "rice plus non-agricultural income sources" (RN) and "rice plus other agricultural plus non-agricultural incomes" (RAN). "Rice income only" (no diversification) group was selected as the base category for the multinomial logit to determine the factors influencing income diversification of rice farmers so that all other choices of diversification strategies were compared to this group.

Maximum likelihood estimation method was used to obtain the Multinomial Logit parameters in STATA. In all, 204 observations were analysed. The entire model was statistically significant at 1 percent significance level as measured by the probability of the Wald chi-squared estimate. The marginal effects are discussed and not the coefficients since they tell not just the direction alone but also the actual probability/magnitude of change that will occur to the dependent variable as a result of changes in the independent variables. Multicollinearity among the independent variables was tested using the VIF (Variance Inflation Factor) method. The results (presented in the Appendix C) show that there was no multicollinearity among the variables as none of the VIF outcomes exceeded 10. Presented in Table 4.9 are the estimated marginal effects from the analysis and the corresponding z-values are in parenthesis.

Table 4.9: Multinomial Logit results for factors influencing income diversification

Variable	**Rice and other agricultural incomes (RA)**	**Rice and non-agricultural incomes (RN)**	**Rice, other agricultural and non-agricultural incomes (RAN)**
Age	-0.0014	-0.0011	0.0022
	(-0.2800)	(-0.3300)	(0.0900)
Education	-0.0216	0.0082	0.0107
	(-0.9100)	(-0.1400)	(-0.1000)
Gender	0.2182*	-0.3834***	0.1238
	(-1.7500)	(-3.9300)	(-0.7300)
Household head	0.1179*	0.0863**	-0.0877
	(1.6900)	(1.9300)	(0.9800)
Household size	-0.0087***	-0.0193***	0.0034*
	(-2.6100)	(-2.6300)	(-1.8000)
Rice farm size	0.0731**	-0.0016**	-0.1107**
	(-2.0100)	(-2.0900)	(-2.0800)
Rice income	0.0000	0.0000	0.0000
	(1.0800)	(0.7100)	(1.0000)
Income saved	0.0004**	-0.0002	-0.0002
	(2.100)	(0.6400)	(0.8900)
Job availability (perception)	0.1996**	0.0985**	-0.1023
	(2.3400)	(2.2700)	(1.5600)
Employable skills	-0.3891	0.2516**	0.1412
	(-0.6900)	(2.2700)	(1.1700)
Rice credit	-0.1228***	-0.0282***	0.0490***
	(-3.1800)	(-2.8900)	(-2.4600)
Asset base	0.0000	0.0000	0.0000
	(0.9200)	(1.3600)	(1.2100)
Food expenditure	-0.0020	0.0011*	0.0013*
	(0.8300)	(1.8600)	(1.7200)
Constant	(0.9400)	(-0.6900)	(-1.0500)
Number of observations = 204			**Wald chi2(39) = 122.7700**
Log pseudolikelihood = -159.9281			**Prob > chi2 = 0.0000**
			Pseudo R2 = 0.4056

*, ** and *** denote statistically significant variables at 10%, 5% and 1% significant levels respectively
Figures in parenthesis are Robust Standard Errors
Source: Field survey (2016)

Gender, household size of rice farmer, size of rice farm and being a household head were among statistically significant determinants of choice of income diversification strategy. The other factors

found to be statistically significant were; the income saved by the farmer, the farmer's perception of available job/income generating opportunities in the area, farmer's employable skills, access to credit for rice farm during the major season of 2015 and total monthly household expenditure on food.

Gender

The multinomial logit for males relative to females is 0.3834 units lower for being in RN diversification category relative to "rice only" given all other predictor variables in the model are held constant. What this means is that female rice farmers were more likely to adopt the RN diversification strategy compared to their male counterparts. This is because self-employment activities such as petty trading make up a significant proportion of non-farm activities in rural Ghana and women usually dominate this. Male farmers are rather likely to be involved in agricultural related activities as their diversification strategy. This assertion is confirmed by the fact that males were rather 21.82% more likely to take up other agricultural activities in addition to their rice farming (that is adopt RA diversification strategy) than their female counterparts. The fact that males have better land access over females in Ghana makes it easier for them to go into cultivation of other crops (usually on different piece of land), classified in this study as 'RA income strategy'. This finding corroborates that of Hjelm and Dasori (2012) and Newman and Canagarajah (2000) who also reported that females are more likely to be involved in non-farm activities than males.

Household head

Compared to cultivating only rice (no diversification), respondents who were heads of their households were 11.79 percent more likely to diversify into "rice and agricultural" (RA) and 8.63 percent more likely to choose 'rice and non-agricultural' (RN) diversification. This is because being a household head comes with added responsibility of being the major economic anchor of the household. Therefore, rice farmers who were household heads were likely to participate in other income-generating ventures so as to earn additional income to meet the needs of their entire household.

Household size of rice farmer

Adoption of RAN diversification strategy conformed to our apriori expectation of increase in the probability of income diversification as one's household size increases. For each person added to the household, the likelihood that the rice farmer will adopt RAN diversification strategy increases by 0.34 percent. This observation is so because bigger household sizes imply more mouths to feed and also more needs to be met. It therefore makes sense that the rice farmer responds to this additional responsibility by participating in more income-generating ventures which will lead to an increase in his income. This confirms the argument by Asfaw et al. (2015) in rural Malawi that larger household is associated with income diversification.

On the contrary, household size had an inverse effect on the choice of RA and RN income diversification strategies. Every person added to a respondent's household decreased the probability of the rice farmer choosing RA and RN income diversification strategies by 0.87 and 1.93 percent respectively. This might be due to the fact that compared to smaller households, large

households are likely to be made up of many income earners who would help raise the needed income for the household. The fact that overall income needs of larger households would be a shared burden among the many income earners might compel respondents therein not to take up multiple jobs but rather concentrate on in their rice production, hence specialization. This was what Ahmed (2012) reported in Borno State of Nigeria where household size was inversely related with income diversification.

Size of rice farm

As rice farm size increases, a respondent was less likely to add on other non-farm income activities (RN and RAN strategies) because rice cultivation in itself is both capital and labour intensive. Increasing rice farm size means upsurge in both labour and capital commitments for the rice farm which the farmer would have needed if he/she were to go into other income ventures. Specifically, for every 1-hectare increase in rice farm size, respondents were 0.16 and 11.07 percent less likely to engage in RN and RAN diversification respectively. This finding supports the argument of Man (2009) that larger farm size is an indicator of good asset holding and social status, hence persons with larger farm size are less likely to engage in non-farm income diversification. Teshome and Edriss (2013) also reported similar results in Ethiopia where participation in income diversification decreased with an increase in farm size among smallholder farmers.

The result however showed that an increase in rice farm size increased the probability that the rice farmer would add on cultivation of other crops and/or rearing animals (RA diversification strategy) by 7.31 percentage points. It is relatively easier for the typical rice farmer to go into crop diversification (which constitutes RA diversification) than to combine the rice production with an

entirely new non-farm activity (which would imply RN or RAN strategy in this study) hence the observation. In a related study in Ogun State of Nigeria, Idowu et al. (2014) also reported similar findings of marginal increase in crop diversification with increase in farm size.

Income saved by the farmer

Personal savings can be an important source of income for one to tap from and invest in other ventures. Savings can also serve as a buffer for the farmer in a season where the farmer experiences a shortfall in harvest. Compared to engaging in only rice farming, farmers who had saved more income had a higher likelihood of diversifying into rice and other agricultural activities (RA strategy). For every GHS 1 saved, the farmer had a 0.04 percent likelihood of adding up another agricultural income-generating venture to the rice farming (RA diversification).

Farmer's perception of available job/income-generating opportunities in the area

The availability of paid job and other income-generating opportunities in the area was measured using the farmer's perception. To be able to take advantage of available income opportunities, one must first of all be able to spot such openings. Those who perceived there were available opportunities in the area were more likely to choose RA strategy (19.96 percent) and RN strategy (9.85 percent) than those who thought otherwise. In other words, respondents who perceived there were no available opportunities in the area from which they could earn additional income were less likely to diversify as they were more inclined to growing only rice.

Employable skills

The farmer's employable skills was captured by asking them whether they had any special abilities aside their farming skills that could facilitate their getting employed or exploiting other income avenues aside farming. Respondents who gave affirmative responses were more likely to diversify into non-agricultural activities in addition to growing rice (RN) and had 25.16 percent likelihood of combining their rice farming with other non-agricultural activities to earn income. The limited skills of those who gave "no" responses meant that it would be relatively difficult for them to get involved in income-generating activities outside the farming circles. This finding is in line with a study conducted by Escobal (2001) in Peru who found human capital development through education and skill training to influence non-farm work availability to households.

