Analysis of Maize Biomass-based Value Web and Household Livelihood Security in Nigeria

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Abstract

Biomass-based value web describes complex systems of interlinked value chain activities ranging from production to trading of agricultural products. This concept is increasingly being identified as a veritable tool for improving household livelihood security in sub-Sahara Africa. However, there is limited information on its effect on household livelihood security. Therefore, this study was carried out to add to the existing wealth of knowledge on the significant influence of biomass value web on the livelihood security of households in Africa at large and Nigeria in particular. The result of this study will make farmers realize the income potentials and opportunities available in the maize biomass value web which could improve their livelihood status. The outcome of the study will also provide decision-makers with information on the importance of biomass value web essential to policy formulation for the improvement of households' livelihood security in Nigeria. The objectives of the study were to: (i) identify the different food and non-food uses of maize within the maize biomass value web in the study area; (ii) analyse the livelihood security status of maize farming households in the study area; and (iii) examine the effect of involvement in the maize biomass value web on the livelihood security status of households in the study area.

The study used cross-sectional design technique. The target population was all the maize farmers in Niger and Nasarawa states of North-central Nigeria. A multistage random sampling technique was used to select a sample of 288 maize farmers in Niger and Nasarawa states of Nigeria that were administered a well-structured questionnaire. The statistical tools used for the analysis were descriptive statistics, livelihood security analysis and Seemingly Unrelated Regression (SUR) technique.

The findings of the study were that: households put maize into seven uses which are Cooked/Roasted corn (88.9%), Pap (88.2%), 'Tuwo' (95.1%), 'Massa' (2.1%), Animal feed (24.7%), Fuel (35.1%), and Mulch/Manure (16.7%), where 'Tuwo' (a boiled maize paste) was found to be the most predominant use in the study area; majority (>50%) of the households had low Economic (54.9%), Health (62.8%), and Education Security (62.2%) domains, with average security index of 0.34, 0.39, and 0.5 respectively; and a unit increase in the index of maize usage brings about 10% increase in economic security ($p < 0.05$) and 17% increase in food security ($p < 0.05$) of the households.

The study concluded that intensified maize biomass value web involvement improves the livelihood security of maize farming households. The study recommended that farmers be encouraged to intensify maize use through effective sensitization programmes by relevant stakeholders.

1 INTRODUCTION

Livelihood insecurity, micronutrient deficiency and hunger generally in sub-Sahara Africa are still at high levels, while at the same time the demand (international and domestic) for non-food agricultural products, such as feed, energy and industrial raw materials, is continually increasing. Thus, leading to serious competition for the cultivation of food and non-food crops subject to limited available resources, which is a major challenge in the region. Concepts are as such needed that can help to improve household food and livelihood security for the poor through increased food production, while at the same time supplying sufficient non-food, processed biomass to offer employment and income opportunities to the poor without one affecting the other negatively. For these concepts to be effective, analytic approaches are required which should cover the increasingly complex ways of biomass from crop production to final consumption. In this regard, conventional value-chain approaches analysing single value chains are neither sufficient nor effective any longer (Adeyemo *et al*., 2016; Virchow *et al*., 2016). This leads to the emergence of a biomass-based value web concept. The 'web perspective' of the biomass-based value web is used as a multi-dimensional methodology instrumental to bringing about an increase in the agricultural sector's efficiency as a whole.

The web perspective concentrates on the numerous alternative uses of raw products, including recycling processes and the cascading effects during the processing phase of biomass utilization (Adeyemo *et al*., 2019). Increasing global demand for biomass products has increased pressure on the agricultural sector and food production in the past decades, especially in sub-Saharan Africa. The concept of biomass-based value web according to Knauf and Lubekke (2007), therefore aims at contributing to food and household livelihood security among poor households by focusing on complex systems of interlinked value chains in which food and fodder, fuels, and other raw materials are produced, processed and traded. The conventional value chain approach analyses the series of activities, profitability, efficiency, and actors involved in the production of a raw product, while the biomass value web approach analyses the interrelation and synergies between several value chains and as such captures the manifold products obtainable from a raw product. Hence, it is no longer sufficient to analyze the system by following the conventional (mainly product-focused) value chain approach. Analytical perspectives are needed which covers the complex pathways of biomass which include but go beyond the concept of value chain analysis. Here the holistic concept of biomass-based value webs becomes very important.

Instead of examining the pathway of a single product and thus being in tendency more industry-oriented, the web approach captures the manifold products which are and can be derived from one biomass raw product and respectively looks at the whole product mix produced by an household, the different value chains the household participate in and how they could be linked. The web perspective helps to explore synergies between these value chains, identify inefficiencies and pinpoint available potentials for sustainable improvement in the entire biomass sector. This includes the analysis of existing and potential recycling processes and cascading uses during the processing phase of biomass, which gives room to locally capture more of the value-added products. The cascades of use and interlinking of value chains are essential to increase in the efficiency of resource-use and biomass sector as a whole, and making use of innovation potentials (BMBF, 2011; BMEL, 2014). The web perspective also assists to better identify participants and beneficiaries across the different value chains, activities and processes involved, and cooperation between actors. The biomass web analytical approach can also be used to assess profit and other benefit distributions among the different actors and participants in the whole web. Thus, opportunities can be detected where more value could be captured in poor producing regions, how to ensure equitable distribution of value addition and where income-generating activities can be increased (Kaplinsky, 2000; Bolwig et al., 2010).

