48- Determinants of food-poverty states and the demand for dietary diversity in Nigeria

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Contributed paper prepared for presentation at the 4th International Conference of the African Association of Agricultural economist (AAAE), Cape Town, Hammamet, Tunisia, 22 - 25 September, 2013.

Abstract

The study employed multinomial logit and fractional regression models to investigate determinants of food-poverty *FP* states and the demand for dietary diversity, respectively using 2003/2004 Nigerian Living Standard Survey (NLSS) data. The FP states is derive by combining two food security indicators defined as food expenditure (FOOD_exp) and dietary diversity score (DDS), which yielded four possible scenarios viz. completely food secure, food insecure based on FOOD_exp only, food insecure based on DDS only, and completely food insecure households in the study. The determinants of the household FP states show that odds ratio of households being in state of food insecure relative to completely food secure increased significantly with household size, among households headed by farmers, households that own produced and purchase only food consumed, and households in the rural areas but decrease significantly as income level increases. Also, the determinants of household dietary diversity shows that household income, household size, household with members <40 years old, households headed by farmers and households in rural areas, increased significantly dietary diversity consumed in the study. In contrast, more educated household head and household that only home produced their food are likely to demand for less dietary diversity. The implication of these findings is that households in the different states of food-poverty problem are likely to be affected by different socio-economic characteristics, as demand for dietary diversity also differ across household socio-economic variables in Nigeria. Based on this, the study suggests that the present approach could be useful in targeting different types of food insecurity problem in the developing economies and Nigeria as a whole.

Key words: dietary diversity, food security, food-poverty, food expenditure, Nigeria

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Acknowledgements
The author gratefully acknowledges the financial support of the Alexander von Humboldt (AvH) Foundation towards his postdoctoral fellowship at the Dept. of Food Economics and Consumption Studies, University of Kiel, Germany, where this study was carried between November2010-September2012. The views in this paper are the author's own and do not necessarily represent those of the AvH and University of Kiel.

1.0. Introduction

The multidimensional features of poverty makes it difficult to define and measure other than through indicators for assessing household welfare such as food, clothing, and shelter and among others. Within this context, household food–poverty or more generally food insecurity is often used interchangeably with concept such as poverty. This is because discussion of food insecurity cannot be divorced from those of core poverty, since sufficient access to food is one of the key components of United Nations' Millennium Development Goals (MDGs) of having poverty across the globe by the 2015. Besides, food is regarded as one of the major key for sustaining life through the provision of life's essential nutrient for maintenance of good health, labour productivity, and human well-being. As noted by Nyariki and Wiggins (1997), food poverty just like core poverty is a relative concept. Meaning that food insecurity problem/food-poverty may not be of the same nature and extent for all people at all times and in all regions; it may be time, location, group or even culture –specific.

The state of household food-poverty or food insecurity is an evolving concept that is wide spread in both the developed and developing countries. As noted by Smith and Subandoro (2007), food insecurity continues to be a major developmental problem across the globe, thus undermining people's health, productivity and often their very survival. The phenomenon is most felt in the low-income countries, especially in sub-Saharan Africa (SSA). For example, of the estimated 923 million undernourished people in the world, about 200 million are in SSA (FAO, 2008). And, according to Kuku and Liverpool (2010) and Amalu (2002), conflict, drought, famine, degradation, deforestation, land tenure system, increased food price due to the growth in the demand for biofuel, water stress, global climate change, extension gap, and low agricultural productivity are some of the factors restricting access to food or constraints to food production and food security in SSA.

However, the definition, perception, and concept of food security have evolved over the years. In the 1970s, the conventional wisdom was that food insecurity or state of food poverty is a supply issue at aggregate level and thus, was caused by decline or failure of aggregated food availability either at the local, regional, national or global level (Feleke *et al.,* 2005). Also, in the early 1980s, Amartya Sen's (1981) suggestion that food insecurity is more of demand side, affecting the poor's access to food, than a supply side affecting availability of food at the national level shifted the discussion towards this direction. But in the mid 1990s, there is a growing concern of nutritional and health dimensions of food security, which led to the modification of the then definition of food security and subsequently the introduction of new definition during the 1996 World Food Submit in Rome Italy. The new food security definition is thus defined as situation when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). Nevertheless, the widely accepted 2009 World Food Submit

definition reinforces multidimensionality of food security that includes food availability (supply side), food accessibility (demand side), food utilization (demand side), and food sustainability/stability (supply side) (FAO, 2009). And, these four dimensions of food security are hierarchical in nature. Meaning that food availability is necessary but not sufficient for food accessibility and accessibility is necessary but not sufficient for food utilization, while food utilization is necessary but not sufficient for food sustainability.[2]

The Nigerian food security situation is characterized by inadequate domestic food supplies and increasing food imports (Akoroda, 2010). As noted by Ogundari (2013a), the growth rate in the food sub-sector currently observed is about 2.7 percent in Nigeria, which is far too low for a country whose population is growing at the rate of 3.5 percent. The author argued further that this low growth is largely responsible for the worsening food insecurity in some parts of the country as domestic food production cannot keep pace with the rapid growing population of over 170 million people. In terms of nutrient intake, available statistics also show that between 1961-2008, the average daily per capita calorie and protein intakes in Nigeria are still below the recommended daily consumption by the Food and Agricultural Organization (FAO) in Nigeria (Ogundari, 2013b). Also, Akinyele (2009) found that about 42%, 25%, and 9% of children in Nigeria were stunted, underweight, and wasted, respectively in 2003. Likewise, recent statistics by Anyanwu (2012) revealed that the national poverty incidence as at 2010 is about 69%, which is about 15%, 2%, 26%, 23% and 41% higher than what was obtained in 2004, 1996, 1992, 1985, and 1980, respectively in Nigeria. The implication of these findings is that one of the basic development challenges facing Nigeria today is the quest for self-sufficiency in food in spite of evidence that the country is blessed with enormous human and material resources.

There are two measures of food poverty (food insecurity) in the literature viz., subjective (or indirect) and objective (direct) measures. A typical example of subjective measure includes the use of indicators such as coping strategy index (see Kuku and Liverpool, 2010) and self-report/self-assessment (Obayelu, 2010). Also, example of objective measures include indicators such as cost of attaining minimum energy, food expenditure/share of food in household total expenditure, food production index, dietary diversity score, nutrient intake (calorie, protein, vitamins etc.)-known as FAO indicator of undernourishment, food stock, the global hunger index, global food security index, food and hunger index, and anthropometric measures among others (for more detail see; Pradhan *et al.,* 2001; Savey *et al.,* 2005; Rhoe *et al.,* 2008;Heady and Ecker, 2012; Pangaribowo *et al.,* 2013). As often mentioned in the literature, the use of subjective approach avoids shortcomings associated with the use of objective indicators that includes measurement error, recall problem or under report in the survey data. But according to Barrett (2010), the choice among the indicators involves tradeoff as objectives necessitating measurement commonly drives the choices of the indicators and also data availability. As also noted by Habicht and Pelletier (1990), the choice of

[2] Availability connotes physical presence of food in large amounts, accessibility suggests efficient purchasing power at al times, utilization reflects the demand for sufficient quantity and quality of food intake in term of nutrient consume, and sustainability refers to adequacy of food at all times.

indicators, measurements, analyses, and the need for other data can be very different for inferences from research, for making public policy, or for planning or evaluating program. In view of this, the authors concluded that there is no best indicator, best measure of an indicator, or best analysis of an indicator in a generic sense as "best" depends ultimately on what is most appropriate for the decision that must be made.

A search in literature shows that several studies have focused on determinants of food security/insecurity across the globe and also in Nigeria over the years. Some of the studies from Nigeria include; Sanusi *et al.,* 2006; Babatunde *et al.,* (2007), Omonona and Adetokunbo, (2007), Fakayode *et al.,* (2009), Babatunde and Qaim (2010), Arene and Anyaeji (2010), Obayelu (2010), Austin *et al.,* (2011), and Asogwu and Umeh (2012) and among others. These studies like many other studies across the globe employed various food and nutrition security indicators to classify households into food secure or insecure but with mixed results. However, some of the indicators used by these studies ranges from self-report/assessment, recommended daily calorie requirement of 2500 kilocalorie per day, two-third of per capita food expenditure to anthropometric measure. But unlike these aforementioned studies, a major contribution of this study to knowledge is the novel idea of combining two food and nutrition security indicators to reflect the hierarchical nature of food security dimensions, in particular food availability and accessibility, which represent food supply and demand side, respectively in Nigeria.[3] Besides, the present study is unique in that unlike previous studies, it uses nationally representative household survey that cut across all the geopolitical zones in the country, as this likely to provide national estimates that is more crucial for policy making, since individual level estimates demonstrated in the previous studies are not ensue at the national level.

To this end, household food poverty indicators is obtained by combining per capita food expenditure representing food accessibility and dietary diversity score (DDS) representing food availability and dietary diversity index derive from household expenditure on the identified food groups in the study.[4] The combined two indicators yielded four possible states of food-poverty defined as *completely food secure*, *food insecure based on FOOD_exp only*, *food insecure based on DDS only*, and *completely food insecure* household to reflect different groups of households with different types of food security problem/situations in Nigeria. And, given this, the study intended to identify households socio-economic variables, which distinguish completely food insecure and transitorily food insecure households from completely food secure households in Nigeria. This analysis however, is important because food insecurity indicator is synonymous to social welfare indicator. Based on this, the approach can be useful targeting different types of interventions to groups of households with different types of

[3] Since food security analysis has shifted from global and national level to household and individual level (Barrett, 2010), food availability and accessibility are best measure using micro or household level data, especially for short-term food security outcome (Pangaribowo *et al.,* 2013).