Access to credit for rice farm during the major season of 2015

Diversification into RAN followed the findings of Aidoo et al. (2013) and Akaakohol and Aye (2014) who argued that credit access would compel a farmer into income diversification. Consequently, this present study found that access to rice farm credit was likely to lead to a 4.9 percent increase in the probability that a farmer will choose the RAN diversification strategy. The opposite was however true for choice of RA and RN diversification strategies. Access to rice farm credit was rather likely to reduce the chances that a farmer would choose RA and RN income diversification strategies by 12.28 and 2.82 percent respectively. This ties in with the findings of Asfaw et al. (2015) and Ahmed (2012) who both reported credit access to have a negative influence on decision to diversify income. This is because the credit the farmers received was specifically meant for their rice farm hence it led to intensification of the rice farming rather than diversification.

Total monthly household expenditure on food

Higher monthly household food expenditure is associated with higher likelihood of diversifying into RN and RAN income generating activities. For every GHS 1 increase in household food expenditure, farmers were 0.11 and 0.13 percent more likely to adopt RN and RAN diversification strategies respectively so they can meet earn more income to meet the rising food needs of their respective households. This is understandable considering the important role that rice farmers play in meeting the food needs of their households as established in the socio-economic discussion above. On the average the farmers bore about 85.5% of their household food cost through cash and food produce contribution and so there was a need to diversify their income sources in order to earn additional income to cater for increasing household food expenditure.

4.4 Estimating the household food security of the respondents

4.4.1 Outside of home consumption

The respondents were asked if any member of their households bought and consumed meals or snacks outside of home during the recall period to ascertain the feasibility of the HDDS in the study. About 92.2 percent of the households did not record any outside home consumption of food (Table 4.10). What this means is that the use the household dietary diversity score is appropriate for this study since nearly all food consumption can be appropriately captured. The fact that inhabitants of North Tongu are mostly rural dwellers (GSS, 2014a) explains the above observation since compared to their urban counterparts, rural dwellers are known to mostly eat home prepared meals. This supports the argument by Cudjoe et al. (2016) that eating meals prepared outside of home is a typical feature of urban lifestyles due partly to the lack of time on the part of urban dwellers to prepare meals at home regularly.

Table 4.10: Outside of home food consumption

Outside home consumption	Frequency	Percent
Yes	16	7.8
No	188	92.2
Total	**204**	**100.0**

Source: Field survey (2016)

4.4.2 Dietary pattern of the households in the sample

Out of the reference list of 12, the food groups consumed by at least fifty percent of the households in the sample were cereals, vegetables, roots and tubers, fish, condiments and sweets. Food groups which fell below fifty percent consumption by the sample included; fats and oils, pulses, meats, milk, fruits and eggs. After cereals (99% consumption), vegetables and roots/tubers were the most consumed food groups with 84.8% and 71.6% consumption rate respectively. The fact that the diet of the respondents was mostly cereal-based staple foods such as *banku*[4], *akple*[5], and rice explains this dietary pattern. These foods were mostly eaten in combination with some vegetable sauce/stew and some fish (which was the main dietary protein source for the households). The proximity of the study area to both the Volta Lake and Ada Junction (where fish and oysters abound) meant that fish and oyster were in relative abundance compared to other protein sources. Condiments, primarily spices and pepper (flakes) were consumed by 58.3 percent of the households.

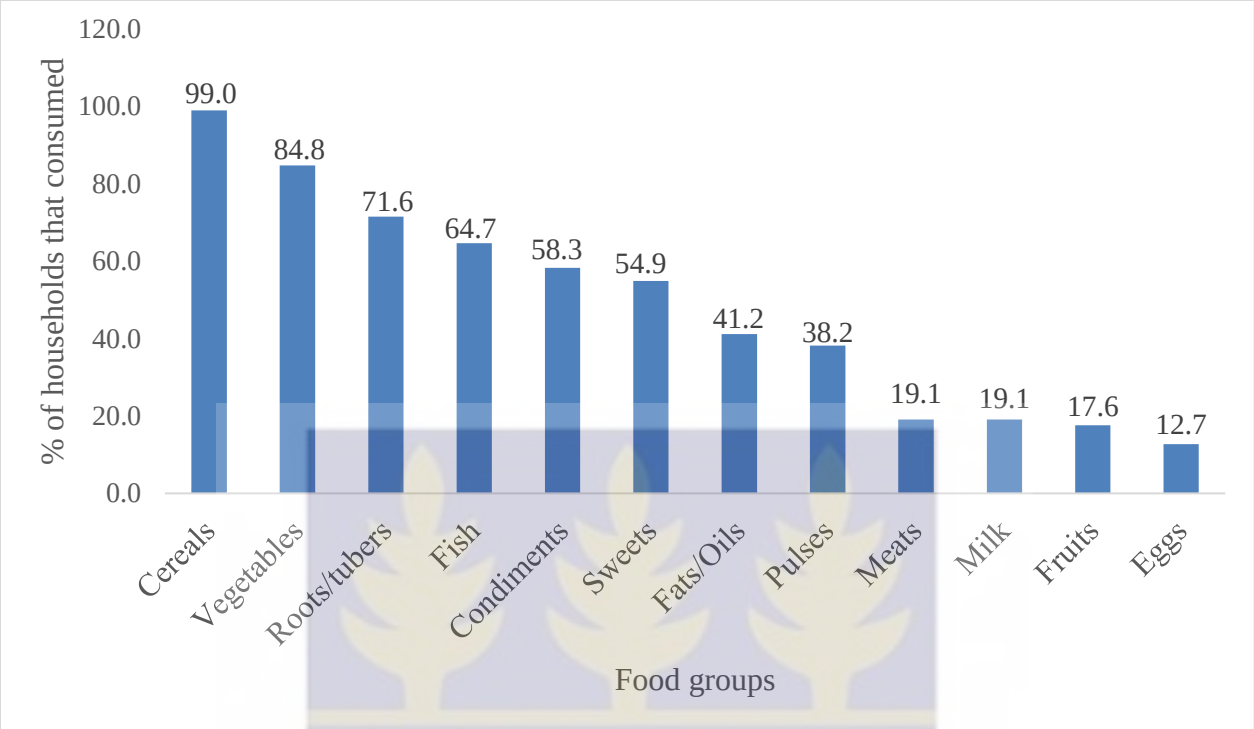
Consumption of fruits was very low with only 17.6% of the respondents reporting it during the recall period. Banana was notably the most commonly consumed fruit in the area and was mostly

[4] *Banku* is a composite Ghanaian dish prepared from cassava dough and corn dough.

[5] *Akple* is another composite Ghanaian dish prepared from maize flour.

eaten as snack. The presence of Musa Hamat Farms Limited, a commercial banana producing farm operating in the study area accounts for its relative availability compared to other fruits. Again, a little less than a fifth of the respondents ate food items from the meats and milk groups respectively while the lowest consumed group was eggs. The distribution of the different food groups consumed by the sample in the last 24 hours leading to the interview is presented in Figure 4.1.

The dietary pattern of the households is similar to what Jolly et al. (2006) reported for households in the Ejura Sekyeredumase District of Ghana where consumption of maize and other cereals as well as cassava was observed among most households. The results also uphold the findings of Schönfeldt and Hall (2012) who argued that persons in low income countries mostly derive their dietary energy from cereals and that only a minute proportion of their dietary energy comes from meat. The findings on consumption of roots and tubers however contradicted latter study as they reported a much lower percentage (11%) contribution of roots and tubers to dietary energy.



Source: Field survey (2016)

Figure 4.1: Distribution of food group consumption by the sample

4.4.3 Household Dietary Diversity Scores (HDD Scores)

The HDDS which is a simple count of the different food groups consumed by the households ranged from 3 to 10 out of the total of 12 food groups for the sample (Table 4.11).

Table 4.11: HDDS for the sample households

HDDS[6]	Frequency	Percent
3	7	3.4
4	30	14.7
5	40	19.6
6	70	34.3
7	37	18.1
8	15	7.4
9	4	2.0
10	1	0.5
Total	**204**	**100.0**

Source: Field survey (2016)

The mean HDDS for the sample was 5.81 and the standard deviation around the mean was 1.34. What this means is that, the sampled households consumed approximately 6 different food groups on the average out of the maximum of 12 over the recall period. This is reflected in the dietary pattern above (Figure 4.1) where the number of different food groups consumed by more than 50 percent of the households was 6 (cereals, vegetables, roots and tubers, fish, condiments and sweets). The study is cautious in directly comparing this mean HDDS to other works in different places since the number of reference food groups in question might not be exactly the same as that used for this study. That notwithstanding, the general consensus is that a higher number of food group consumption is associated with better food access by the household (Swindale & Bilinsky, 2006). In a study by Birhane et al. (2014) in Addis Ababa, Ethiopia using a reference of 12 food groups, the authors recorded a mean HDDS of 6.3. Similar to the finding of this present study, they also found cereals to be the highest consumed food group by the sample. In a related study in rural Mali, Torheim et al. (2004) recorded a much higher mean dietary diversity score of 7.8 for

[6] Mean of HDDS = 5.81 Standard deviation = 1.34 Variance = 3.24

their sample over a 7-day recall period, albeit the individual HDD scores ranged from 4 to 10 just as in this present study.