Maize (Zea mays L.) is the third most important cereal in the world after wheat and rice with regard to cultivation areas and total production (Purseglove, 1992; Osagie and Eka, 1998; Oladejo and Adetunji, 2012). It is perhaps, the most important cereal crop of significant economic importance in many African countries (including Nigeria) that has replaced sorghum and millet (Olaniyan, 2015). It is a staple crop cultivated in diverse environments and consumed by people with varying socio-economic background and food preferences in Nigeria. Maize is a multipurpose crop of which, every part of its plant has great economic value (IITA, 2009). Although maize is increasingly being utilized for livestock feed, it is still a very important staple food for many Nigerian citizens. The importance of maize cannot be over emphasized in Nigeria, including the potential to mitigate the present food insecurity and alleviate poverty. Maize is a preferred staple food for over 900 million poor consumers, 120 – 140 million poor farm families and about one-third of malnourished children (CIMMYT and IITA, 2010). In sub-Saharan Africa (especially Nigeria), the absence or shortage of maize invariably leads to famine and starvation. Since maize is highly responsive to production inputs, its food and industrial uses, and its production potential can hardly be matched by any other major cereals in Nigeria, as evidenced by the value web presented in Figure 1. It can be deduced from the chart in Figure 1 that all the main parts of maize plant (the stalk, leaves, ear, and tassel) can be used to produce over 20 maize products within the biomass value web. Considering the enormous uses of maize in Nigeria, it is important to examine the biomass value web of the crop to ascertain the intensity of use of the crop and associated benefits within the web.

Moreover, many African countries have the potential to meet not only their future demand for biomass-based produce but also to provide other African and industrial countries with raw materials and, most importantly, processed biomass products. But it is disheartening that the actual available biomass is underutilized in sub-Saharan Africa, especially in Nigeria. Despite the great potential of biomass-based value web, sub-Saharan Africa remains the region with the highest proportion of undernourished people related to the total population. To meet the food demand of Africa's fast-growing population and at the same time increase the supply of non-food processed biomass, Africa's agricultural sector will have to swiftly adopt a mechanism to increase productivity and maximize the utilization of agricultural produce. In addition, many farming households in Nigeria cultivate different multipurpose crops (like maize, cassava, sugarcane, sorghum, and so on) that can be used to produce diverse food and non-food products. However, it is worrisome that most of these farming households in Nigeria focus primarily on the food use of agricultural products with little attention to non-food use. This in turn negatively affects the intensity of utilization of multipurpose crops within the biomass value web and livelihood security of rural households in the country. Household livelihood security is defined as adequate and sustainable access to income and resources to meet basic human needs. Livelihoods can be comprised of a range of on-farm and off-farm activities which in combination provides a variety of procurement strategies for food and income for rural households (Frankenberger and McCaston, 1998).

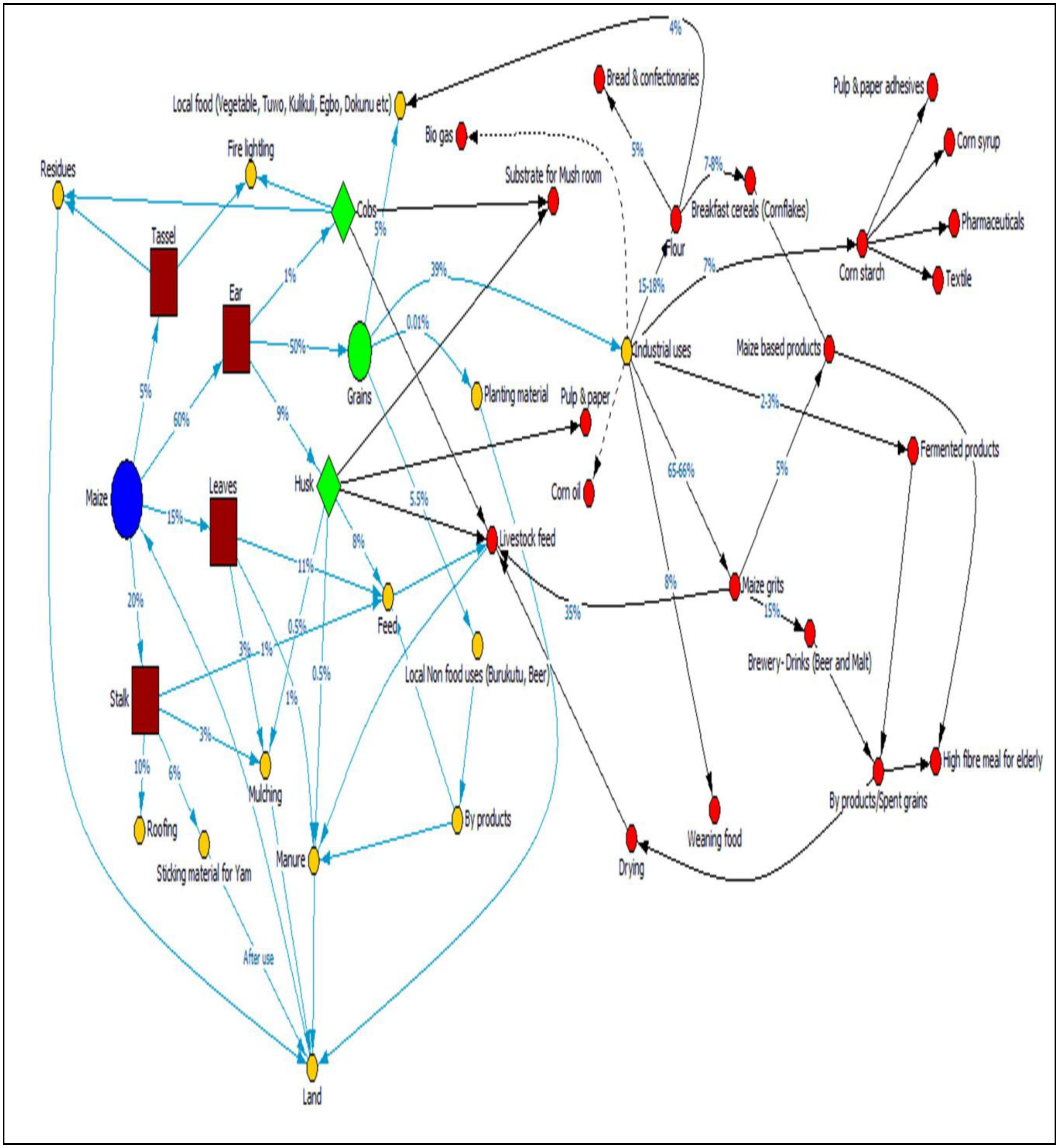

Figure 1: Value web of Maize in Nigeria
Source: Adapted from Adetoyinbo *et al.*, 2016.