[4] The important questions is, does dietary diversity capture by the DDS necessary translate to sufficient and adequate food security or does available purchasing power capture by expenditure on food translate to acquiring quality food at all time? In as much it is obvious that these indicators cannot stand alone to provide the answer to the questions, the combination of these indicators is likely to provide information on different groups of households with different types of food (in) security situations/problem in Nigeria.

food insecurity/welfare problem. In this case, understanding the link between household food insecurity indicators and household socio-economic characteristics is important for policy makers as potential information for improving and designing social welfare programs that could help more vulnerable members of society to move out of food-poverty states in Nigeria. However, the rest of the paper is organized as follows. The next section describes the theoretical framework and food security indicators in the study. Section three focuses on the data used in the study. Section four presents the empirical mode, while section five focuses on the results and discussion. Concluding remarks are provided in section six.

2.0 Theoretical framework and food security indicators in the study

2.1. *Theoretical framework*

The theoretical framework for modeling household food poverty and in general food insecurity is build within the framework of household utility model. Given this, we model household utility within the framework of consumer demand and production theories in recognition that some households are both consumer and producer. In this regards, we adapted generalized household utility function proposed by Singh *et al.,* (1986), where households' utility is model to integrate production, consumption and leisure decisions simultaneously as

$$U_i = u\left(C_i, l_i \middle| x_i\right) \qquad 1$$

where, $U$is a utility function that is twice differentiable, increasing in its arguments, and strictly quasi-concave; $C_i$is a vector of *i-th* household consumption demand, which include food (C_f), and non-food (C_{nf}); $l_i$is time devoted for leisure and $x_i$is vector of household socio-demographic variables included in order to recognize that household utility derives from combination of decisions depend on preferences of its members.

Thus, C_i can further be defined as

$$C_i = \left(C_f, C_{nf}\right)' \qquad 2$$

Since we recognize that it is likely some households are both consumer and producer of food, then $C_f$can be considered as a vector of home-produced and consumed food (f_{hp}) and market –purchase food (f_{mp}). Within this context, $C_f$can further be specified as

$$C_f = \left(f_{hp}, f_{mp}\right)' \qquad 3$$

Substituting equations 2 and 3 into equation 1 gives Singh *et al.,'s* (1986), generalized utility function defined as

$$U_i = u\left(\left(C_f, C_{nf}\right)', l_i \middle| x_i\right) \quad 4a$$

$$U_i = u\left(\left(\left(f_{hp}, f_{mp}\right)', C_{nf}\right)', l_i \middle| x_i\right) \quad 4b$$

But optimization of equation 4b requires that household's production and consumption decisions are made separately on the assumption that all relevant market function, especially for households that are both producer and consumer of food items and subject to certain constraints viz., production, income and time. In this case, production decisions are made first and subsequently used in allocating the full income between consumption of goods and leisure (Strauss, 1983). According to Feleke *et al.,* (2005), it is important to have this assumption because it is believe food security or food consumption depends on production variables, but not vice-versa.

Thus, in consistent with the work of Singh *et al.,* (1986), the production, income and time constraints impose in course of optimizing equation 4b can be specified as follows

Production Constraint:

$$f\left(Q_{hp}, L, A^o, K^o\right) = 0 \quad 5$$

Therefore, equation 5 is typical household production function for commodity Q_{hp} produced at home assumed to be twice differentiable, increasing in outputs, decreasing in inputs, and strictly, convex; Q_{hp} is vector of quantity of food produced from the farms; A^o is the farm size; K^o is the fixed capita stock; L is total labour used on the farm.

Income Constraint:

$$P_i\left(Q_{hp} - f_{hp}\right) - P_{mp}.f_{mp} - P_{np}.C_{nf} - w\left(L - l_f\right) + N = 0 \quad 6$$

From equation 6, P_i is the price of food produced, $Q_{hp} - f_{hp}$ is the marketed surplus food produced; w is the wage rate; l_f is the total family labour supply on the farm; P_{mp} is the price of market purchased food items; P_{np} is the price of non-food item; f_{mp} is quantity of market purchase food; C_{nf} is non-food item demanded such as education, health, housing etc.; N is the non-farm income adjusted to ensure that equation 6 equal to zero.

Time Constraint:

$$T = l_f + l \text{ and } l_f = T - l \quad 7$$

where, T is household's time endowment receive in each time period, which is allocated between leisure l and time spent working on the farm l_f.

Substituting right hand side (RHS) of equation 7 into 6 gives

$$P_i\left(Q_{hp} - f_{hp}\right) - P_{mp}.f_{mp} - P_{np}.C_{nf} - w\left(L - T + l\right) + N = 0 \qquad 8$$

Expanding equation 8 gives

$$P_i.Q_{hp} - P_i.f_{hp} - P_{mp}.f_{mp} - P_{np}.C_{nf} - wL + wT - wl + N = 0 \qquad 9$$

Re-arranging equation 9 to household income and expenditure gives

$$\underbrace{P_i.Q_{hp} + wT + N - wL}_{HH\ Income} = \underbrace{P_i.f_{hp} + P_{mp}.f_{mp} + P_{np}.C_{nf} + wl}_{HH\ Expenditure} \qquad [5] \qquad 10$$

Equation 10 shows that the left hand side (LHS) equals household income (HH income), which comprises of the value of farm produce $P_i.Q_{hp}$, value of HH's time endowment wT, the value of labour used wL and non-farm income N. Likewise, the RHS is equivalent to household expenditure (HH expenditure), which comprises of value of home produce food $P_i.f_{hp}$; value of market purchase food $P_{mp}.f_{mp}$; value of non-food expenditure $P_{np}.C_{nf}$ and purchase of leisure wl. The optimization of equation 4b gives rise to income and expenditure equation within the separability assumption, which is necessary to have first order conditions. It is equally possible via optimization of equation 10 to yield production and consumption equations separately. This is however discussed below.

The demand for inputs such as labour and output produced, especially for households that home produce their food can be derive by maximizing the first-order condition of the LHS of equation 10 w.r.t labour (L) and output produced (Q) as

$$L^* = l^*\left(P_i, w, A^o, K^o\right) \qquad 11$$

$$Q^* = Q^*_{hp}\left(P_i, w, A^o, K^o\right) \qquad 12$$

where $L^*$is the optimum labour used and Q^* is the optimum output produced when profit represented by equation 10 is maximized (*see foot note 5*).

[5] This can also be expressed in terms of profit as:

$$\pi = \left(\underbrace{P_i.Q_{hp} + wT + N - wL}_{HH\ Income} - \underbrace{P_i.f_{hp} + P_{mp}.f_{mp} + P_{np}.C_{nf} + wl}_{HH\ Expenditure} \right)$$

Substituting equations 11 and 12 into LHS of equation 10 representing income side of the expression gives optimum income/full income (Y^*) under the assumption of maximized profit π^* as

$$Y^* = P_i.Q^* + wT + N - wL^* \quad 13a$$

$$Y^* = wT + \pi^*\left(P_i, w, A^o, K^o\right) + N \quad 13b$$

where, $\pi^*\left(P_i, w, A^o, K^o\right) = P_i.Q^* - wL^*$

Also, household demand for food consumption C_f can be derive by solving the first–order conditions of the RHS of equation 10 representing expenditure as follows:

Recall in equation 3 that C_f is a vector of $f_{hp}$and f_{mp} as $C_f = \left(f_{hp}, f_{mp}\right)'$, but the various components of C_f also depend on their respective prices, which is thus specified as

$$C_f = c_f\left(P_i, P_{mp}, P_{np}, w, Y^*\right) \quad 14$$

Because household food consumption or demand for food depends also on the preferences of its members, it is important to incorporate household demographic variables represented by x to equation 14 to shape the preferences of the households. Thus, in order to have broad determinants of C_f, we can further specify Y^* in equation 14 in reference to equation 13b as

$$C_f = c_f\left(P_i, P_{mp}, P_{np}, w, Y^*\left(P_i, w, A^o, K^o\right)\middle| x\right) \quad 15$$

Therefore, if household demand for food or food consumption could be refer to as a measure of household food and nutrition security represented by FS_i, then C_f in a reduced form of utility function of equation 1, which allows evaluation of the effects of household level as well as economic factors can be represented by

$$C_f \cong FS_i = \left[FOOD_{\exp}, NT, DDS / DDI, ...etc\right]' \quad 16$$

where, FS_i is taken as a vector of various indicators of household food and nutrition security, which could be food expenditure($FOOD_{\exp}$), nutrient intake (NT) such as calorie, protein etc., dietary diversity score(DDS) or dietary diversity index (DDI), production index, and among others (for details see, Smith and Subandoro,2007;Heady and Ecker, 2012; USDA-ERS, 2012; Pangaribowo *et al.,* 2013).

2.2. **Food security indicators in the study**

In recognition of various indicators of FS_i outlined above and elsewhere in the literature, the study is designed to combine two FS_i indicators viz., $FOOD_{\exp}$ and DDS to generate what we termed household food-poverty states FP_i. Furthermore, the study intended to use FP_i, DDS and, DDI_i-derive from household expenditure on identified food groups to investigate household socio-economic determinants of FS_i defined as $FS_i = \left[FP_i, DDS_i, DDI_i\right]'$ in Nigeria. While, FP_i is a qualitative (discrete) indicator, DDS and DDI_i are quantitative measure of FS_i. This is essentially important because deriving conclusions from carefully chosen food and nutrition security proxies such as FP_i would be more useful than relying solely on single indicator. However, for the FP_i states, the study implicitly employed a quasi-experimental procedure such that households in the sample are randomly first identified as either food secure or not base on certain food security threshold from the $FOOD_{\exp}$ and DDS before they are combine. The subsequent sub-sections focus on these measures.