4.4.4 Creating Tertiles using the Dietary Diversity Scores

The HDDS for the sample followed a normal distribution as revealed by the Shapiro-Wilk test. The Shapiro-Wilk test which tests for normality was not statistically significant (Appendix D), implying that the null hypothesis of normality of the HDDS distribution holds. Therefore, following the recommendation by Swindale and Bilinsky (2006) and the approach used by Birhane et al. (2014), the sample was further divided into tertiles using the mean HDDS and standard deviation (5.81 ± 1.34)

The first tertile (Low Food Security households) comprised of respondents whose dietary diversity score was less or equal to 4. Respondents in this class had the lowest HDD scores in the sample. The mean HDD score for this tertile was 3.81 and the standard deviation around the mean was 0.40. In all, 18.1 percent of the respondents interviewed were in this tertile. Households in the second tertile, otherwise referred to as Moderate Food Security group had scores ranging from 5 to 7 with a mean score of 5.98. Majority of the respondents (72.1 percent) were in this tertile. The third tertile (High Food Security) comprised of respondents whose households had consumed 8 or more different food groups in the past 24 hours before the interview. They made up 9.8 percent of the sample and their average HDDS score was 8.3. The corresponding mean monthly incomes for the different tertiles are also presented in Table 4.12.

Table 4.12: Distribution of households in the different tertiles and their corresponding mean monthly incomes

Food security level	Frequency	%	HDDS		Monthly income GHS	
			Mean	Standard Deviation	Mean	Standard Deviation
Low (HDDS ≤4)	37	18.1	3.81	0.40	351.21	253.73
Moderate (HDDS 5-7)	147	72.1	5.98	0.73	719.98	360.84
High (HDDS ≥8)	20	9.8	8.30	0.57	1045.00	562.21
Total	**204**	**100.0**	**5.81**	**1.34**	**684.96**	**410.62**

Source: Field survey (2016)

A difference in means test was conducted to ascertain whether or not the mean monthly incomes of respondents within the different food security levels were significantly different from each other. Results from the independent sample t-test (Table 4.13) confirmed that these mean incomes were indeed different and that the observed differences could not be due to chance. Respondents in the low food security group (Tertile 1) earned the least (GHS 351.21) while those in the high food security group (Tertile 3) earned the highest mean monthly incomes (GHS 1054.00). This finding confirms earlier assertions of Hoddinot and Yohannes (2002) and Hatloy et al. (2000) who held the view that higher incomes imply better economic access to food hence better dietary diversity, leading ultimately to an improved food security.

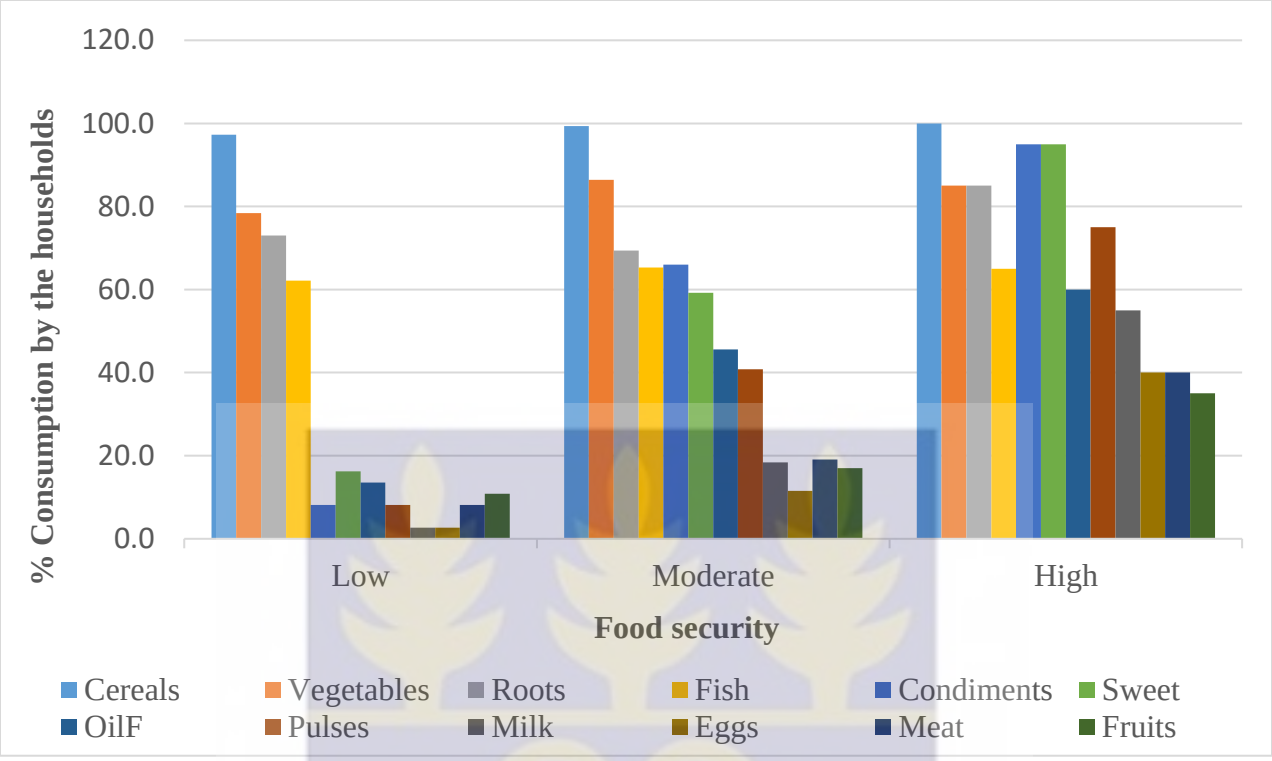
Table 4.13: Difference in mean monthly incomes across the different HDDS tertiles

	t-value	Sig (2-tailed)
Tertile 1 versus Tertile 2	-5.83	0.000
Tertile 1 versus Tertile 3	-7.84	0.000
Tertile 2 versus Tertile 3	-4.37	0.000

Source: Field survey (2016)

4.4.5 Dietary pattern within the different tertiles

Using the approach by Kennedy (2009), the study made pronouncements on dietary pattern within the different tertiles based on the food groups consumed by more than 50 percent of the households within that tertile. On that basis, households in the first tertile (low food security) consumed only 4 food groups; cereals, vegetables, roots/tubers and fish (depicted in Figure 4.2). This was consistent with the mean HDD score of 3.81 for that tertile reported in Table 4.12. Households in the second tertile (moderate food security) consumed a lot more food groups than those in the first tertile; in addition to the food groups consumed by the first tertile, consumption of condiments and sweets was observed in the second tertile. The 6 different food groups they consumed is also consistent with their mean HDD score of 5.98. Households in the third tertile (high food security) consumed much more variety of food groups than the other two tertiles as depicted by Figure 4.2. In addition to what the first 2 tertiles consumed, consumption of oils, pulses and milk was observed in this tertile. As argued by Swindale and Bilinsky (2006) that dietary variety is a reflection of households' economic access to food, we can remark that economic power increases across the 3 tertiles, with households in the third tertile (high food security) having the highest food access hence their relatively high food variety.



Source: Field survey (2016)

Figure 4.2: Dietary pattern within the different tertiles

4.4.6 Cross-tabulations of HDDS with other socioeconomic indicators of food security.

As noted earlier, even though findings from other studies cannot be directly compared to the results this present study, some common themes emerge in literature concerning the correlates of HDDS and food security. As a result, this study double-checked the HDDS obtained with other measures of food security the study measured.

4.4.6.1 HDDS tertiles versus income tertiles

Based on their total monthly incomes, the farmers were grouped into 4 percentiles. The Farmers who earned GHS 433.33 or less (1st quartile) were classified as poor, while those whose incomes ranged between GHS 433.34 - 611.67 were the middle class for the sample. The rich and richest quartiles earned GHS 611.68 - 820.83 and greater than GHS 820.84 respectively. Their

corresponding distributions are presented in Table 4.14 which is a cross tabulation of the income classes of farmers by the HDDS tertiles.