From the literature, improving household livelihood security, fighting poverty, ensuring food and nutritional security through optimal use of agricultural products while protecting the environment still remains a major challenge facing the developing countries of the world. Many researchers in the field of Agricultural Economics have argued that significant livelihood insecurity, food and nutrition problems exist in Africa, especially in Nigeria. To buttress this, the number of hungry people in Nigeria is estimated to be over 25 million, which is about 12.6% of the country's total population of roughly 200 million (World Bank, 2020). Though crop production, as well as population, has been on the increase in Africa in general and Nigeria specifically, it is worthy of note that a substantial proportion of the total production is lost to wastage and the demand of the growing population seems to exceed the total supply of production. As a result of this, advocates have recently been for a more efficient way of reducing wastage and at the same time increasing the intensity of use of crops to meet up with the growing demand of the populace in Africa, especially in Nigeria. This makes the concept of biomass value web of great importance and relevance in ensuring improved food and livelihood security of many Nigerians. Focusing on the production of food and non-food biomass from locally adapted crops can offer pathways to improve food security (directly) and livelihood security (indirectly) by generating jobs for households. It is in this regard that this paper examined the effect of maize biomass-based value web on livelihood security of farming households in North-central Nigeria.

The objectives of the paper are to:

- identify the different food and non-food uses of maize within the maize biomass value web in the study area;
- analyze the livelihood security status of maize farming households in the study area; and

- examine the effect of involvement in the maize biomass value web on the livelihood security status of farming households in the study area.

2 THEORETICAL AND CONCEPTUAL FRAMEWORK

The theoretical framework of this paper is premised on Porter's value chain theory. A value chain is a set of activities that a firm operating in a specific industry carries out in order to produce a valuable product or service for the market. Critically examining Porter's classical, firm-based value chain, three main strands of concepts evolved to explain how global industries are organized and governed, and how, in turn, those relationships affect the development and upgrading opportunities of the various regions and firms involved. These concepts are the global commodity chain (GCC), the global value chain (GVC) and the global production networks (GPN). A biomass-based value web approach utilizes the 'web perspective' as a multi-dimensional framework to have an in-depth understanding of the linkages and associations between several value chains and how they are organized and managed. Like global production networks, the web approach views the process of activities that result in a final product as one in which, the flows of materials, semi-finished products, production, design, marketing and financial services are organized vertically, horizontally and diagonally in complex and dynamic configurations. Instead of examining the pathway of a single product, the web approach captures the manifold products which are derivable from one biomass raw product, and also examine the whole product mix produced on family farms, the different value chains the households participate in and how they are or could be linked.

The study conceptualize how household involvement in maize biomass value web interact with socioeconomic variables like age of household head, years of schooling, household asset value, household income, farm size, household size, e.t.c, and intervening variables like Government policies, infrastructural facilities, extension services, in order to bring about an outcome effect on household livelihood security. Figure 2 shows the conceptual framework of the study and reveal that high level of involvement in the maize biomass value web, which translates to intensified maize usage, can bring about improved household livelihood security.