2.2.1 *Per capita food expenditure*

The use of per capita food expenditure as indicator of FS_i is well documented in the literature (see Smith and Subandoro, 2007; Farid and Wadood 2010;Heady and Ecker, 2012; USD-ERS, 2012). According to Hendriks and Msaki (2009), expenditure on food is regarded as important indications of food security because it captures the concept of vulnerability to food insecurity. Besides, food expenditure has also been used as a proxy for household poverty level. As noted by Farid and Wadood (2010), higher expenditure proportions are essential indicator of inter-temporal vulnerability to food insecurity. Therefore, a search of the literature show that a number of studies such as Canagarajah and Thomas (2001), Omonona and Adetokunbo (2007), and Kuku and Liverpool (2010) have employed household expenditure with weighted two-third of mean of per capita expenditure as threshold to construct food-poverty line or food security line. Within this context, a household is referred to as food secure (or food insecure) when observed per capita food expenditure is greater (or less) than weighted two-third of mean of per capita expenditure.[6] This approach if often used by the international aid organization such as World Bank to analyze household poverty in the developing economies (Canagarajah and Thomas, 2001). Guided by this, we follow previous literature to define the threshold as two-third of the mean monthly expenditure on food as food-poverty line to classify households in the sample as food secure/insecure.

2.2.2. *Dietary Diversity Score of food purchase*

The dietary diversity (DD) is consumption of a wide variety of foods across nutritionally distinct food groups developed by the World Food Program (WFP) also known as dietary diversity score (DDS) and is generally known as economic vulnerability measure

[6] Alternatively, Smith and Subandoro, (2007) used share of food such that a household is considered food insecure (or experiencing food-poverty) if they spend 75% or more if their total expenditure on food.

of household diet quality. The food items consumed by households are group into various food groups to reflect dietary diversification of the households. Thus, DDS represents how frequency households consumed food from different food groups and it is more important because a more varied diet is a valid outcome in its own right. According to USDA-ERS (2012), higher DDS connotes a more variety of diet and are suggestive of a higher quality diet with a potential for higher micronutrient. As noted by Ruel (2003), indicator of dietary diversity has been validated against dietary quality. And, household DDS holds premise as food security indicator because as poor households gain additional income they are better able to regularly access food needed for a healthy life and thus increasing their food security (Ruel, 2003; Hoddinott and Yohannes, 2002). For example, a varied diet either directly or indirectly through improved acquisition of micro nutrient is associated with a number of improved outcome in areas such as a birth weight (Rao *et al.,* 2001), child anthropometric status (Tarini *et al.,* 1999), improved hemoglobin concentrations (Bhurgara *et al.,* 2001) and among others.

Thus, following the work of Smith and Subandoro (2007), a household is considered food insecure if their DDS is less than the average DDS of the households in the upper quintile (i.e., highest 40%) taken as the threshold. In this case, the DDS threshold used to classify the household into food secure/insecure is equivalent to 4.8 food groups out of maximum 6 identified food groups in the sample, which includes staple food, flesh food (meat & fish), vegetable & fruits, dairy products, oil & fats, and sweeteners.

2.2.3. *Dietary Diversity Index*

The traditional demand theory takes into account consumers' preferences for various food items and how rational consumer maximizes his/her utility by choosing quantities of available goods subject to a budget constraint. Given this, the study follows the work of Thiele and Weiss (2007) and Drescher (2007) to construct dietary diversity index (DDI), which was later used to investigate factors affecting household food security defined by both the DDS and DDI in Nigeria. The DDI is typically an index, which ranges between 0 and 1 and derive from the share of household expenditure on the identified food groups in the household food basket. Although, both the DDI and DDS is the same indicator by construction, but in order to capture extent of diversification in the household dietary demand, DDI provides a better framework for doing this by construction.[7] Nevertheless, a major weakness of both measures is that they do not consider or take into account or provide information on the distribution of quantity of nutrient consumed by the households across the food groups in the sample.

2.2.4. *Household Food-Poverty (FP) States*

As discussed earlier, we derive FP_i by combining $FOOD_{\exp}$ and DDS indicators using predetermined threshold discussed above to classify households into four mutually

[7] The result of spearman correlation between DDS and DDI is about 0.500 and significantly different from zero.

exclusive food-poverty FP_istates. The identified four FP_i states are; (1) completely food insecure state evident from both indicators, (2) state of transitorily food insecure based on $FOOD_{\exp}$but food secure based on DDS, (3) state of transitorily food insecure based on DDSbut food secure based on $FOOD_{\exp}$, and (4) completely food secure state evident from both indicators. In this case, a transitorily food insecure households are those who are only food insecure based on one indicator, which is more closely to intuition.

Hence, we configure FP_i as discrete numbers, such that households in completely food insecure state from both indicators have $FP = 3$, households in transitorily food insecure state based on $FOOD_{\exp}$ and food secure based on DDS have $FP = 2$, households in transitorily food insecure state based on DDS and food secure based on $FOOD_{\exp}$ have $FP = 1$ and households in completely food insecure state as reveal from both indicators have $FP = 0$.

3.0 The data and data description

The study employs data from Nigeria Living Standard Survey (NLSS) conducted from September 2003 to August 2004. The sampling design of the NLSS involves a two-stage stratified random sampling technique. The first stage was a cluster of housing units called Enumeration Area (EA), while the second stage was the random selection of the housing unit. There were seven interviewer visits to each selected household at a minimum of four-day intervals in a cycle of 30 days.

The survey instruments are questionnaire to capture households' non-food expenditure and dairy of daily food consumption and expenditure, to capture own produced and purchased food items by the households. The NLSS contains information on 19,158 households, while we employed 18,870 as 288 households were deleted due to incomplete information.

The information contained in the NLSS includes detailed value of own-food produced and expenditure on the type of food purchased by the households. For each household, expenditure profile on the following six food groups were included: (1) staples {i.e., yam, cocoyam, cassava, rice, maize, and millet}, (2) meat and fish, (3) dairy products, (4) fruits and vegetables, (5) fats & oils, (6) sweeteners. And provided also in the dataset are detailed information on the non-food expenditure which includes; expenditure on education, healthcare, housing (i.e., house rent, cost of maintaining the house and the furniture), Clothing (clothes, shoes), utilities, house appliance, transportation (transport fares, petrol purchased, maintenance of cars, bicycles etc.), and communication. Included also are household's socio-economic variables such as: gender, years of education, and major occupation of household head, household with different age composition, and household size. The definition and summary statistics of these variables are presented in table A of the appendix. Likewise, summary statistics of the variables and household food non-food expenditure details, DDS and DDI by the identified FP states are presented in Table B and C of the Appendix, respectively.

4.0 Empirical model

Because of data limitation and within the framework of equation 15, we implicitly defined the relationship between household food security FS_i and its determinants as[8]

$$FS_i = \left(Y_i^*, x_i | \phi\right) + \eta_i \qquad 17$$

Thus, in consistent with section 2.1, we defined vector of FS_i indicators used in the empirical analysis as $FS_i = \left[FP_i, DDS_i, DDI_i\right]'$. Where, Y_i^* represents household income, x_i is vector of household demographic variables, ϕ is the parameters to be estimated, and η_i is the error term of the regression. Hence, subsequent sub-section focused on the determinants of each component of FS_i which includes food-poverty states FP_i, dietary diversity score DDS_i and dietary diversity index DDI_i in the study.

4.1 *Determinants of household food-poverty states*

The four possible food-poverty states discussed earlier are defined as discrete number such that completely food secure has FP_i=0, food secure based on DDS has FP_i=1, food insecure based on FOOD_exp has FP_i=2, and completely food insecure has FP_i=3. Given this, the determinants of household's food-poverty states are assess using a multinomial logit model. The dependent variable in this case is the discrete variable represented by the FP_i. According to Rose and Chariton (2002), this type of regression is a generalization of the familiar logistic regression, which is used when there are more than two discrete possibilities for the dependent variable.

The multinomial logit model generally captures how household socio-economic variables affect the probability that a household in the sample exhibit any of the identified M-1 possible states of FP_i discussed earlier in reference to completely food secure households. As noted by Bhat (2003), the use of multinomial logit model is often a strategy, when the choices are unordered. As is the case in the present study

Thus, following Greene (2008), we defined the multinomial logit model for the study for M discrete alternatives (*i.e., m = 0,1,...M*) with an odds ratio Z_{mj}, if the first outcome of the FP, which in this case is 0 serves as the reference point as[9]

$$pr_{im} = \mathrm{pr}\left(FP_{im}\right) \quad \forall\ \mathrm{m} = 0,1,\ldots\mathrm{M} \qquad 18$$

$$Z_{im} = ln\left(\frac{pr\left(FP_{i,m=1,2,..M} \middle| x\right)}{pr\left(FP_{i,m=0} \middle| x\right)}\right) = ln\left(\frac{FP_{i,m=1,2,..M}}{FP_{i,m=0}}\right) = \alpha_{im} + \sum_{k=1}^{K-1} \beta_{ikm}\, x_{ik} \qquad 19$$

$$Pr\left(FP_{i,m=1,..M}\right) = \frac{exp\left(Z_{im}\right)}{1 + \sum_{m=0}^{M} exp\left(Z_{im}\right)} \qquad 20$$

[8] Lack of information on prices of food and non-food give rise to the reduced form of equation 15 specified as equation 17.

[9] The first state of FP, which represents completely food secure households, will serve as a reference state.

$$Pr\left(FP_{i,m=0}\right)=\frac{1}{1+\sum_{m=0}^{M} exp\left(Z_{im}\right)} \quad 21$$

where, pr_{im} is the probability indicator for *i-th* household in M state; Z_{mj} is the odds ratio of households being in *M-1* state in reference to households in m=0 (or FP=0); ln is the natural logarithm; x is the households socio-economic variables hypothesized to explain FP states (see Table A of the appendix for the list of the variables) and β is the parameters to be estimated.