Almost all the farmers in the low food security households (28 out of the total of 37) were in the poor class of earners. Also worth mentioning is the proportion of rice farmers from the high food security (third HDDS tertile); more than half of rice farmers in these households were in the richest percentile of earners (11 out of 20). One thing is clear from Table 4.14; rising farmer income is associated with higher HDD scores hence better dietary diversity. The importance of the rice farmers in the study area to their household food security cannot be overemphasized. The study found (as reported in descriptive statistics of the socio-economic characteristics) that the average farmer in the study area contributed more than 85% directly to his household's food expenditure through cash and/or farm produce contributions. Consequently, an increase in the farmer's income will have a telling impact on his household's food access seeing that farmers in the richest class have more financial capability to nourish their households with diverse food groups. This finding is in congruence with what Demi et al. (2013) reported in Central Region of Ghana. In that study, the authors found food security to increase with income as a result of rising purchasing power. The Spearman correlation coefficient between HDDS and farmer's monthly income of 0.56 (Table 4.16) was statistically significant. This indicates a strong positive correlation between the rice farmer's monthly income and household dietary diversity, supporting the above assertion.

Table 4.14: Cross-tabulation of the income classes of farmers by household food security levels

Food Security Level	Income classes				Total
	Poor	Middle	Rich	Richest	
Low Food Security	28	4	1	4	**37**
Moderate Food Security	20	47	44	36	**147**
High Food Security	1	2	6	11	**20**
Total	**49**	**53**	**51**	**51**	**204**

Source: Field survey (2016)

4.4.6.2 Cross tabulation of HDDS tertiles by per capita food expenditure

Just as was done with the incomes of the rice farmers, the respondents were grouped into 4 quartiles based on their monthly food expenditure per capita. Households in the least class spent GHS 43.54 or less on food per capita whereas those in the middle class spent GHS 43.55 - 60.00. The high and highest classes expended GHS 60.01 - 79.17 and above GHS 79.18 respectively on each household member's food needs. The corresponding distributions are reported in Table 4.15 which is a cross-tabulation of the food security groups by the per capita household expenditure on food.

Most of the households in the low food security group spent the least on food per head (31 out of 37). None of the households in the high food security group (high HDDS tertile) was in the class of least spenders on food per capita. More than half of them (12 out of the total of 20) were actually in the highest quartile of spenders on food per capita. This highlights the fact that per capita expenditure on food increases dietary diversity of the household. This assertion is further buttressed by the strong positive correlation of 0.71 (Spearman's correlation) between HDDS and expenditure on food per capita in Table 4.16. Once a household increases its monetary allocation to food, members are able to access more food varieties. This sustains the argument by Thorne-

Lyman et al. (2010) who also reported per capita household expenditure on food in Bangladesh to be correlated with dietary diversity in Bangladesh.

Table 4.15: Cross tabulation of food security levels by per capita food expenditure

Food Security Level	Per capita food expenditure classes				Total
	Least	Middle	High	Highest	
Low Food Security	31	3	2	1	37
Moderate Food Security	20	48	42	37	147
High Food Security	0	3	5	12	20
Total	**51**	**54**	**49**	**50**	**204**

Source: Field survey (2016)

4.4.7 Correlation of HDDS with other indicators of food security

The correlation of HDDS with other food security indicators in literature that the study measured was tested (Table 4.16). The correlation with each indicator used was statistically significant at 0.05% significance level. HDDS was strongly correlated with per capita food expenditure, farmer's monthly income and household size. The Spearman's correlation coefficient between dietary diversity and food expenditure per capita is 0.71, indicating a strong positive relationship. Though also found to be statistically significant, the total household food expenditure had rather lower correlation coefficient with HDDS (0.44) than per capita household expenditure. The relatively higher correlation that HDDS has with per capita food expenditure than with total household food expenditure can possibly be attributed to the effect of increase in spending that comes with large household sizes. The inverse correlation HDDS has with household size can be attributed to the fact that an increase in the number of persons in a household, holding every other thing constant will lead to a reduction in the per capita food expenditure hence relatively less money available to purchase food leading to a decline in the household's food variety. This result

corroborates the findings of Kennedy (2009) who observed significant correlation between HDDS and per capita expenditure on food in Northern Uganda and Lao People's Democratic Republic. The above findings justify the HDDS as a useful indicator of food security for this study.

Table 4.16: Correlation of HDDS with other indicators of food security

Indicator	HDDS	
	Spearman's rho	P-value (2-tailed)
Monthly per capita expenditure on food	0.71	0.000
Total monthly household food expenditure	0.44	0.000
Total monthly income	0.54	0.000
Household size	-0.44	0.000

Source: Field survey (2016)

4.5 Effects of income diversification on household food security

This section deals with the effects of income strategies on food security. It begins by reporting the distribution of the different income strategies within each food security group as well as the proportion of the different food security levels within the different income strategies. This was obtained by doing a cross tabulation of the food security groups with the 4 income strategies. Percentages from the cross tabulation are reported in tables and graphs.

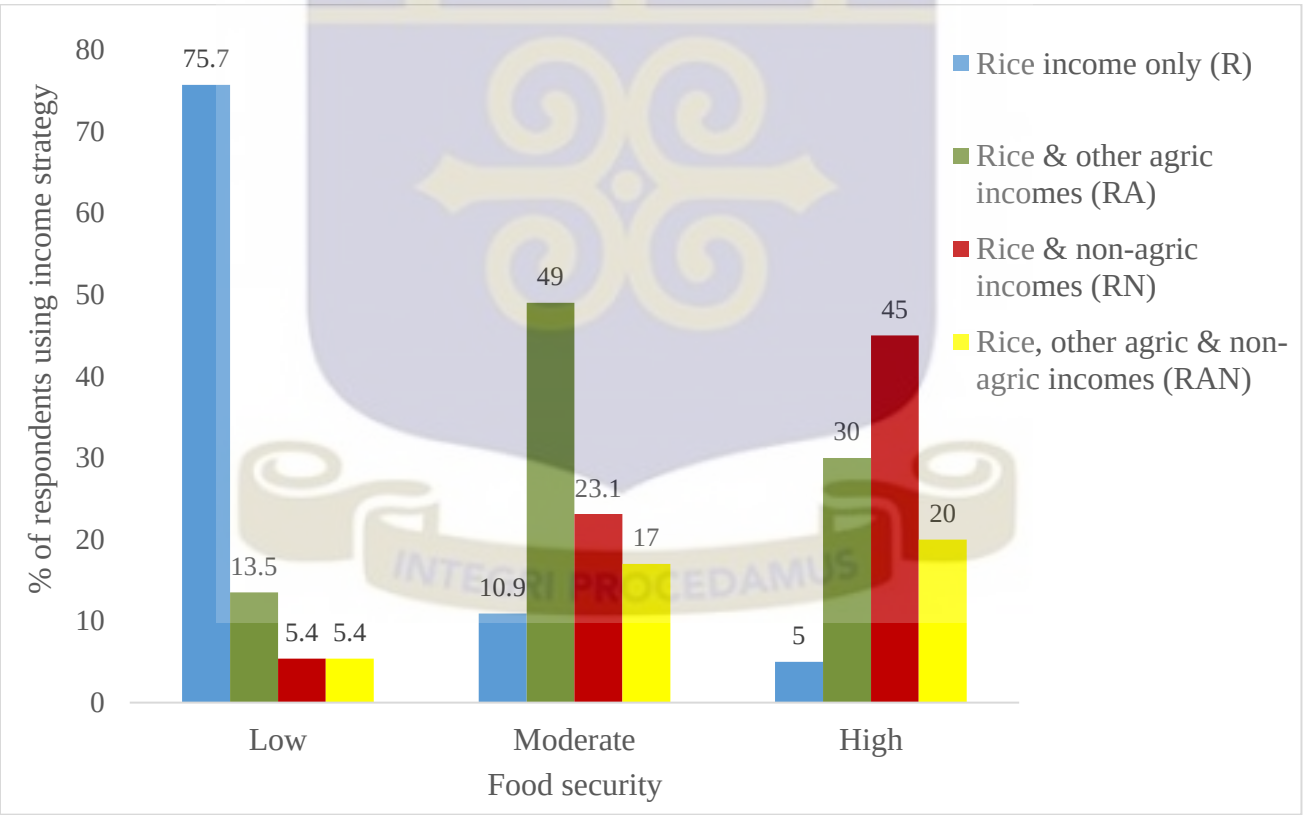
4.5.1 Cross tabulation of food security groups and income strategies

Table 4.17 reports a breakdown of the different income strategies within each food security group (HDDS tertile). Majority of the respondents who were in the low food security group (75.7%) adopted the 'rice income only' (R strategy). Among those who reported the highest dietary diversity (high food security), only 5 % of them did not diversify their income sources. This reveals the strong association between non-diversification and low dietary diversity and thus low food security. The result is further presented in the Figure 4.3 for a clearer illustration.