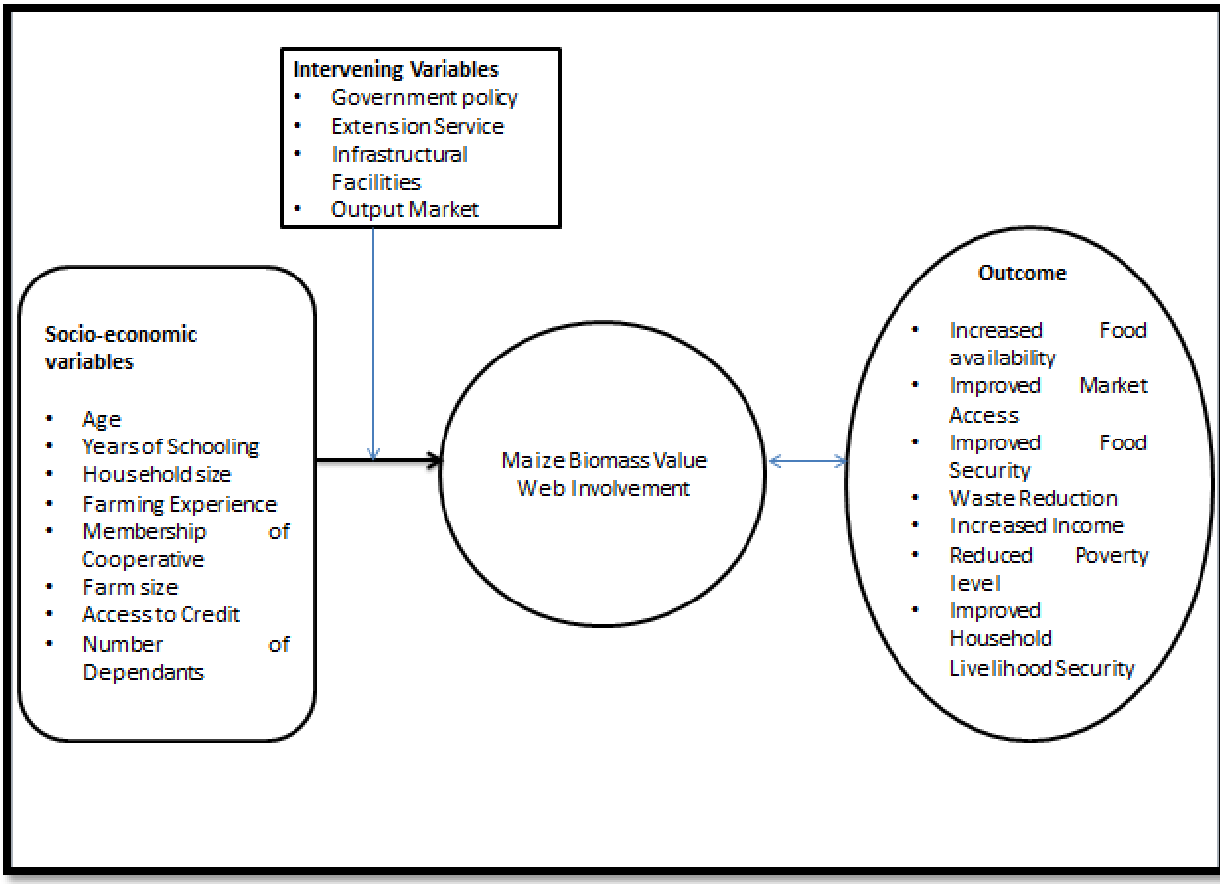

Figure 2: Conceptual Framework for Maize Biomass Value web
Source: Author's Design

The analytical framework of this study involves the use of Herfindahl-Hirschman index to measure the intensity of use of maize within the biomass value web. Also, the livelihood security of maize farming households in the study area was measured using the composite Livelihood Security. The Household Livelihood Security (HLS) index uses a balanced weighted average approach with a large number of indicators, where each indicator contributes equally to the overall index. The indicators used to compute the composite Household Livelihood Security are grouped into five security domains namely: Economic Security, Food Security, Health Security, Education Security, and Empowerment Security.

3 DATA AND METHODOLOGY

3.1 The Study Area

The study locations for this study are Niger and Nasarawa States in north-central Nigeria. Although information from only two states can hardly be considered representative for a large and diverse country as Nigeria, Niger and Nasarawa States are still considered to be interesting study locations, because of their considerable socioeconomic heterogeneity, location and prominence for maize cultivation. Maize is cultivated in almost all the agricultural development project zones of Niger and Nasarawa states and the two states ranks among the top major producers of maize in the country (World Atlas, 2019). Maize is generally used for various food and non-food uses by households in the two states.

3.2 Source of Data

The study used primary data collected from a target population of 300 farming households involved in the maize biomass value web using a well-structured questionnaire.

3.3 Sampling Technique

A three-stage random sampling technique was used to select the sample households for the study. In the first stage, two Agricultural Development Project (ADP) zones were randomly selected from each of Niger and Nasarawa states. The second stage involved the random selection of five communities from each of the selected ADP zone using the complete list of communities in each zone. In the final stage, 15 maize farming households were selected from each of the selected community using the snowball technique. In the snowball technique adopted, a sampled maize farming household referred another maize farming household within the same community and continued in a cycle until the last maize farming household was sampled in the community. Thus, a total of 300 maize farming households were sampled and administered questionnaire for the purpose of the study. However, only 288 maize farming household data were found useful for the analysis of the study.

3.4 Data Collection and Analysis

Primary data for this study were collected in the year 2019 through the use of the interview schedule method. Information was collected on a wide range of variables using a well-structured questionnaire. The study used a number of analytical tools based on the study objectives. The analytical tools that were used in analysing data collected include those involving descriptive statistical analysis, Livelihood Security analysis, and regression models.

Descriptive statistics was used to analyse the first objective of the study. The second objective was analysed using Livelihood Security analysis, while the third objective was analysed using Seemingly Unrelated Regression (SUR) analysis.

Descriptive Analysis

The descriptive analysis that was used included measures of mean, standard deviation, charts and frequency distribution.

Household Livelihood Security Analysis and SUR Model

Intensity of maize usage in the maize biomass value web

The intensity of use of maize in the study area was measured by the Herfindahl-Hirschman index. The Herfindahl-Hirschman Index was originally developed for measuring the degree of market concentration and takes into account both the relative size and distribution of each firm. It increases as the number of firms in the market falls and the disparity in the size of those firms increases. Also, households were classified into those with high and low levels of involvement in biomass value web based on the value of Herfindahl index such that, any household with an index of ≥0.18 had a high level of involvement in biomass value web and any household with an index of <0.18 had a low level of involvement in biomass value web (Crowley et al., 2016). The specification of the Herfindahl-Hirschman Index is stated below.

$$H = \sum_{i=1}^{288} (ai)^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where, H = Herfindahl index, and

$$ai = \frac{Monetary\ value\ of\ maize\ usage\ by\ household\ (Naira)}{Maximum\ obtainable\ monetary\ value\ of\ maize\ usage\ in\ the\ area\ (Naira)}$$

Household Livelihood Security Analysis

The livelihood security of maize farming households in the study area was measured using the composite Livelihood Security. The Household Livelihood Security (HLS) index uses a balanced weighted average approach with a large number of indicators, where each indicator contributes equally to the overall index. The indicators used to compute the composite Household Livelihood Security are grouped into five security domains namely: Economic Security, Food Security, Health Security, Education Security, and Empowerment Security. The details of the indicators used to compute each security domain are presented in the appendix.

Since each indicator was measured on a different scale, indicators were standardized following the approach adopted in measuring 'Life Expectancy' in Human Development Reports (likewise adopted by Hahn *et al.*, 2009; Shaheen and Sanzidur, 2012; Kamaruddin and Samsudin, 2014). For example, a standardized indicator j is given by:

$$Zind_j = \frac{Indicator_j - Min_j}{Maz_j - Min_j} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

Where minimum and maximum values of the indicators are from the same community within which the household belongs. Once each indicator representing a particular livelihood security domain was standardized, then the relevant household livelihood security index for the particular domain was constructed by averaging the standardized indicators as follow:

$HLS_i = \sum_{j=1}^{J} \text{Zindj} / J$ …………………………………. (3)

Where J is the number of indicators used to construct the index. Once each HLS index was constructed, then the composite (overall) Livelihood Security (LS) index for the household was constructed by using the formula in equation (4)

$LS_i = \sum_{i=1}^{288} wiHLSi \, / \sum_{i=1}^{288} wi$ …………………………. (4)

Where w_i is the weight determined by the number of indicators used to construct each HLS index. Weights varied between households because of the household level variation in the number of indicators that were used to construct each index.