4.2 *Determinants of household demand for dietary diversity*

The determinants of household demand for dietary diversity (DD) has always been model using DDS and DDI in the literature. For example, Hoddinot and Yohannes (2002) and more recent Woldehanna and Behrman (2013) and Ecker *et al.,* (2013) employed DDS, while Thiele and Weiss, (2003), Drescher, (2007), and more recently Gaiha *et al.,* (2012) employed DDI. However to investigate household determinants for DD, we specified implicitly the relationship between DD and household socio-economic characteristics x' as

$$DD_i=\psi_0+\beta x'+\varepsilon_i \quad 22$$

where, DD is the vector of DDS and DDI defined as $DD_i=\left[DDS,DDI\right]'$, x' is vector of explanatory hypothesized to explain both the DDS_i and DDI, ψ_0 and β are parameters to be estimated and ε is the random error of the fractional response regression.

While DDS is as defined earlier, we follow the work of Thiele and Weiss, (2003), and Dresher (2007) to derive DDI_i from household food expenditure on the identified food groups using Berry index defined below.[10]

$$DDI_i=1-\sum_{j=1}^{J} w_{ji}^2 \quad 23$$

where, DDI_i is as defined earlier and ranges between 0 and 1 with a value towards 1 implies higher dietary diversity, w_{ji} is the share of *j-th* food group by the *i-th* households.

However, the estimation of equation 22 when DDS is taken, as dependent variable is straightforward since the dependent variable is a continuous variable which can easily

[10] There are other frequently used indices such as entropy, Herfindahl, Simpson and among others. The present study employed Berry index because of its simplicity and also it has been used in the previous studies, which provide ease of comparison.

be handle by using ordinary least square (OLS) technique. But, because DDI is bounded between 0 and 1, Papke and Wooldridge (1996) argued that such indices is simply a fractional data/proportional data by construction that is best handle by fractional response regression proposed by the same authors. According to Kieschnick and McCullough (2003), since fractional data are only observed over a closed interval implies that the conditional expectation function will be nonlinear (or not normally distributed). Meaning that the use of linear models such as average response function (OLS), censored regression (Tobit), and transformed logistic normal model (e.g., the log-odds ratio of dependent variable) for fractional dependent variable data would yields inefficient results as distribution of error terms is likely to be heteroskedastic (McDonald 2008)[11]. This is because the conditional variance of the error term will approach zero as the conditional mean approaches either of the boundary points of the fractional data.

Thus, the fractional response regression proposed by Papke and Wooldridge (1996) for fractional/proportional dependent variable as in the case of DDI in the present study is best handle by non-linear model such as Quasi-Maximum Likelihood Estimation (QMLE).[12] A search in the literature shows that McDonald (2008), Oberhofor and Pfaffermayer (2009) and recently Sauer *et al.,* (2011) employed QMLE in their respective studies.

However, the Bernoulli Log-likelihood function for estimating equation 22 is specified below

$$L_i(\beta) \equiv DDI_i \ell n\left(G\left(x'\right)\right) + \left(1 - DDI_i\right) \ell n\left(1 - G\left(x'\right)\right) \qquad 24$$

where, $0 \le DDI_i \le 1$denotes the dependent variable while x' refers to the explanatory variables of observation *i*.

Accordingly, equation 24 is well defined for $0<G\left(x_i\right)<1$. The QMLE of β is obtain by simply maximizing equation 22 [that is., $\max_{\beta} \sum_{l=1}^{N} L_i\left(\beta\right)$]. Papke and Wooldridge showed that Bernoulli QMLE β is consistent and $\sqrt{N}$ -asymptotically normal regardless of the distribution of DDI_i conditional on x' while no special data adjustments are needed for the extreme values of zero and one for DDI_i. The conditional expectation of DDI_i given the explanatory variables according to the authors are estimated directly. Asymptotically efficient, unbiased and consistent estimator is achieve in QMLE by simply transform the $G\left(x'\right)$ to produce models similar to either logit or probit in the binary choice situation (McDonald, 2008). Cox (1996) and Papke and Wooldridge

[11] The problem in using OLS on fractional dependent variable is that it is not asymptotically efficient estimator but rather unbiased and consistent estimator.

[12] This is a departure from previous studies such as Thiele and Weiss (2003) and Drescher, (2007) that used transformed DDI as dependent variable before estimating with OLS or Gaiha *et al.,* (2012) that employed OLS technique directly on the DDI.

(1996) proposed different specification for $G(x')$ such as logistic or probit distribution. But, Papke and Wooldridge used logistic function for $G(x')$ in the framework of generalized linear models (GLM) [that is., $G(x') = \frac{exp(x')}{1+exp(x')}$] which was extensively discussed in their paper and implemented in STATA software used for the empirical analysis in this paper[13]. QMLE is estimated by weighted non-linear square allowing for heteroskedasticity and testing procedures, which are asymptotically efficient within a class of estimators (Oberhofor and Pfaffermayer, 2009).[14]

The Quasi-Maximum Likelihood regression employed for the empirical analysis of equation 22 when DDI is considered as dependent variable is specified below;

$$E(DDI_i | x_k) = G\left(\psi_0 + \sum_{k=1}^{K} \alpha_k x_{ki} + \varepsilon_i\right) \qquad 25$$

where, DDI_i is as earlier defined, x_k represented the hypothesized variables to explain DDI_i (see Table A of the appendix for the list of the variables), ψ_0 and α are parameters to be estimated , $G(.)$ is the logistic function while ε_i represented the error term.

5. Results and Discussion

5.1. *State of Food-Poverty in Nigeria*

As discussed earlier, the study employed two food insecurity indicators defined food expenditure (FOOD_exp) and dietary diversity score (DDS), which represents food accessibility and food availability, respectively (Pangaribowo *et al.,* 2013). However, the result of spearman correlation between the two indicators gave an estimated coefficient of 0.3725, which was found to be significant at 1% level. The implication of this is that the indicators can to some extent be regarded as two partially dependent measures of food security in the study-condition necessary for their combination to yield robust food-poverty states. And for the DDS, six distinct food groups were identified from the ranges of food items available in the 2003/2003 NLSS data used for the empirical analysis. The food groups are staple foods (cereals & tubers), flesh food (fish and meat), vegetable & fruits, oils & fats, dairy products, and sweeteners (sugar & honey). Within this context, our results show that 22%, 38%, 28%, and 12% of the households in the sample consumed a maximum of 6, 5, 4, and less than 4 food groups with an average of about 4.6 food groups in the study. A search of literature from the SSA shows that about 3.3 and 3.6 food groups was obtained for households in Ethiopia and South Africa by Woldehannan and Behrman (2013) and Steyn *et al.,* (2006), respectively, which is significantly below what was obtain in present study. However as noted by Swindale

[13] In STATA, QMLE could be estimated using generalized linear model (glm) command with family (binomial), link (logit), and robust standard error option.
[14] QMLE accommodates naturally, non-constant variances and skewness (Oberhofor and Pfaffermayer 2009).

and Bilinsky (2005), households that consume for example an average four different food groups implies that their diets offer some diversity in both macro and micronutrients.
Across the quintile of household income distribution, the analysis shows that more than 95% and about 63% of households in the upper and lower quintile consumed four or more food groups, respectively in the sample.

Therefore, to provide a better picture of the household dietary diversity defined in terms of DDI, we constructed dietary diversity (DDI) index, which is presented in Figure A of the appendix with an average index of 0.5849 and standard deviation of 0.1892 (see Table A of the appendix). The index ranges from zero, reflecting consumption of one food group, to one, reflecting consumption of six food groups. Thus, the higher the index, the more diversify the household diet quality. As shown in the figure, a large number of the households in the sample are located in the region with the index ranges from 0.41-0.80, suggesting that most of the households in the sample consumed at least four different food groups, while relatively few number consumed just one food groups, which was found to be staple food in the study. Furthermore, a similar analysis was carried out across the income groups (figure B of the appendix) and across the identified food-poverty (FP) states (figure C of the appendix). Figure B shows that the number of household with indices 1 and 0.41-0.80 increased and decreased, respectively as quintile of household income increases. Meaning that DDI increased as household income increases in the study. In a related development, figure C shows that the numbers of households within the indices 0.41-0.80 increased as households in the sample move from the state of completely food insecure to the state of completely food secure.

Based on food expenditure (FOOD_exp) and dietary diversity (DDS) indicators with two-third of mean per capita food expenditure and average DDS of the households in the upper quintile as thresholds, the analysis reveal that about 66% and 60% of the households in the sample could be referred to as food secure, respectively. Interestingly, the rate is consistent with previous studies on food security in Nigeria by Babatunde *et al.,* (2007) that found about 38% but differ significantly from the finding of Omonona and Adetokunbo (2007) that found about 49% food insecurity incidence. Also from the SSA, we found that 40% incidence of food insecurity obtained in Ethiopia by Feleke *et al.,* (2005) is similar to what was obtained in the present study.
But when these two indicators are eventually combine as discussed earlier, which give rise to presumed food-poverty states, the result shows that about 42%, 18%, 24%, and 16% of the samples could be referred to as completely food secure households, transitorily food insecure households-based on FOOD_exp only, transitorily food insecure households-based on *DDS* only, and completely food insecure households based on both measures (see also Table A of the appendix), respectively. Also, we used Smith and Subandoro's (2007) 75% food share as *FOOD_exp* threshold instead of the two-third of the mean per capita food expenditure mentioned above and later combine with DDS to generate another set of FP states. In this case, the results show that about 52%, 14%, 28%, and 6% of the samples could be considered to be completely food secure households, transitorily food insecure households-based on *FOOD_exp* only, transitorily food insecure households-based on DDS only, and completely food insecure households, respectively. The implication of these results is that with food share as food security threshold, there is about 10% increase in the number of households within the

completely food secure state as equal number of households moved from completely food insecure in the sample.