Table 4.17: Proportion of income strategies within each food security group

Food Security Level	Income strategy among farmers				Frequency
	Rice income only [R]	Rice & other agricultural incomes [RA]	Rice & non-agricultural incomes [RN]	Rice, other agricultural & non-agricultural incomes [RAN]	
	(Percent)				
Low	75.7	13.5	5.4	5.4	**37**
Moderate	10.9	49	23.1	17	**147**
High	5	30	45	20	**20**

Source: Field survey (2016)



Source: Field survey (2016)

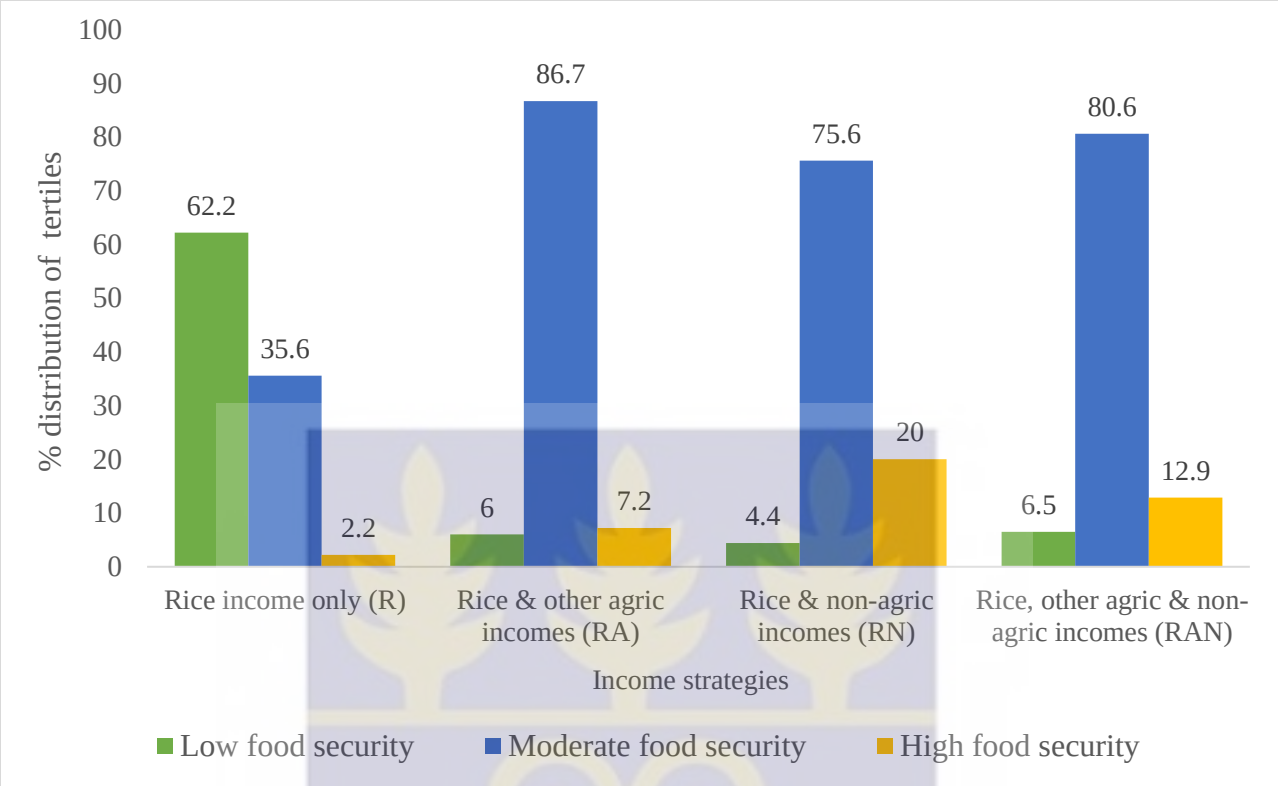
Figure 4.3: Proportion of income strategies within each food security group

A distribution of the different food security levels within the different income strategies presented in Figure 4.4 shows that majority of those who did not diversify (up to 62.2 %) were in the low food security group (first HDDS tertile). Unsurprisingly however, majority of the sampled respondents who diversified (adopted RA, RN and RAN strategies) had relatively better dietary diversity as most of them were in the moderate food security group. Again, this observation goes to confirm the link between income diversification and better household dietary variety since the study found diversification to be associated with higher earnings. This is so because rising income means that households are in a better position to be able to purchase a variety of food items leading to an improved dietary quality.

Table 4.18: Distribution of food security levels within each income strategy

Food security level	Income strategy among farmers			
	Rice income only [R]	Rice & other agricultural incomes [RA]	Rice & non-agricultural incomes [RN]	Rice, other agricultural & non-agricultural incomes [RAN]
	(Percent)			
Low	62.2	6	4.4	6.5
Moderate	35.6	86.7	75.6	80.6
High	2.2	7.2	20	12.9
Total frequency	**45**	**83**	**45**	**31**

Source: Field survey (2016)



Source: Field survey (2016)

Figure 4.4: Distribution of different food security groups within each income strategy

4.5.2 Poisson regression estimates

The Poisson results for effects of income diversification on household food security is presented in Table 4.19. A total of 204 observations were used in the analysis. The probability of the Wald chi-square estimate indicates that the entire model is statistically significant at 1 percent significance level. As already mentioned, the Poisson model works under the assumption of equality between the conditional variance and the conditional mean of the dependent variable. If that is not the case however, then the standard errors will be bias albeit the estimated coefficients are still accurate. For this study, there was no evidence of over-dispersion but rather under-dispersion since the variance of the HDDS (3.24) was less than the mean HDDS of 5.81 (Table 4.11 footnote). To correct for this, robust standard errors were estimated in STATA. The chi-

squared test for goodness of fit (both Deviance and Pearson) were not statistically significant, confirming that the data used fits reasonably well and that the standard Poisson model is indeed suitable. Had the goodness of fit test been statistically significant (without any evidence of over-dispersion of the HDDS), it would have implied that the data does not fit the standard Poisson model hence a variant form of the model such as the Negative Binomial Model could be more appropriate. Multicollinearity test among the independent variables was done using the VIF. The results (presented in the Appendix E) shows no multicollinearity amongst the independent variables as all the estimated VIFs were less than 10.

Rice farm size

An increase in size of rice farm of respondents was statistically significant and positively associated with dietary variety of the household. Farmers with relatively bigger farm sizes are more likely to get more output. The reason is that farmers with large rice farm sizes can produce more to get more income. This will enable them to purchase more food variety for their households leading ultimately to household food security. The argument by Najafi (2003) that one way by which food production can be increased is by expanding area under cultivation supports this very assertion. This finding concords with Aidoo et al. (2013) who maintained that the odds ratio of being food secure increases with an increase in the area under cultivation.

Education

The results show that if a farmer were to increase his education by one year, the difference in the logs of expected household dietary diversity would be expected to increase by 0.0126 unit, ceteris paribus. Education is generally associated with higher incomes as it improves one's chances of

getting better job opportunities. Dietary diversity can also increase with education possibly because farmers with higher education might have better knowledge about dietary intake and the importance of dietary quality hence will incorporate the consumption of more food groups into their habitual household diets than those with relatively low level of education. This substantiates Stewart and Harris (2005) who reported attainment of college education to be positively and significantly related to dietary diversity.

Number of contributors to household food

Contribution to household food took into account the value in-cash and in-kind (food produce from own farm) provided by household members. An increase in the number of contributors to household food could mean two things. In one vein, an increase in the number of persons making in-kind contributions to food could suggest a higher food variety for the household. This is because for a typical household with 3 different farmers for instance, there is the tendency that all the farmers in question are contributing different food stuffs from their respective farm to the home since chances are that each of them might be cultivating different crops. This will inevitably lead to an increase in the variety of food items available to the household. In another scenario, an increase in the number of household cash contributors to food expenditure with a constant household size implies a rise in the available household per capita income for food. In this situation, relatively more persons will now be sharing the burden of household food expenditure hence that household will be able to purchase a variety of food items/food groups, leading to a better dietary quality for that household. A study by Ojogho (2010) revealed that a high number of non-working household members puts pressure on the food and non-food resources of the household which increases the household food insecurity, thus supporting the finding of this study.

Household size

Increase in household size was negatively associated with household dietary diversity even as expected. For instance, a seventh person added to a household without a change in the household income implies a reduction in household per capita income which can indirectly impact on the household ability to purchase a variety of foods. An increase in household size implies more pressure on household food resources. Increasing household size with constant income means a reduction in funds available per head for food and other needs. This will limit the household's ability to purchase food since the same amount of money which was hitherto allocated for the needs of the household is now going to be shared by relatively more persons. If a farmer's household size increases by one person, the difference in the logs of expected household dietary diversity would be expected to decrease by 0.0221 unit, holding all other predictor variables unchanged. This finding further confirms the result of the correlation test between dietary diversity and household size above which was inverse and statistically significant. The result however differs from that of Gaiha et al. (2012) but conforms to the finding of Stewart and Harris (2005) who also reported an inverse relationship between household size and dietary diversity.