Seemingly Unrelated Regression (SUR) Analysis

Seemingly Unrelated Regression (SUR) Analysis was used to analyse the effect of the level of maize biomass value web involvement on the five domains of Household Livelihood Security, namely: Economic Security, Food Security, Health Security, Educational Security and Empowerment. The econometric model that was used to examine the effect of maize biomass value web on Household Livelihood Security is implicitly stated as follow:

$Y_i = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, \ldots\ldots U)$; i= 1, 2,3, 4, 5.

Where,

Y_1 = Economic Security Index

Y_2 = Food Security Index

Y_3 = Health Security Index

Y_4 = Education Security Index

Y_5= Empowerment Security Index, and

X_1 = Gender of household head (Female $= 0$, Male $= 1$)

X_2 = Age of household head (Years)

X_3 = Number of household income sources

X_4 = Cooperative Membership (Yes= 1, No= 0)

X_5 = Number of dependants

X_6 = Maize farm size (Hectares)

X_7 = Maize cultivation (Main crop= 1, 0 otherwise)

X_8 = Infrastructure Index

X_9 = Involvement in maize biomass value web (Herfindahl index)

X_{10} = Health insurance beneficiary status (Yes= 1, No= 0)

X_{11} = Market distance (kilometers)

U= Random error term.

The model was analysed using Zellner's iteration SUR estimation technique.

4 RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Maize Farmers in Niger and Nasarawa State.

The descriptive result of the socio-economic characteristics of the maize farmers sampled in Niger and Nasarawa States shows that 92.4% of the maize farmers in the study area are male while only 7.6% are of the female gender. Moreover, table 1 shows the mean values of socioeconomic characteristics such as age, years of schooling, total household asset, credit amount procured in the last 12 months, farm size, farming experience, adjusted household size, composite household livelihood security among others, can be obtained.

Table 1: Summary statistics of the socioeconomic characteristics of respondents (n= 288)

Variable	Minimum	Maximum	Mean	Standard Deviation
Age (years)	29	65	48.69	6.51
Education (YOS)	0	16	7.8	5.17
Farming Experience (years)	5	50	25.34	8.8
Maize Farm Experience (years)	4	45	20.03	9.8
Credit Amount (₦)	0	250,000	18,368.06	40,756.48
Total Maize harvested (Kg)	800	7,500	2,864.75	636.49
Total Farm Size (Ha)	1.5	6.5	3.45	1.07
Maize Farm Size (Ha)	0.5	4	2.25	0.68
Infrastructure Index	0	1	0.69	0.25
Household Size (AE)	2.2	12.3	6.31	1.71
Per capita Income (₦)	18,915.66	177,272.7	55,332.51	21,693.02
Per capita Calorie intake (Kilocal/AE/day)	1,016.16	4,033.69	2,299.68	588.01
Market Distance (Kilometer)	2	25	10.47	5.83
Maize usage (number)	2	7	3.49	1.21
Composite HLS (index)	0.27	0.56	0.43	0.06

Source: Data Analysis, 2019; n= Number of Observations, ₦= Naira, AE= Adult male Equivalent, Ha= Hectare(s), YOS= Years of schooling, HLS= Household Livelihood Security.

It can be deduced from Table 1 that on the average, maize famers in the study area has an age of about 49years, education of about 8years of schooling, farming experience of 25years out of which 20years was strictly for maize farming, obtained a credit loan of about ₦18,370, harvested maize of 2864.75kg, and total farm size of 3.45hectares. It can also be seen in the table that on the average, 2.25hectares of the household total farm size was used for maize cultivation, household in the study area had infrastructure index of 0.69, household size of about 6 in adult male equivalence, household per capita income of ₦55,332.51 (153.7 US dollars) per annum, calorie intake of 2,299.68 Kilocal/AE/day, distance to nearest market of about 10.5km, maize usage of at least 3 counts, and composite livelihood security of 0.43.

4.2 Household involvement in Maize Biomass Value Web

Food and Non-Food Uses of Maize in the Study Area

Maize Usage was estimated by the count and monetary worth of use household put maize into within the last 30days. Table 2 shows the ranking of maize usage (multiple responses) among households in the study area. This was captured as multiple responses since household can put maize into two or more uses at the same time. Figure 3 on the other hand shows the average monetary worth adjusted by household size of various food and non-food uses of maize in the study area.

Table 2: **Food and Non-Food Uses of Maize**

Maize Usage	Frequency	Ranking
Cooked/Roasted	256 (88.9%)	2nd
Pap	251 (87.2%)	3rd
Animal Feed	71 (24.7%)	5th
Tuwo	274 (95.1%)	1st
Fuel	101 (35.1%)	4th
Massa	6 (2.1%)	7th
Mulch/Manure	48 (16.7%)	6th

Source: Data Analysis, 2019; Figures in parenthesis represents the percentage in relation to the total sample size (288).

Table 2 shows the seven prominent food and non-food uses of maize in the study area. As it can be seen in the table, the most common use of maize in the study area was for 'Tuwo', a locally consumed delicacy in the study area with over 90% of households using maize for 'Tuwo' preparation either for home consumption or for the market. While the least use of maize in the study area was for 'Massa' with only 2.1% of households in the study area engaged in its preparation.