5.2. *Determinants of Food-Poverty states*

To address the effect of household's socio-economic characteristics on the states of food-poverty outcomes identified in the study, the results of odds ratio from the estimated multinomial logit model is presented in Table 1. For the present study, the coefficients are odds ratio of an households being in the state of completely food insecure or transitorily food insecure in reference to households in the state of completely food secure conditional on households socio-economic.

Table 1 shows that the odds of being food insecure based on DDS only, FOOD_exp only, and on both measures relative to completely food secure households is 0.99 times significantly less with increase in household income in the study. Likewise, the odds of being food insecure based on DDS only, FOOD_exp only, and on both measures relative to completely food households is 0.95 times lower, 1.10 times higher, and 1.07 times higher and significant, respectively with increase in household size. Also, odds of being food insecure based on DDS only, FOOD_exp only and on both measures vs. being completely food secure for households headed by farmer (or households located in the rural areas) is 1.41 (1.41) times higher, 0.63 (0.87) times lower and 1.20 (1.36) times higher, respectively than the odds for households not headed by farmers (or households in urban areas). The odds of being food insecure based on DDS only, FOOD_exp only, and on both measures vs. being completely food secure for households headed by male is 0.84, 0.88, and 0.81 times lower and significant, respectively than the odds for the female headed households in the sample. The odds of being food insecure based on both measures vs. being completely food secure for households that only produce food consume are 6.89, 92.26, and 44.66 times higher and significant than the odds for households that both home produced and purchase food consume in the study. In contrast, we found that the odds of being food insecure based on DDS only, FOOD_exp only, and on both measures vs. completely food secure households that only purchase food consume are 0.84 times lower and significant, 0.99 times lower and insignificant, and 1.72 times higher and significant that odds for households that both home produced and purchase food consume in the sample. The results conform to the finding of Rose and Chariton (2002), where the authors found that households with home production had lower odds of being on either the food poverty of food insecure groups.

Other results show that the odds of being food insecure across the FP states vs. food secure households having with members < 40 years old was found to have a mixed significant results. However, the odds of being food insecure based on DDS only, FOOD_exp only, and on both measures relative to completely food secure decreased significantly for households located in the south-south, south-east, north- central, north-east, and north-west than the odds for households in the south west (the reference region). The implication of these findings is that effects of household socio-economic characteristics differ significantly across the identified FP states in the study. This

however, suggests that the classification of households into different states of food-poverty by combining two-food insecurity indicator probably reflect better different food insecurity problem in Nigeria.

Table 1: Determinants of household food-poverty states

Explanatory Variables	**Odds ratio for food insecure HH based on DDS Indicator only**		**Odds ratio for food insecure HH based on FOOD_exp Indicator only**		**Odds ratio for completely food insecure HH from both Indicators**	
	Odds ratio	*Std. Error*	*Odds ratio*	*Std. Error*	*Odds ratio*	*Std. Error*
HH_INCOME	0.9999***	0.0009e-03	0.9999***	0.0003e-02	0.9998***	0.0004e-02
HHSIZE	0.9468***	0.0094	1.1042***	0.0104	1.0735***	0.0112
EDUCATION	1.0003	0.0033	0.9962	0.0035	0.9982	0.0038
D_OCCUPATION	1.4116***	0.0933	0.6326***	0.0422	1.2106***	0.0943
D_GENDER	0.8439***	0.0527	0.7504***	0.0566	0.8099***	0.0699
D_OWNPRODUCEDONLY	6.8597***	4.0436	92.2685***	53.74447	44.6613***	26.7612
D_PURCHASEONLY	0.8442***	0.0574	0.9885	0.0673	1.7254***	0.1283
D_AGE<25	0.8967	0.1194	1.1981	0.2229	1.5173**	0.2942
D_AGE25-29	0.8776	0.0743	1.0063	0.1058	0.9548	0.1124
D_AGE30-34	0.7890***	0.0574	0.8496**	0.0683	0.8748	0.0769
D_AGE35-39	0.7369***	0.0517	0.8247***	0.0595	0.7499***	0.0605
D_AGE40-44	0.8267***	0.0571	0.9490	0.0642	0.8771*	0.0664
D_RURAL	1.4117***	0.0926	0.8789*	0.0609	1.3583***	0.1119
D_SOUTHSOUTH	0.4883***	0.0378	0.7299***	0.0657	0.5417***	0.0547
D_SOUTHEAST	0.3326***	0.0262	0.3215***	0.0317	0.2694***	0.0296
D_NORTHCENTRAL	0.7137***	0.0550	0.8586*	0.0758	0.4334***	0.0441
D_NORTHEAST	0.5169***	0.0412	0.4618***	0.0419	0.3384***	0.0342
D_NORTHWEST	0.6851***	0.0518	0.3939***	0.0351	0.4102***	0.0397

****, **,* implies that the estimated parameters are significantly different from zero at 1%, 5%, and 10% significance level, respectively. Figures in parentheses are standard error.*

5.3. *Determinants of Household Demand for Dietary Diversity*

Table 2 presents the results of determinants of households demand for dietary diversity (DD) when DDI and DDS are taken as indicator of food and nutrition security in Nigeria. The table shows that both the DDI and DDS gave similar significant results. Hence, the empirical results show that household income increased significantly the dietary diversity consumed in the study. Meaning that household diet quality diversifies as income level increases or an increase in household income is associated with the demand for dietary diversity in Nigeria. According to Thiele and Weiss (2003), a significant and positive impact of household income on food variety/dietary diversity is in line with hypothesis that consumption evolves along hierarchical order as income increases. From the case study, staple food (cereal & tubers) is believed to supplies energy/calorie as flesh food (fish & meat) supplies protein for bodybuilding and growth. Likewise, vegetables & fruits and fats & oil supply vitamins and minerals to human body

among others. Thus, by attaching nutritional values to DDS or DDI any reduction in the score or index across households may be approximately associated with nutritional decline. Hence, this could be a basis to estimate food gaps, thus suggesting that policies designed towards increasing household income could be a useful driver of dietary diversity in Nigeria. A search in the literature shows that our finding is consistent with previous studies by Jekanowski and Binkley (2000), Thiele and Weiss (2003), Langat et al., (2010), Woldehanna and Behrman (2013) and Ecker *et al.,* (2013), for households in USA, Germany, Kenya, Ethiopia, and Ghana, respectively.

Other results show that household dietary diversity increased significantly with increase in household size. While this result contradict the finding of Stewart and Harris (2005) and Galha *et al.,* (2012), it conforms to the finding of Moon *et al.,* (2002), Rashid *et al.,* (2003), Woldehanna and Behrman (2013) and Ecker for households in Bulgaria, Bangladesh, Ethiopia, and Ghana, respectively where dietary diversity increase with household size. Also, education of the household head (which could be take as a proxy for consumer dietary knowledge and ability to process dietary information) and being male-headed household has significant but negative effect on the demand for dietary diversity in the sample. Guided by the previous studies from the developing economies, one would expect households with educated and female head to have higher demand for dietary diversity as observed by Vanyam *et al.,* (1998), Moon *et al.,* (2002), Rashid *et al.,* (2003), and Woldehanna and Behrman (2013).

Furthermore, the estimates reveal that the demand for dietary diversity increased significantly among households headed by farmers in the study. This is in contrast to what was obtain by Thiele and Weiss (2003), where the authors found that being a farmer decreased food diversity in Germany. However, a closer look at the NLSS data shows that about 63% of the households are farmers, while 91% of this number consumed at least four different food groups in the study. This observation perhaps is in line with the argument in the literature that because rural households in the developing economies rely on agriculture for survival, the energy needs of such agriculturally dependent households may be higher since agricultural labour tends to be more physical demanding than non-farm labour. While dietary diversity decreased significantly among households that only own produce food consume, the results also show that it increases significantly among households that rely only on purchase food to consume inference to households that both own produced and purchase food consume in the sample.

Other results show that households with members less than 40 years old demand for higher dietary diversity, compared to households with members >44 years old. A possible explanation for this can view from two perspectives. First, for physical and mental development necessary to engage in education and labour activities, households with members <44 years old are more likely to consume variety of food leading to increasing dietary diversity consumed in the sample. Second, from viewpoint of healthcare of the members, households with members >50 years old are less likely to demand for none healthy food that can be easily consume by households with members

< 40 years old. In this case, household with members > 50 years old are likely to consume less variety of food in the sample.

Also, our estimates show that the demand for dietary diversity also increases among households in the rural areas, compared to households in the rural areas. A closer look at the literature shows that our finding contradict Thiele and Weiss (2003) argument that households in large cities have a higher demand for dietary diversity than people living in rural environment. The results of whether regional differences exist in household demand for dietary diversity show that households in north-east, north-west, south-east and south-south of the country exhibit higher and significant demand for dietary quality compared to households in South West Region taken as reference in the study. In contrast, the results also show that the demand for dietary diversity decreased significantly among households in the north central compared to households in the southwestern region. The implication of this finding is that demand for dietary diversity not only differs across the sector but region as well in Nigeria.