Per capita food expenditure

Though this study considered dietary diversity at the household level, per capita expenditure on food was used for the analysis of this objective to control for the effects of household size on spending. The Poisson regression results revealed a positive and a significant relationship between per capita monthly food expenditure and household dietary diversity at 1 percent significance level. An increase in per capita food expenditure will predictably lead to 0.0012 unit increase in

the difference in the logs of expected counts of household dietary diversity. As spending increases, households try new food items leading to more dietary variety. Similar to this finding, another study by Pellegrini and Tasciotti (2013) involving 8 different developing countries across different continents also revealed a positive and significant relationship between dietary diversity and household food expenditure. In another study to find out the associations between dietary diversity score and commonly used indicators of socioeconomic status in Bangladesh, Thorne-Lyman et al. (2010) also found a positive correlation between dietary diversity and household food expenditure.

Effects of income diversification on food security

To shed extra light on both the direction and the extent of the relationship between income diversification of respondents and household food security, three dummy variables were included in the regression to represent each of the three diversifying income portfolios in the study. These were; diversification within the agricultural sector (RA strategy), combination of rice income with non-farm income (RN strategy) and combination of rice farm with both agricultural and non-agricultural incomes (RAN strategy). These variables test for the effects of the different income diversification strategies on household food security. The results in Table 4.19 show a positive relationship between diversification and food security. Each of the diversification strategies farmers adopted (RA, RN and RAN) influenced household food security positively.

The effect of RN diversification strategy (combining rice income with non-agricultural incomes) on household dietary diversity was more pronounced than the other diversification strategies. This observation holds true because the study established in discussion of the socio-economic characteristics that income diversification was associated with higher incomes, with farmers in RN

diversification category being joint highest earners (GHS 5506.67) with those who chose RAN income strategy (earned GHS 5475.81) for the sample. This is not surprising because food is a normal good and from economic theory, as income increases, consumers increase their demand for it. Varying income levels result in different quantity demanded because of the difference in purchasing power. Consequently, households with more monetary power will increase their utility by purchasing a lot more food variety leading to a better food security. The magnitude of the effect of the RN diversification strategy on food security was 0.2050. What this implies is that adopting RN income diversification strategy will result in a farmer increasing the difference in the logs of expected household dietary diversity by 0.2050 unit. In line with this finding, Thiele and Weiss (2003) argued that a positive effect of income of a household on food diversity is corroborates the hypothesis that consumption evolves along hierarchical order as income increases. In a study by Owusu et al. (2011) in Northern Ghana, the authors found participation in non-farm work to improve household food security, arguing that participation in non-farm work is crucial in raising household income.

The results also revealed that adopting income diversification strategy RAN and RA will result in farmers increasing the difference in the log of expected household dietary diversity by 0.1863 and 0.1625 units respectively. Income diversification does not only raise income of farmers. It can also serve as an important risk mitigating strategy bearing in mind the risky nature of farming. By combining rice farm income with other agricultural and non-agricultural income sources, respondents smoothen their incomes which in turn smoothens or better still improves their household food security.

The positive and significant association between income diversification and dietary diversity in the Poisson model confirms the graphs presented in figures 4.3 and 4.4 above where a linkage between non-diversification and being in the low food security household was observed. This finding draws credence to the assertion by Aidoo et al. (2013) that participation in off-farm activities improves food security status in the Sekyere-Afram Plains District of Ghana. In another study, Pellegrini and Tasciotti (2013) also found a positive correlation between crop diversification (which in this study falls in the RA strategy), crop income and dietary diversity.

Table 4.19: Poisson regression results for effect of income diversification on household food security

HDDS	Coefficient	z
Number of contributors to household food	0.0390**	1.9300
	(0.0202)	
Education	0.0126***	3.5800
	(0.0035)	
Household size	-0.0221**	-2.2200
	(0.0100)	
Land tenure	-0.0099	-0.4100
	(0.0242)	
Per capita food expenditure	0.0012***	2.5500
	(0.0005)	
Rice farm size	0.0355**	2.2000
	(0.0161)	
Rice yield	0.0000	1.5800
	(0.0000)	
Income saved	0.0000	1.1800
	(0.0000)	
Rice and other agric (RA)	0.1625***	4.0300
	(0.0403)	
Rice and non-agric (RN)	0.2050***	4.4300
	(0.0463)	
Rice, agric and non-agric (RAN)	0.1863***	3.9200
	(0.0476)	
Constant	1.2758***	10.3700
	(0.1230)	
Number of observations = 204	**Prob > chi2 = 0.0000**	
Wald chi2 (11) = 255.9500	**Log pseudolikelihood = -383.0425**	
	Pseudo R2 = 0.0403	
Deviance goodness-of-fit = 31.6039		
Prob > chi2(192) = 1.0000		
Pearson goodness-of-fit = 31.3822		
Prob > chi2(192) = 1.0000		

** and *** signify statistical significance at 5% and 1% significance level respectively.

Figures in parenthesis are Robust Standard Errors

Source: Field survey (2016)

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of key findings and draws conclusions based on these findings. The chapter ends with policy recommendations made by the study.

5.2 Summary of major findings

The study assessed the effect of income diversification of rice farmers on household food security in the North Tongu District of the Volta Region. Three specific objectives were set out. The first was to estimate the factors that influence the choice of income diversification strategies by rice farmers. The second objective was to measure the household food security status of the rice farmers and the last objective was to estimate the effects that rice farmer income diversification has on household food security. In all, 204 rice farmers were sampled using multi-stage sampling technique. Data on income and all economic activities that the rice farmers indulged in during the major planting season of 2015 was collected using well-structured questionnaires in a survey. Information on household food consumption and expenditure on food were also obtained during the survey. Depending on their income portfolios, the farmers were categorized into four (4) groups: 'Rice income only' (no diversification), 'Rice and other agricultural incomes' (RA strategy), 'Rice and non-agricultural incomes' (RN strategy) and 'Rice plus other agricultural and non-agricultural incomes' (RAN strategy). The data collected was analaysed using STATA. The factors influencing the choice of income diversification strategies of farmers was estimated using the multinomial logit model. Rice farmers' household food security was measured using the household dietary diversity score. The Poisson regression model was used to estimate the effects

of rice farmers' income diversification on household food security. Major findings from the study are as follows:

- Rice farmers who did not diversify their incomes ('Rice income only' strategy) comprised of 22.06% of the sample. Diversification within the agricultural sector ('Rice and other agricultural income sources') was the modal income strategy; more than 40 percent of the respondents chose this strategy. Among all the income portfolios, respondents who chose the 'Rice and non-agricultural incomes' and 'Rice, other agricultural and non-agricultural incomes' were the joint highest earners while those who did not diversify at all had the least incomes
- The study revealed that gender of respondent, household size, being a household head, rice farm size and income saved were among factors found to affect the choice of income strategy. The rest were perception of available job opportunities, employable skills, rice credit access and household monthly expenditure on food.
- Out of a total of 12 reference food groups, the households reached consumed an average of 6 food groups; cereals, vegetables, roots and tubers, fish, condiments and sweets. These are food groups consumed by more than 50% of the sample. The mean dietary diversity score of 5.81 for the sample further reflects this finding.
- Households in the low food security group had an average HDDS of 3.81; they were 18.1% of the sample. The moderate food security households were over 72% of the sample; they had an average dietary diversity score of 5.98, consistent with the number of food groups consumed by more than half of the households therein. Households in the high food security category had an average HDDS of 8.3; only 9.8% of the households were in this group.

- The corresponding mean incomes of respondents in the different food security levels (HDDS tertiles) showed that those in the low food security level earned the least while their counterparts in the high food security group earned the highest incomes. Results of the difference in mean income test for the different income strategies highlighted this assertion.
- Rising farmer income as well as household food expenditure per capita, were both positively and significantly associated with dietary diversity as was evidenced in the correlation tests and cross tabulations. Household size however had an inverse relationship with dietary diversity albeit it was also significant.
- The study revealed that majority of the respondents from the low food security households did not diversify their income. On the contrary, only a few of the respondents from high food security households did not diversify their incomes; most of them engaged in multiple income generating activities. Again, distribution of the different food security levels within each income portfolio revealed that majority of respondents who did not diversify happened to be in low food security households.
- The study found rice farm size, education of rice farmer, household size, number of income contributors to household food and food expenditure per capita to be the socio-economic factors that affected the rice farmers' household food security. Most importantly, the model revealed that each of the income diversification strategies (RA, RN and RAN strategies) had a positive and significant effect on the food household security as measured by the household dietary diversity.