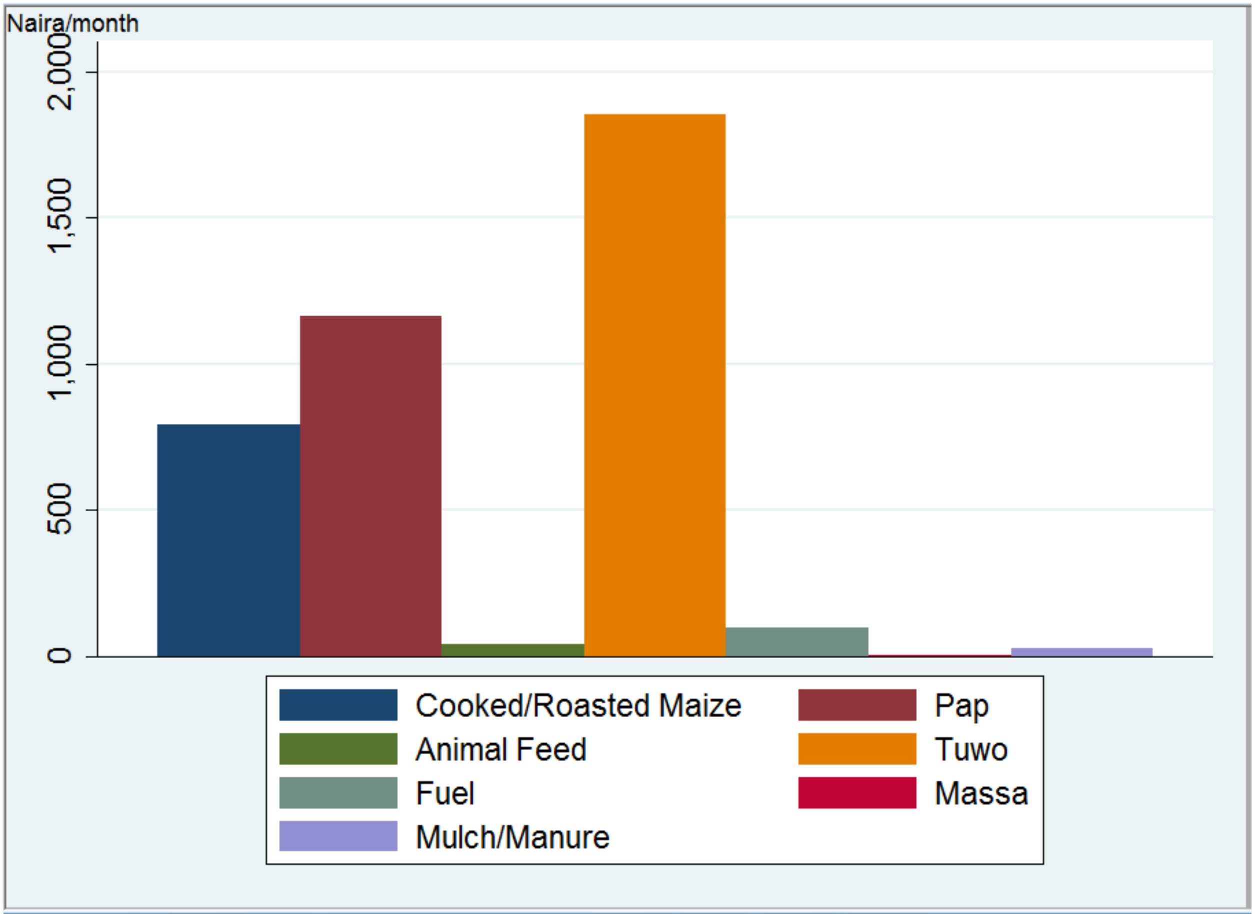

Figure 3: Food and Non-Food Uses of Maize
Source: Data Analysis, 2019

The chart in Figure 3 also buttresses the fact that maize is mostly used by households for 'Tuwo' with an average consumption of ₦1,851.56 per month (5.14 US dollar per month). While the least use of maize in the study area was for 'Massa' with an average consumption of less than ₦5 per month.

Table 3: Maize Usage Distribution of Households

Maize Usage (count)	Frequency	Percentage
2	67	23.3
3	92	31.9
4	73	25.4
5	38	13.2
6	13	4.5

7	5	1.7
Total	**288**	**100**
Mean Maize Usage	**3.49**	

Source: Field Survey, 2019.

The result in Table 3 shows the distribution of households by maize usage. It can be deduced from the table that over 50% of the sampled households put maize in to 2 or 3 uses, while only 1.7% put maize into 7 different uses in the study area. The average usage of maize in the study area was above 3 uses. This result is similar to the findings of Adeyemo *et al*. (2016), where they discovered that most of the smallholder farmers in Edo state have more than 3 areas of income generation from the cassava web.

Figure 4 further shows the seven prominent maize uses in the study area and the actors in the maize biomass value web.