Table 2: Determinants of Household Demand for Dietary Diversity

Variables	**DDI Estimates**		**DDS Estimates**[a]	
	Coefficients	*Std. Error*	*Coefficients*	*Std. Error*
LOG_HHINCOME	0.3222***	0.0106	0.2489***	0.0052
LOG_HHSIZE	0.1739***	0.0108	0.1714***	0.0052
LOG_EDUCATION	-0.0152***	0.0043	-0.0169***	0.0019
D_GENDER	-0.0162	0.0157	0.0049	0.0076
D_OCCUPATION	0.2821***	0.0168	0.1728***	0.0084
D_OWNPRODUCEDONLY	-2.0441***	0.1416	-0.8099***	0.0231
D_PURCHASEONLY	0.5385***	0.0187	0.2226***	0.0096
D_AGE<25 YEARS	0.1468***	0.0335	0.0699***	0.0161
D_AGE25-29 YEARS	0.1249***	0.0208	0.0677***	0.0101
D_AGE30-34 YEARS	0.0987***	0.0176	0.0671***	0.0084
D_AGE35-39 YEARS	0.0985***	0.0161	0.0643***	0.0075
D_AGE40-44 YEARS	0.0389***	0.0156	0.0302***	0.0074
D_RURAL	0.2239***	0.0162	0.1233***	0.0082
D_SOUTHSOUTH	0.1775***	0.0175	0.1585***	0.0085
D_SOUTHEAST	0.1900***	0.0179	0.1459***	0.0084
D_NORTHCENTRAL	-0.3412***	0.0234	-0.1591***	0.0123
D_NORTHEAST	0.3345***	0.0188	0.1543***	0.0090
D_NORTHWEST	0.1261***	0.0186	0.1169***	0.0091
CONSTANT	-3.6708***	0.1248	-1.5906***	0.0617
Model Diagnostics **(DDI/DDS)**				
Log Pseudo Likelihood / Prob. > F	-8582.43		0.0000	
(1/df) Deviance/ R^2	2347.92		0.4066	
(1/df) Pearson/ Root MSE	2055.55		0.3243	
Sample Size	18870		18870	

****, **,* implies that the estimated parameters are significantly different from zero at 1%, 5%, and 10% significance level, respectively. Figures in parentheses are standard error.[a] DDS is estimated with robust option.*

6 Conclusions

The study combines two quantitative indicators of food insecurity defined as food expenditure (FOOD_exp) and dietary diversity score to generate four possible states of food-poverty (FP) which include; completely food secure, transitorily food insecure based on DDS only, transitorily food insecure based on FOOD_exp, and completely food secure households. In addition, the study used household expenditure on the six identified food groups to construct dietary diversity index (DDI) in the sample. Given this, the study investigates determinants of Food-Poverty states using multinomial logit model and the demand for dietary diversity based on DDS and DDI using fractional

regression model. The empirical findings show that about 42%, 18%, 24%, and 16% of the households in the sample could be referred to as being in the state of completely food secure, food insecure based on FOOD_exp only, food insecure based on DDS only, and completely food insecure based on both measures, respectively. The determinants of food-poverty (FP) states reveal that odds of being food insecure relative to completely food secure households decreases with higher income, among households headed by male, and households in the rural areas but it increases with household size, among households headed by farmers and among household that only own produce food consume and only purchase food consume in the study.

Also, the results of determinants of household demand for dietary diversity shows that dietary diversity defined by DDS and DDI increased with increase in household income and household size, among households headed by farmers, household that only purchase food consume, and among households in the rural areas. In contrast, we found that the dietary diversity decreased significantly among educated household heads and households that only purchase food consume in the sample. Our results also suggest that regional differences exist in the demand for dietary diversity in the sample.

While the empirical evidence seems to support the existence of different types of food – poverty/food insecurity problems that require specific needs, the results also shows that effects of household socio-economic characteristics differ significantly across the identified food-poverty states in the study. Also, the effects of household socio-economic characteristics on dietary diversity not only differ across the rural vs. urban households but also across the regions in the country. The implication of this is that understanding factors influencing household food-poverty states and dietary diversity is crucial for understanding human well-being and for designing food policy program. For example, the fact that income drives down food insecurity and increases dietary diversity in the study suggests that policies tailor towards higher income is likely to promote nutritional/dietary quality security in the country. In this case, we suggest that policies that contributes to earning capacity of the households is likely to reduce food insecurity and at same time increase the dietary diversity cum food security of households in the country.

The future challenge, which is associated with data limitation in the present study, is to be able to consider the role of food prices in determining states of food-poverty in Nigeria. Besides, it will be interesting to also consider other popular food security indicators such as nutrient availability viz. calorie intake to classify households into states of food insecure or not.

References

Akinyele, I. O (2009). Ensuring food and Nutrition security in Rural Nigeria. An assessment of the challenges, information needs and Analytical capacity. Nigerian Strategy support program (NSSP). Paper No. 007, IFPRI Washington D.C.

Arene, C. J and R. C. Anyaej (2010). Determinants of food security among households in Nzukka metropolis of Enugu state Nigeria. *Pakistan Journal of Social Sciences*, Vol. 3(1): 9-16.

Anyanwu, J. C (2012). Accounting for poverty in Africa: Illustration with survey data from Nigeria. African Development Bank Group, Working paper No. 149 Tunisia.

Asogwu, B.C and J. C. Umeh (2012). Food insecurity determinants among rural farming households in Nigeria. International conference on Ecology, Agriculture and Chemical Engineering (ICEACS' 2012), December 18-19, Phuket Thailand.

Austin, O. C., A. C. Nwosu and A. H. Baharuddin (2011). Rising food insecurity: Dimensions in Farm Households. *American Journal of Agricultural and Biological sciences*, Vol. 6(3): 403-409.

Amalu, U. C (2002). Food security sustainable food production in sub-Saharan Africa. *Outlook on Agriculture*, Vol. 31(3): 177-185.

Babtunde, R. O. and M. Qaim (2010). Impact of off-farm Income on Food security and Nutrition in Nigeria. *Food Policy*, Vol. 35(4): 303-311.

Babatunde, R. O., O. A. Omotesho and O.S. Osholotan (2007). Economic charateristcs and food security status of farming household in Kwara state, North-central Nigeria. Pakistan Journal of Nutrition, Vol. 6(1): 49-58.

Bhat, C. R (2003). Random utility-Based Discrete Models for Travel Demand Analysis. In Goulias. K.G (Eds), Transportation systems Planning: Methods and Applications, CRC Press, Boca Raton, Pp. 10-1 to 10-30.

Bhargava, A., H. Bouis and N. Scrimshaw (2001). Dietary intakes and socio-economic factors are associated with the hemoglobin concentration of Bangladesh women, *Journal of Nutrition*, Vol. 131(3): 758-764.

Drescher, L. S (2007). Health food diversity as a concept of dietary quality; Measurement, determinants of consumer demand and willingness to pay. Published PhD Dissertation at the Dept. of Food Economics and consumption studies, University of Kiel, Germany. ISBN-978-3-86727-300-8.

Ecker, O., J-F.T Tan, V. Alpuerto and X. Diao (2013). Economic Growth and Agricultural diversification matters for food and Nutrition security in Ghana. Ghana Strategy Support Program, Discussion Note Number 031, IFPRI, Washington DC.

FAO (1996). Food and Agriculture Organization (FAO) of United Nation's 1996 Rome declaration f World Food Security and World food submit plan of action. www.fao.org/DOCREP/003/W3613E00.htm.

Feleke, S.T., R. L. Kilmer and C. H. Gladwin (2005). Determinants of food security in Southern Ethiopia at the household level. *Agricultural Economics*, Vol. 33: 351-363.

Fakayode, S. B., M. A.Y. Rahji, O.A. Oni and M. O. Adeyemi (2009). An assessment of food security situations of Farm Households in Nigeria: A USDA Approach. *The Social Sciences* Vol. 4(1): 24-29.

FAO (2008). Food and Agricultural organization (FAO) state of Food Insecurity in the World, Rome Italy.

FAO (2009). World summit of food security, Food and Agriculture Organization of the United Nations, Rome, www.fao.org/wsfs/world-summit/wsfs-challenges/en/.

Faridi, R and S. N. Wadood (2010). An econometric assessment of household food security in Bangladesh. The Bangladesh Development Studies, Vol. XXXII (3): 97-111.

Greene,W. H. (2008). *Econometric Analysis*. 7th Edition Prentice-Hall, New Jersey.

Gaiha, R., H. Kaieker, K.S. Imai, V.S. Kulkarni and G. Thapa (2012). Diet diversification and Diet quality in India: An analysis. Discussion paper series RIEN DP 2012-30, Kobe University Japan.

Habicht, J and J. Pelletier (1990). The importance of context in choosing Nutritional Indicators, *Journal of Nutrition*, Vol. 120S (11): 1519-1524.

Hendriks, S. L and M.M Msaki (2009). The impact of smallholder commercialization of organic crops on food consumption patterns, dietary diversity and consumption elasticities, *Agrekon,* Vol. 48, No 2 : 184-199.

Hoddinot, J and Y. Yohannes (2002). Dietary diversity as a food security indicator, FCND Discussion paper No. 136, IFPRI Washington D.C.

Idrisa, Y.L., M. M. Gwary and H. Shehu (2008). Analysis of food security status among farming households in Jere Local Government of Borno state, Nigeria. *Journal of Tropical Agriculture, Food , Environment and Extension*, Vol. 7(3): 199-205.

Jekanowski, M. D and J. K. Binkley (2009). Food purchase diversity across U.S. Market. *Agribusiness*, Vol. 16: 417-433.

Kieschnick, R and B. D. McCullough (2003). Regression analysis of variants observed on (0,1): percentages, proportions and fractions. *Statistical Modeling* 3: 193-213.

Langat, B.K., T. K. Salo, P. M. Nyangiweso, V. K. Ngeno, M. K. Korir and M. J. Kipsat (2010). Household Food security in Commercialized subsistence economies: factors influencing Dietary Diversity of Smallholder Tea farmers in Nandi South Kenya, Poster presented at the 3rd African Association of Agricultural Economist (AAAE) and 48th Agricultural Economist Association of South Africa (AEASA) conference cape Town, South Africa 19-23 September 2010.