5.3 Conclusions of the study

The following conclusions are made from the study:

- Most of the respondents diversified their income sources. Chief among the diversification strategies adopted by the rice farmers was engaging in other income activities within the agricultural sector ('Rice and other agricultural incomes' strategy) as that was the modal income portfolio. This could be attributed to the relative ease with which it will take the average farmer to cultivate other crops in addition to the rice farming or seek wage employment in the commercial farms in the area than enter into an altogether new non-farm venture.
- Income increases with diversification since farmers who did not diversify earned the least incomes for the season. Engaging in non-agricultural activities alongside farming was especially associated with earning high incomes.
- Gender, household size, being a household head, rice farm size, income saved, perception of job availability, employable skills, rice credit access and total household monthly food expenditure were the factors that influenced the rice farmers' decision to participate in income diversification.
- The average dietary diversity score of the rice farmers' households was 5.81, indicating consumption of fairly 6 out of the total of 12 food groups by households in the study area. Majority of the households had moderate food security (middle HDDS tertile). Only 18.1% of the households were in the low food security group (least HDDS tertile). Dietary diversity showed fair relationship with common food security indicators. It was strongly correlated with the income of rice farmers and household food expenditure per capita. The

score also showed an inverse and significant relationship with household size, implying that household food security decreased with increasing household size.

- Majority of the households of farmers who did not diversify had low food security. This is because of importance of rice farmers to provision of the food needs of their households. As a result, the income portfolio farmers chose had a predictable impact on their households as a whole.
- Attainment of high food security is associated with diversification into non-agricultural activities. This is because engaging in non-agricultural activities was associated with high incomes and farmers who did so had sufficient money to help meet the food needs of their households.

5.4 Recommendations of the study

Based on the findings and conclusions of this study, the following recommendations were made:

- The North Tongu District Directorate of Agriculture (formerly called District MOFA Office) should in collaboration with NGOs organize farmer-field workshops periodically in the area to train farmers in order to develop their skills and increase their awareness of available opportunities in the area so they can take on non-farm jobs to complement their farming.
- The Women in Agricultural Development (WIAD) Unit of MOFA which specializes in equipping women with special skills outside of farming such as soap making, soya kebab making among other business enterprises should intensify their programmes in the area as female rice farmers were more likely to combine their rice farming with non-farm activities.

- Particular attention should be given to commercial farms operating in the study area by government. Policies that will foster the production of these farms should be given priority as they serve as a major source of employment to the farmers in area.
- Farmer awareness on the need for crop diversification and livestock production should also be intensified in the area. This can be achieved through on-site demonstration for different crops and livestock that can do well in the area. Advice on particular crop and/or livestock to choose should be based on the margins that emerge from the field trials.

5.5 Suggestions for future research

Researchers may want to consider expanding this current study to different districts in the region as well as different parts of the country to look at how income diversification affects food security and the specific factors that affect income diversification so that specific policies can be formulated to improve the welfare of farmers.

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APPENDICES

APPENDIX A
QUESTIONNAIRE FOR THE SURVEY
DEPT OF AGRICL ECONOMICS AND AGRIBUSINESS, UNIVERSITY OF GHANA

This study is a student thesis on the topic, **Effect of Income Diversification on Household Food Security: The case of Rice Farmers in the North Tongu District of Ghana**. All information gathered will be treated with much confidentiality and will solely be for academic purposes. Your support and contribution would be very much appreciated.

Questionnaire ID…… Date of interview……/……/…..…..

District..... Community…….

Enumerator…… Phone Number of respondent……

Demographics

1	Name of household head ……..	2	Age ……years
3	Gender: 1=Male 2= Female	4	English Proficiency 1=Read 2=Write 3= Read and Write 4= None
5	Highest level of formal education? 0= None 1=Basic (Primary/JHS/Middle) 2=Secondary (SHS) 3=Vocational 4=Tertiary (training college/polytechnic/university) 5=Islamic education 6=other, specify	6	Marital status of respondent? 1=Married 2=Single 3= Divorced /Separated 4=Widowed
		7	Are you a household head?
		8	What is your household size?

9. Objective 1: **Detailed household composition (TABLE 1)**

ID	Household Member	Relationship to Household head (Code A)	Age	Sex (1= M 2=F)	Education		Occupation		Other Incomes		Monthly Income Contribution to household
					Highest level attained (Code B)	No. of years spent in school	Primary occupation (Code C)	Income generated per season	Job/ Activity	Income per month	
1.	Rice farmer										
2.											
3.											
4.											
5.											
6.											
7.											
8.											

CODE A
1. Biological child
2. Grandchild
3. Nephew/niece
4. Self
5. Siblings
6. Non-relative
7. Other relative
8. Spouse
9. Others (specify)

CODE B
1. No schooling
2. Primary
3. JHS/Middle School
4. MSLC
5. SHS/Vocational
6. Tertiary
7. Others

CODE C
0=None
1=Rice farming
2= Other Crop farming
3= Fishing
4= Livestock farming
5=Agricultural wage employment
6=Trading
7=Non-agricultural salaried work (specify)
8=self-employed(off-farm)
9=Others (Please specify ……..…...

10. How long have you been farming rice […….] years

11. Ownership status of the land for rice farm? 1= Own 2=Lease (More than 2 years) 3=Rented (for less than 2 years) 4= IDA Project plot 5=Others (Specify)…….

12. What is the main purpose of your farming (choose one)? 1= household consumption 2= sale 3=both consumption and sale 4= other (specify)……

13. Is your income from rice farm sufficient to meet the needs of your household? 1=Yes 0=No

14. Household Food Expenditure: TABLE 2:

ID	Household Member	Cash contribution per month	Food contribution in kind			Total Household expenditure on food per month
			Produce	Quantity contributed per month	Value in GH cedis	
1.	Rice farmer					
2.						
3.						
4.						

Sources of income

15. Farm income activity **TABLE 3**

No	Tick	Farm Enterprise/Activity for 2015	Size/Qty (Hectares/absolute number)	Quantity harvested (kg)	Amount received from sale (GHS)	Income (GHS)
		Rice farm				
		Other crops (Specify):				
		Natural Resource: Fishing, Hunting, Firewood gathering etc				
		Livestock:				
		Farm wages (per season)				
		Others (specify if applicable)				
		TOTAL AMOUNT GHS				

16. How much of your rice farm income did you save in 2015?.....

17. Do you think there are job opportunities available for you in your community? 1=Yes 0=No

17b. If yes, name them……

18. Do you have any employable skills (Apart from farming, can you do anything else for a living)? 1=Yes 0=No

18b. If yes, name them…….

19. Do you engage in non-farm income generating activities? 1=Yes 2=No

19b. If yes, what are the sources of your non-farm income……

20. **TABLE 4: Non-farm income activity (for the season)**

No	Tick	Non-Farm Income activity	Amount received (Cash)	Amount in kind if applicable
		Non-farm wage income		
		Self-employed income (Trading, Artisanship, etc)		
		Other earnings (capital earnings, pensions etc)		
		TOTAL AMOUNT		

20b. Why do you engage in different income generating activities (if applicable) [YOU MAY TICK MORE THAN ONE OPTION?

TICK

a) For income Security [1= Yes 2=No]

b) To meet household needs [1= Yes 2=No]

c) For pleasure [1= Yes 2=No]

d) Other reasons (Specify) ……...[1= Yes 2=No]

21. **Remittances** received per month GHS……

22. From which of the following sources do you get income? (YOU CAN TICK MORE THAN 1 IF IT APPLIES)

1=Rice farming only 2= Other agricultural sources 3= Non-Agricultural sources

23. Did you have access to formal credit for your rice farm during the last cropping season
1=Yes 2=No

23a. If yes, from which source(s)? 1=formal bank 2=NGO/cooperative 3=family members
4=money lenders 5=other,
specify…….....

24b. If no, what are the difficulties you have in obtaining the credit you need? 1=no collateral
2=cannot meet loan repayment schedules 3=complicated loan processing procedure
4=no need 5=other, specify…….