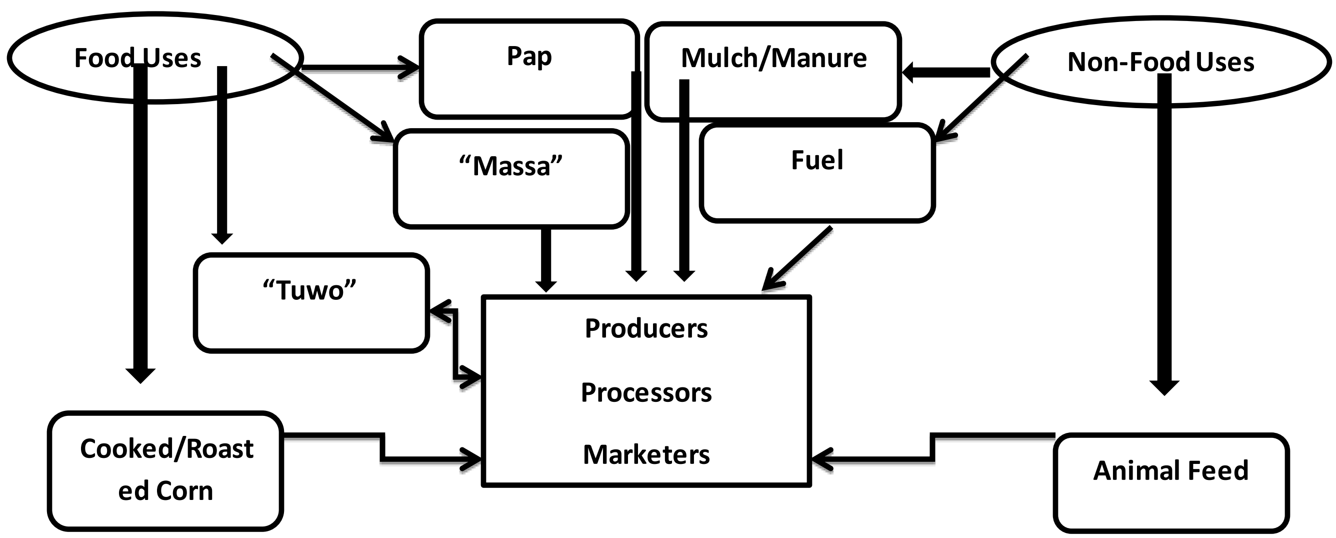

Figure 4: **Cascading Uses of Maize and Actors in Maize Value Web**
Source: Author's Conceptualization (2019)

Maize can be processed into various food and non-food uses as shown in the chart which can be consumed at the household level or make available for sale in the market to generate additional income for the household.

Level of Diversification in Maize Biomass Value Web by Households

The level of involvement of Households in the Maize Biomass value web was classified into low and high levels based on the estimated Herfindahl index of Maize usage following the classification model of Crowley *et al.* (2016), such that any household with an index value of <0.18 has a low level of involvement and household with at least 0.18 value has a high level of involvement. Table 4 shows the distribution of respondents by their level of involvement in the Maize Biomass value web.

Table 4: Distribution of Respondents by Maize Biomass Value Web Involvement

Level of Involvement	Frequency	Percentage
Low	132	45.8
High	156	54.2
Total	**288**	**100**

Source: Field Survey, 2019

As it can be seen in Table 4, 54.2% of the respondents in the study area has a high level of involvement in the Maize Biomass Value Web, while 45.8% can be said to have a low level of involvement in Maize Biomass Value Web. Thus, the majority of the sampled households had a high level of involvement in Maize Biomass Value Web in the study area.

4.3 Household Livelihood Security Analysis

The livelihood security of maize farming households in the study area was measured using the composite Livelihood Security. For the purpose of the study, five livelihood security indices were estimated, namely Economic Security Index, Food Security Index, Health Security Index, Educational Security Index and Empowerment Index. The Composite Household Livelihood Security Index (HLSI) of farming households in the study area was then estimated using these five indices aggregated over 21 indicators. Figure 5 shows the chart of the composite HLSI profile.

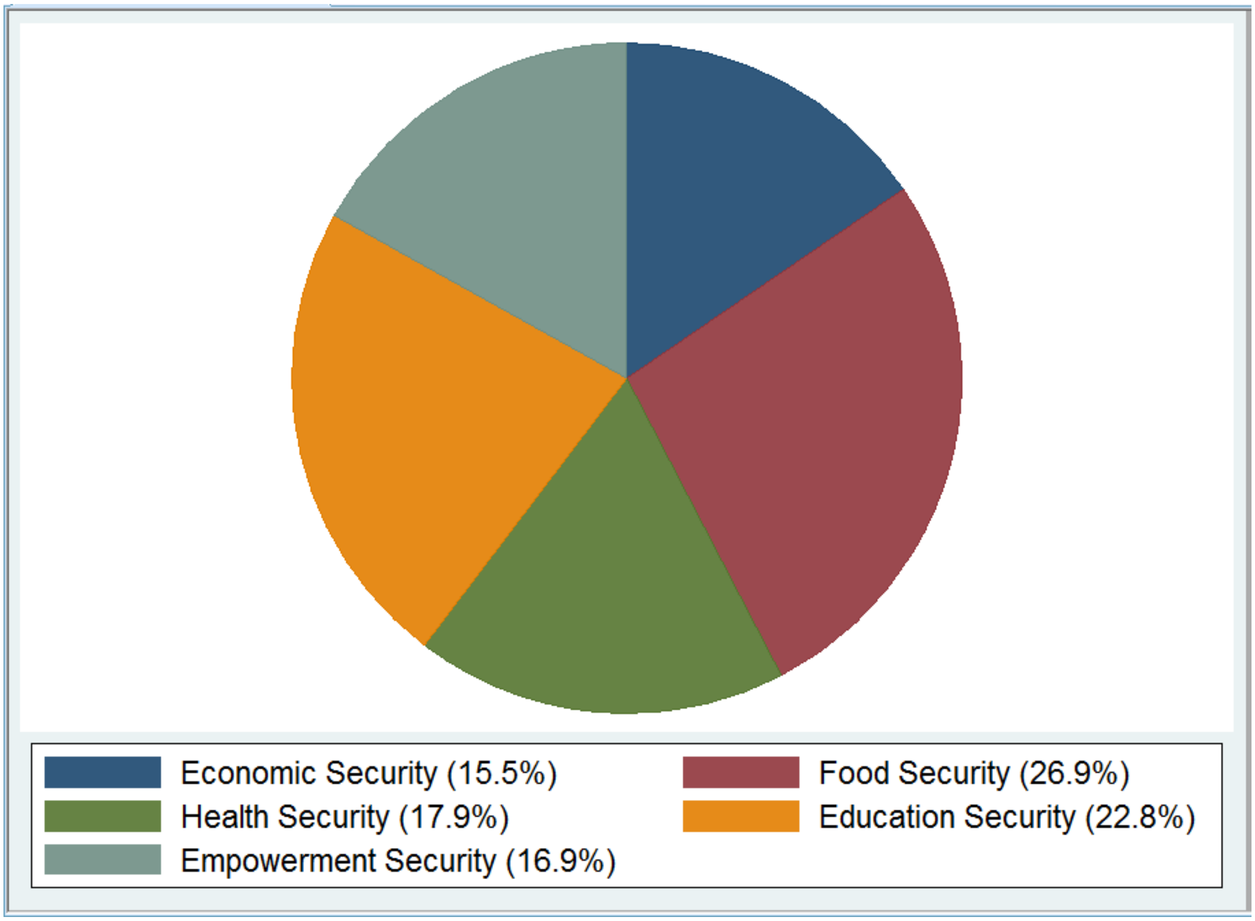

Figure 5: **Profile of Composite HLSI**
Source: Data Analysis, 2019; Figures in parenthesis represents the percentage contribution of each livelihood security domain.