McDonald, J (2008). Using Least Squares and Tobit in Second Stage DEA Efficiency Analyses. *Flinders Business School Research Paper Series 2008-3 ISSN 1441-3906*, Flinders University Adelaide USA.

Moon, W., W. J. Florkowski, L. R. Beuchat, A. V. Resurreccion, P. Paraskova, J. Jordanov and M.S. Chinnan (2002). Demand for Food variety in an emerging market economy. *Applied Economics*, Vol. 34: 573-581.

Oberhofer, H and M.Pfaffermayr (2009). Fractional response models-A replication exercise of Papke and Wooldridge (1996). *A working paper in Econometrics and Statistics, University of Innsbruck* No.2009-02.

Obayelu, A. E (2010). Classification of household into food security status in the central North central Nigeria: An application of Rasch measurement model. *Journal of Agricultural and Biological Science*, Vol. 5(3): 26-41.

Omonona, B. T., and A. G. Adetokunbo (2007). An analysis of Food security situation among Nigerian urban households: Evidence from Lagos state, Nigeria. Journal of central European Agriculture, Vol. 8(3): 397-466.

Ogundari, K (2013b). Crop diversification and technical efficiency in food crop production: A study of peasant farmers in Nigeria. International Journal of Social Economics, Vol. 4(3): 267-288.

Ogundari, K. (2013b). On the relationship between the share of nutrient consumed across selected food groups and income in Nigeria: A short run demand system. *Journal of Economic Studies*, Vol. 40: (*in press*)

Papke, L. S and J. M. Wooldridge (1996). Econometric methods for fractional response variables with an application to 401(K) plan participation rates. *Journal of Applied Econometrics*, Vol.11: 619-632.

Pangaribowo, E. H., N. Gerber and M. Torero (2013). Food and Nutrition Security indicators: A review. Center for Development Research (ZEF), University of Bonn, Working paper No. 108, Bonn Germany.

Rashid, D. A., L. Smith and T. Rahman (2006). Determinants of dietary quality: Evidence from Bangladesh. Contributed paper at the American Agricultural Economics Association annual meeting Long beach, California, July 23-26, 2006.

Ruel, M. T (2003). Operationalizing Dietary Diversity: A review of measurement Issues and Research priorities. *The Journal of Nutrition*, Vol. 133(1): 3911-3926.

Rao, S., C. S. Yajnik and A. Kanada (2001). Intake of micronutrient-rich foods in Rural India mothers in associated with the size of their babies at birth: Pune maternal nutrition study. *Journal of Nutrition*, Vol. 131(4): 1217-1224.

Stewart, H and H. Harris (2005). Obstacle to overcome in promoting dietary variety: the case of vegetables. *Review of Agricultural Economics*, Vol. 27: 21-36.

Smith, L.C and Subandoro (2007). Measuring Food Security using Household Expenditure Surveys. Food Security in practice Technical Guide series. Washington D.C , International Food Policy Research Institutes.

Sauer, J., S. Davidora and L. Latruffe (2011). Determinants of smallholders' Decisions to leave Land Fallow. The case if Kosovo. Journal of Agricultural Economics, Vol. 63(1): 119-141.

Sanusi, R. A., C. A. Badejo and B. D. Yusuf (2006). Measuring household food insecurity in selected local government of Lagos and Ibadan, Nigeria. *Pakistan Journal of Nutrition*, Vol. 5(1): 62-67.

Swindale, A and P. Bilinsky (2005). Household Dietary Diversity Score (HDDS) for measurement of Household food access: Indicator Guide. Food and Nutrition Technical Assistance project, Academy for Educational Development, Washington DC.

Savy, M., Y. martin-Prevel, P. Sawadogo, Y. Kameli and F. Dupeuch (2005). Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. European Journal of Clinical Nutrition, Vol. 59: 703-716.

Steyn, N.P., J.H. Nel, G. Natel, G. Kennedy and L. Labdarios (2006). Food variety and Dietary Diversity Scores in Children: are they good indicators of dietary adequacy? Public Health Nutrition, Vol. 9(5): 644-650.

Tarini, A., S. Bakari and H. Delisle (1999). The overall Nutritional Quality of the Diet is reflected in the growth of children in Niger, *Sante* Vol. 9(1): 23-31.

Thiele, S and C. Weiss (2003). Consumer demand for Food diversity: evidence for Germany. *Food Policy*, Vol. 28: 99-115.

USDA-ER (2012). International food security Assessment, 2012-22/GFA-23. U.S. Department of Agriculture, Economic, Economic Research Service publication, Washington DC.

Variyam, J. N., J. Blaylock, D. Smallwood and D. Basiotis (1998). USDA's Healthy Eating Index and nutrition information. Economic Research Service/USDA, Technical Bulletin, 166, Washington D.C.

Woldehanna, T and J. R. Behrman (2013). What Determines Ethiopian Children's Dietary Diversity. Paper presented at center for the study of African Economics (CSAE) held at St. Catherine's college Oxford 17-19 March 2013.

Appendix

Table A: Summary statistics of the variables and food-poverty states

Description	**Variable**	**Mean**	**SD**
Dietary Diversity Score	*DDS*	4.5739	1.2547
Real monthly per capita food expenditure	*FOOD_exp*	16084.9	12946.2
Food insecurity (FI) Indicator 1: Identified Food Poverty States			
Completely Food insecure households from both indicators	*Food-Poverty (FP=3)*	0.1574	
Transitorily Food Insecure based on Food_exp & Food secure based on DDS	*Food-Poverty (FP=2)*	0.2384	
Transitorily Food Insecure based on DDS & Food secure based on Food_exp	*Food-Poverty (FP=1)*	0.1788	
Completely Food secure households from both indicators	*Food-Poverty (FP=0*)	0.4254	
Food insecurity (FI) Indicator 2: Dietary Diversity Index			
Average Dietary Diversity Index	*DDI*	0.5849	0.1892
Real per capita total expenditure -a proxy for HH income[a]	HH_INCOME	28678.08	32724.82
Household Size	HHSIZE	4.8479	2.9067
Year of education of the Household head	EDUCATION	7.3680	7.3580
Household Head that are male (1/0)	GENDER	0.8562	0.3509
Household Head with farming as major occupation (1/0)	OCCUPATION	0.6257	0.4839
Households that only own produce food consumed (1/0)	D_OWNPRODUCEONLY	0.0139	0.1172
Household that only purchase food consumed (1/0)	D_PURCHASEONLY	0.3083	0.4618
Households with member within < 25 years (1/0)	D_AGE <20	0.0221	0.1470
Households with member within 25-29 years (1/0)	D_AGE25-29	0.0659	0.2481
Households with member within 30-34 years (1/0)	D_AGE30-34	0.1042	0.3056
Households with member within 35-39 years (1/0)	D_AGE35-39	0.1226	0.3279
Households with member within 40-44 years (1/0)	D_AGR40-44	0.1321	0.3386
Households located in the Rural Areas (1/0)	D_RURAL	0.7613	0.4263
Households located in the South-South SS region (1/0)	D_SOUTH_SOUTH	0.1512	0.3583
Households located in the South-East SE region (1/0)	D_SOUTH_EAST	0.1421	0.3492
Households located in the North-Central NC region (1/0)	D_NORTH_CENTRAL	0.1768	0.3815
Households located in the North-East NE region (1/0)	D_NORTH_EAST	0.1697	0.3754
Households located in the North-West NW region (1/0)	D_NORTHWEST	0.2014	0.4010

[a]*Note: Expenditure is expressed in Nigerian currency (naira) and 1US$=133 naira as at 2003/2004*

Table B: Summary statistics of the variables by identified food Poverty States

Variables	*Identified Household Food-Poverty (FP) States*							
	FP=0 (n=8027)		FP=1 (n=3375)		FP=2 (n=4497)		FP=3 (n=2971)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
HH_INCOME[a]	40340	40148	33049	29576	14448	13682	13744	15869
HHSIZE	4.1854	2.5629	3.9949	2.6304	5.9904	3.0439	5.8778	2.9980
EDUCATION	8.1292	7.0266	6.9333	7.2242	6.9132	7.1409	6.4302	7.3036
GENDER	0.8402	0.3664	0.8261	0.3791	0.8795	0.3256	0.8980	0.3027

OCCUPATION	0.5659	0.4957	0.7001	0.4583	0.6035	0.4892	0.7371	0.4403
D_OWNPRODUCEDONLY	0.0005	0.0223	0.0033	0.0570	0.0456	0.2086	0.0145	0.1195
D_PURCHASEONLY	0.3669	0.4819	0.2640	0.4409	0.2577	0.4374	0.2767	0.4474
D_AGE <20	0.0269	0.1618	0.0279	0.1646	0.0127	0.1119	0.0168	0.1287
D_AGE25-29	0.0789	0.2695	0.0788	0.2695	0.0458	0.2091	0.0464	0.2105
D_AGE30-34	0.1139	0.3177	0.1073	0.3095	0.0894	0.2853	0.0973	0.2964
D_AGE35-39	0.1308	0.3372	0.1090	0.3117	0.1212	0.3264	0.1178	0.3224
D_AGR40-44	0.1263	0.3322	0.1111	0.3143	0.1517	0.3587	0.1417	0.3488
D_RURAL	0.7167	0.4506	0.8047	0.3965	0.7541	0.4307	0.8435	0.3634
D_SOUTH_SOUTH	0.1627	0.3691	0.1330	0.3397	0.1481	0.3552	0.1457	0.3529
D_SOUTH_EAST	0.2063	0.4047	0.1286	0.3348	0.0767	0.2662	0.0835	0.2766
D_NORTH_CENTRAL	0.1402	0.3472	0.1689	0.3747	0.2613	0.4394	0.1568	0.3637
D_NORTH_EAST	0.1582	0.3649	0.1535	0.3605	0.1872	0.3901	0.1925	0.3944
D_NORTHWEST	0.1734	0.3786	0.2068	0.4051	0.1910	0.3931	0.2864	0.4522