25. Did you have access to formal credit for your other business in 2015 (If applicable) 1=Yes
2=No

TABLE 5

Assets	**Number**	**Current total value**	**Assets**	**Number**	**Current total value**
Motor cycle			Telephone(mobile)		
Bicycle			Fridge and freezer		
Car/truck			Furniture		
Radio/cassette/CD			Knapsack sprayer		
Television			Sewing machine		
Video/ DVD player			Other land		
Other, specify			Manual farm tools		

26. What is the asset base of your household?

27. What is the distance to the nearest market centre?.....(State the name of the market)

28. Do you have access to electricity 1=Yes 0=No

29. What are the various infrastructures in this community?

……
……
……

Food Security

Household Dietary Diversity Score (HDDS)

30. Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home in **TABLE 6** below

Table 6: Record of food consumed in the last 24 hours

BREAKFAST	Snack	**LUNCH**	Snack	**SUPPER**	Snack

31. Fill in the corresponding food groups consumed by the respondents in Table 7 using the information in Table 6

TABLE 7: Food diversity and consumption score (HDDS)

No.	Food group	Examples	YES=1 NO=0
1	CEREALS	maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + *insert local foods e.g. gari, porridge or paste*	
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots such as cassava dough	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + *other locally available vitamin A rich vegetable (e.g. red sweet pepper)*	
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as ademe, kontomire, cassava leaves, kale, spinach*	
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) + *other locally available vegetables*	
6	VITAMIN A RICH FRUITS	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + *other locally available vitamin A rich fruit*	
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these	
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg	
11	FISH AND SEAFOOD	fresh or dried fish or shellfish	
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OILS AND FATS	oil, fats or butter added to food or used for cooking	
15	SWEETS	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	
16	SPICES AND CONDIMENTS	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages	
Household level only	Did you or anyone in your household eat anything (meal or snack) OUTSIDE the home yesterday?		

Appendix B: Coefficients of Multinomial Logit Regression for factors influencing choice of income diversification strategy

VARIABLES	(1) Rice income only (R) (Base category)	(2) Rice and other agricultural incomes (RA)	(3) Rice and non-agricultural incomes (RN)	(4) Rice income plus other agricultural and non-agricultural incomes (RAN)
Age		-0.0101	-0.0151	0.00380
		(0.0360)	(0.0454)	(0.0403)
Education		-0.1060	-0.0180	-0.0142
		(0.1160)	(0.131)	(0.140)
Gender		-1.3010*	-3.238***	-0.837
		(0.7450)	(0.824)	(1.151)
Household head		1.8230*	2.319**	1.205
		(1.080)	(1.203)	(1.229)
Household size		-0.6570***	-0.768***	-0.625*
		(0.2510)	(0.292)	(0.347)
Rice farm size		-0.9080**	-1.036**	-1.614**
		(0.4520)	(0.495)	(0.774)
Rice income		0.000878	0.000602	0.000949
		(0.000814)	(0.000854)	(0.000949)
Income saved		0.00277**	0.000846	0.00118
		(0.00132)	(0.00132)	(0.00132)
Job availability		2.991**	3.382**	2.101
		(1.279)	(1.489)	(1.349)
Employable skills		-0.510	2.325**	1.066
		(0.745)	(1.025)	(0.909)
Rice credit		-2.824***	-2.807***	-2.346**
		(0.887)	(0.972)	(0.952)
Asset base		0.000561	0.000857	0.000765
		(0.000609)	(0.000631)	(0.000632)
Food expenditure		0.00571	0.0157*	0.0156*
		(0.00690)	(0.00845)	(0.00906)
Constant		2.262	-2.285	-3.504
		(2.415)	(3.310)	(3.326)
Observations	204	204	204	204

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix C: Variance inflation factor test for Multinomial Logit Model regressors

```
. vif

    Variable           |       VIF       1/VIF
-----------------------+----------------------
Rice income            |      2.72    0.367668
Rice farm Size         |      2.50    0.400003
Total Food Expenditure |      2.18    0.459595
Household Size         |      1.82    0.550144
Age                    |      1.76    0.568987
Education              |      1.75    0.572592
Employable Skills      |      1.49    0.669518
Gender                 |      1.47    0.680252
Household Head         |      1.47    0.680296
Asset base             |      1.46    0.683796
Income saved           |      1.42    0.701876
Job availability       |      1.34    0.747263
Rice credit            |      1.18    0.846659
-----------------------+----------------------
              Mean VIF |      1.74
```

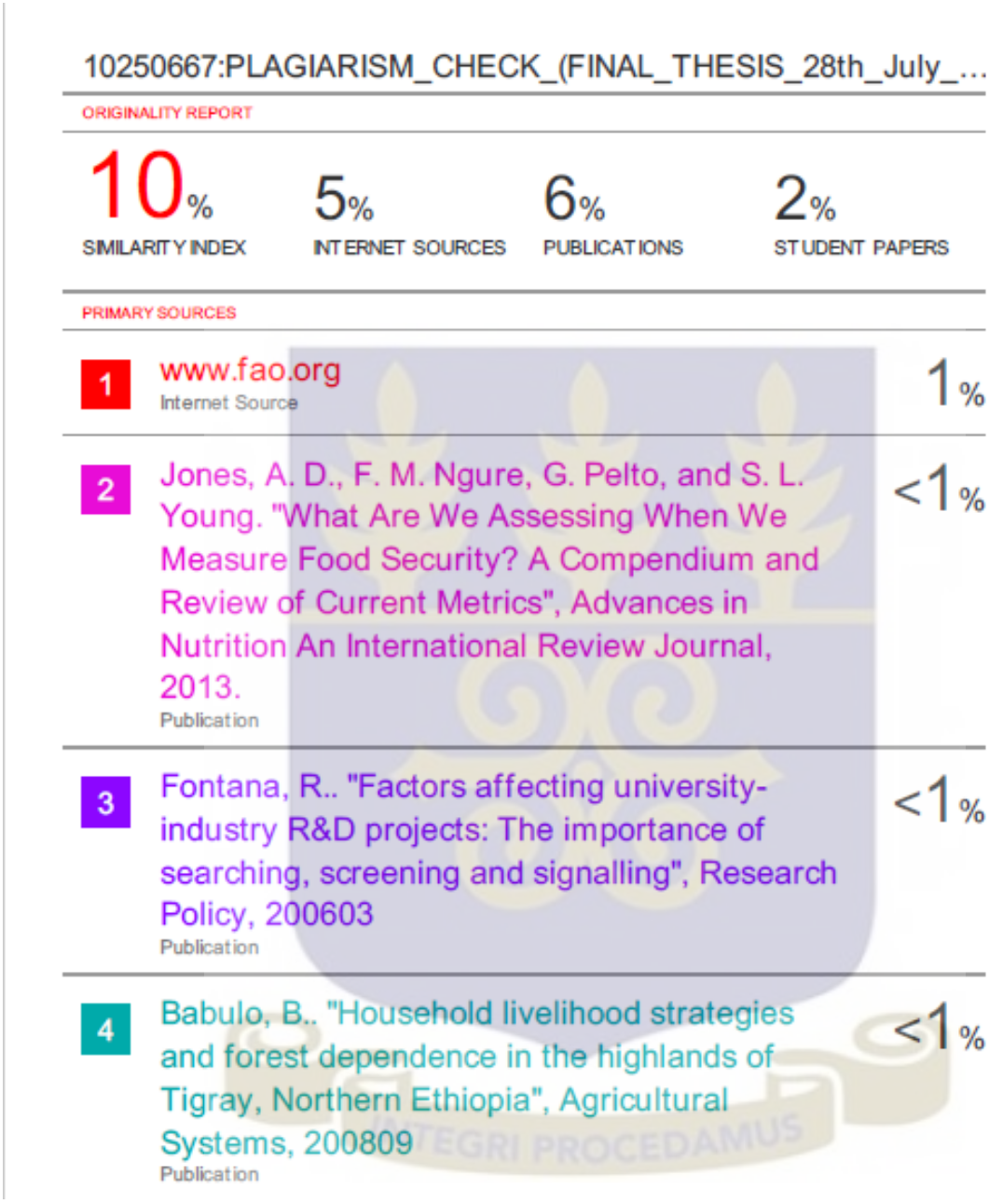
Appendix D: Test for Normality of HDDS

```
swilk HDDS

                  Shapiro-Wilk W test for normal data

    Variable |    Obs       W           V        z       Prob>z
-------------+-------------------------------------------------
        HDDS |    204    0.99373      0.952   -0.113    0.54511


      Ho: HDDS is normally distributed
```

Appendix E: Variance Inflation Factor for regressors of Poisson model

```
. vif

Variable                    |       VIF       1/VIF
----------------------------+----------------------
Per Capita Food expenditure |      2.89    0.346573
Household size              |      2.72    0.368215
RA                          |      2.33    0.428358
RN                          |      1.94    0.514844
RAN                         |      1.81    0.553543
Income saved                |      1.48    0.674687
No. of contributors to food |      1.45    0.687599
Rice farm size              |      1.44    0.696411
Education                   |      1.41    0.707028
Rice Yield                  |      1.12    0.891041
Land tenure                 |      1.10    0.912642
----------------------------+----------------------
                  Mean VIF  |      1.79
```

Appendix F: Plagiarism Report



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