[a]*Note: Expenditure is expressed in Nigerian currency (naira) and 1US$=133 naira as at 2003/2004*

Table C: Summary statistics of household expenditure, DDS, and DDI by Food-Poverty States

Variables[a]	*Identified Household Food-Poverty (FP) States*							
	FP=0 (n=8027)		FP=1 (n=3375)		FP=2 (n=4497)		FP=3 (n=2971)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Real expenditure on non-food	86553	63319	77552	66204	37579	26854	36589	22417
Total Real expenditure on food	57255	111205	35957	57019	43887	79712	35816	72680
Total Real expenditure on food & non-food	143808	141172	113509	94447	81465	87599	72404	79418
Dietary Diversity Score (DDS)	5.3791	0.5502	3.9102	0.3247	4.2270	1.8957	3.6772	0.6205
Dietary Diversity Index (DDI)	0.6471	0.1097	0.5736	0.1322	0.4914	0.2960	0.5712	0.1359
Share of total food spending by food groups								
Share of Staple Food	0.4616	0.1572	0.5189	0.1876	0.5831	0.2790	0.4775	0.2166
Share of Flesh Food	0.1976	0.1266	0.1757	0.1435	0.1381	0.1332	0.1631	0.1656
Share of Fruits & Vegetables	0.1187	0.0861	0.1282	0.1129	0.0888	0.0885	0.1295	0.1202
Share of Fats & Oil	0.0313	0.0433	0.0026	0.0205	0.0231	0.0479	0.0095	0.0496
Share of Dairy Products	0.0313	0.0433	0.0026	0.0205	0.0231	0.0479	0.0095	0.0496
Share of Sweeteners	0.0220	0.0318	0.0016	0.0135	0.0240	0.0417	0.0098	0.0429

[a]*Note: All expenditure are expressed in Nigerian currency (naira) and 1US$=133 naira*

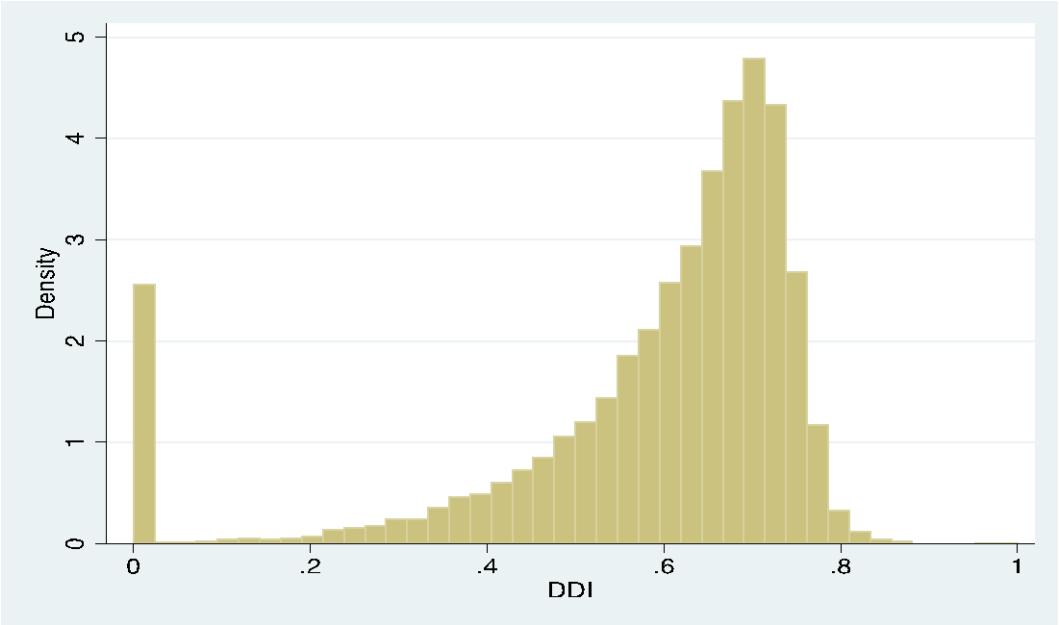

Figure A: The Distribution of Dietary Diversity Index (DDI)

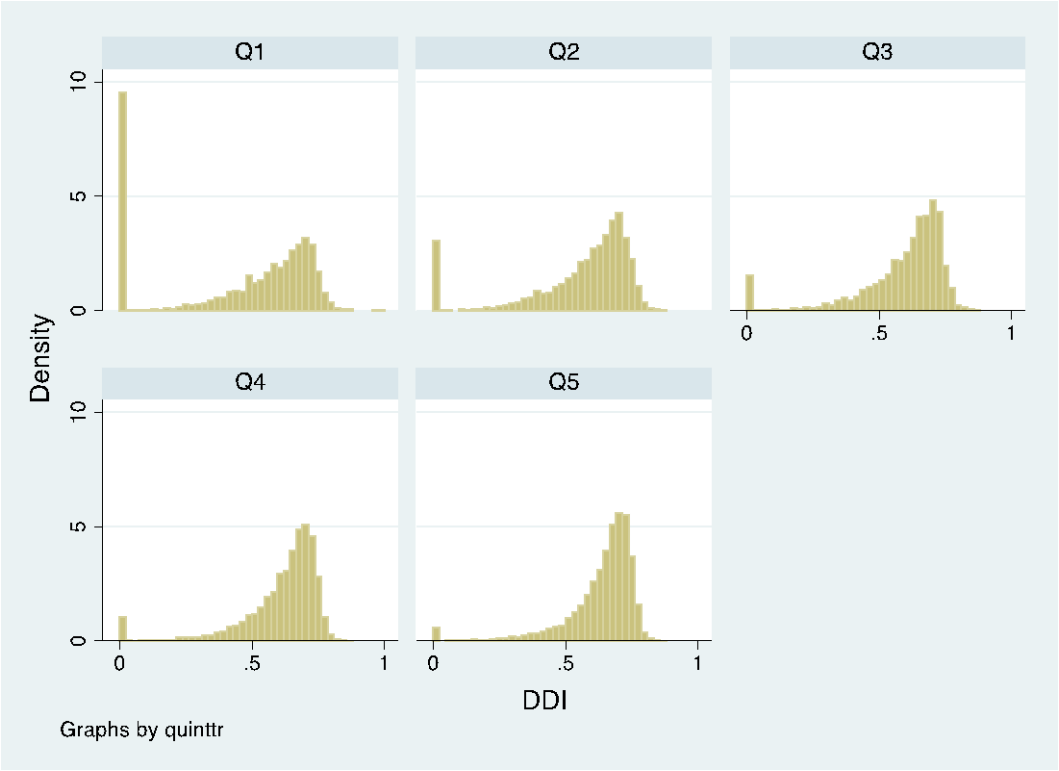

Figure B: The Distribution of the Dietary Diversity Index (DDI) by income group

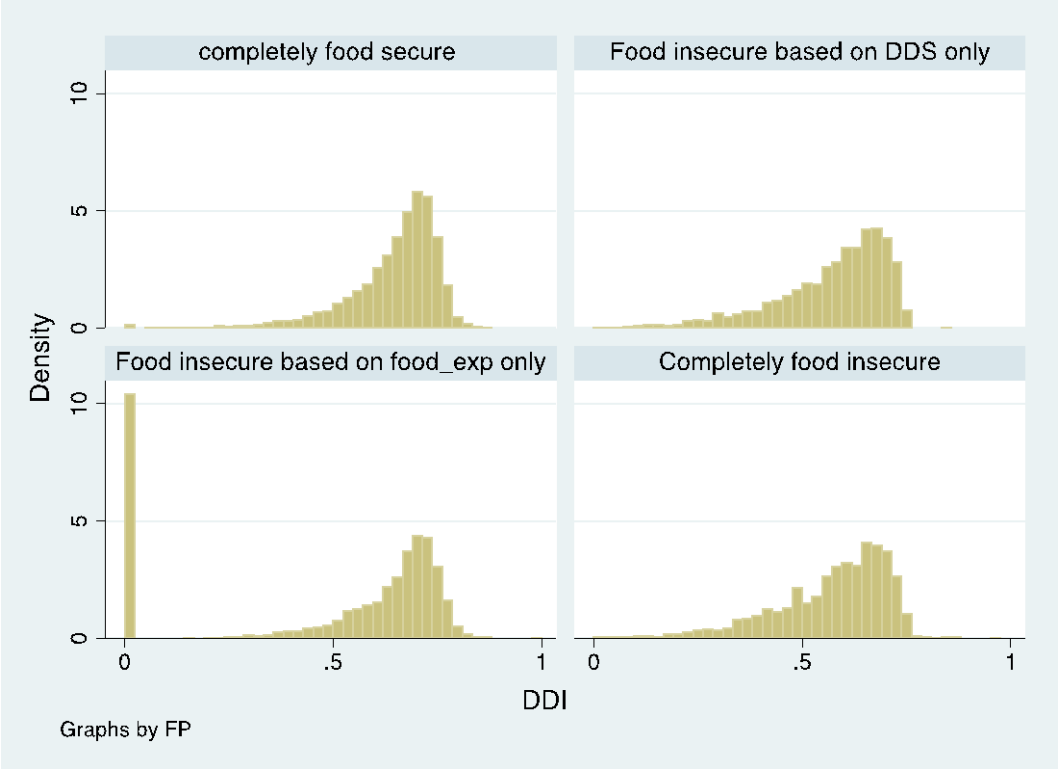

Figure C: The Distribution of the Dietary Diversity Index (DDI) by identified food-poverty states