Figure 5 shows the pictorial representation of the composite HLSI profile by examining the contribution of each of the five livelihood security indices modelled to the composite HLSI. It can be deduced from the figure that Food Security Index contributed the most to the composite HLSI with 26.9%, while the least contributing livelihood security domain to the composite HLSI was Economic Security Index with 15.5%. This result is in consonance with that of Shaheen and Sanzidur (2012) where they discovered households are much better in terms of food security relative to other domains of livelihood security in a similar study.

Maize Biomass Value Web Involvement and Household Livelihood Security

The level of involvement of farming households in the Maize biomass value web was measured using the Herfindahl index to capture the intensity of use of maize among the households. Table 5 shows the regression (seeming unrelated) result of the effect of maize biomass value web involvement on the five livelihood security domains modelled in a five equation system along with 10 other explanatory variables. The 10 other explanatory variables modelled along with maize usage Herfindahl index are gender of household head, age of household head, number of income sources available to the household, membership of cooperative status of household head, number of dependants in the household, household maize farm size, maize cultivated as a main or secondary crop, distance to nearest market, health insurance beneficiary status of household head, and household infrastructure index. The seemingly unrelated regression analysis was concluded with the estimation of the residuals correlation matrix and Breusch-Pagan test of independence (Table 6).

Table 5: Effect of Maize Biomass Value Web Involvement on Livelihood Security Indices

Variable	Economic Security Index	Food Security Index	Health Security Index	Education Security Index	Empowerment Security Index
Gender (Male =1)	-0.015 (-0.96)	-0.0408 (-1.61)	0.1599*** (7.71)	0.0566*** (2.74)	-0.2187*** (-4.43)
Age (years)	0.0015** (2.29)	-0.0049*** (-4.56)	0.0024*** (2.70)	-0.0075*** (-8.46)	-0.0118*** (-5.58)
Cooperative Membership (Member =1)	0.0159* (1.88)	-0.0538*** (-3.89)	0.0381*** (3.37)	0.0397*** (3.53)	0.0753*** (2.80)
Dependants (number)	-0.0281*** (-11.39)	-0.0261*** (-6.48)	-0.0117*** (-3.55)	0.0276*** (8.39)	0.001 (0.09)
Maize Farm size (ha)	-0.0086 (-1.22)	0.0387*** (3.34)	0.0182* (1.93)	-0.0246*** (-2.61)	0.0159 (0.70)
Maize cultivation	0.0254	0.2086***	-0.0214	0.0162	0.2464***

(Main crop=1)	(1.58)	(7.96)	(1.25)	(0.76)	(4.53)
Income sources (number)	0.0117*** (2.77)	0.0416*** (6.01)	0.0125** (2.21)	0.0755*** (13.37)	0.0265** (1.97)
Infrastructure (index)	0.0123 (0.57)	-0.0376 (-1.07)	0.109*** (3.81)	-0.0105 (-0.37)	0.0807 (1.18)
Maize Biomass Value Web (Herfindahl Index)	**0.1044*** (5.7)**	**0.1732*** (5.79)**	**-0.0446 (-1.82)**	**-0.1062 (-1.55)**	**0.1098 (1.48)**
Health Insurance (Beneficiary =1)	0.0127 (0.84)	-0.1888*** (-7.64)	0.106*** (5.24)	-0.1209*** (-6)	0.1062** (2.21)
Market Distance	-0.0008 (-1.13)	-0.005*** (-4.21)	-0.005*** (-5.19)	0.0113*** (11.72)	0.0155*** (6.72)
Constant	0.3214*** (7.75)	0.8539*** (12.61)	0.2459*** (4.44)	0.5083*** (9.21)	0.6035*** (4.58)
R-square	**0.5288**	**0.5319**	**0.4219**	**0.7177**	**0.3573**
Chi-square	**323.16*** **	**327.23*** **	**210.22*** **	**732.30*** **	**160.12*** **

Source: Data Analysis, 2019; Figure in parenthesis represents z-value; * significant at 10%, ** significant at 5%, *** significant at 1%.

It can be deduced from Table 5 that, high level of involvement in the maize biomass value web which translates to intensified usage of maize had a positive influence on all household livelihood security indices analysed except health and education security domains. However, the effect was only significant on food, economic, and health security domains. As shown in the table, involvement in the maize biomass value web has a positive and significant effect on the household economic security index at a 1% statistical level of significance. It can be further deduced from the table that a unit increase in the Herfindahl index of maize usage will likely bring about a 10% increase in the food security of the household, holding every other variable constant. In other words, an increase in the level of maize usage by the household will probably bring about an increase in the economic security of the household, all things being equal. This result is in consonance with that of Adetoyinbo *et al* (2016), where they opined that intensified maize usage within a properly planned biomass value web will positively influence economic security in a similar study. This may be attributed to the fact that households that intensify the usage of maize will be able to venture into different enterprises available within the maize biomass value web to earn additional income which will ensure improved economic security.

It can also be deduced from Table 5 that, involvement in the maize biomass value web has a positive and significant effect on the household food security index at a 1% statistical level of significance. It can be further seen from the table that a unit increase in the Herfindahl index of maize usage will likely bring about a 17% increase in the food security of the household, *ceteris paribus*. In another word, an increase in the level of maize usage by the household will probably bring about an increase in food security of the household, all things being equal. This result is in consonance with that of Adeyemo *et al* (2016), where they found out intensified usage of cassava to positively influence food security in a similar study. This may be attributed to the fact that households that intensify the usage of maize will be able to consume maize in diverse form and also process maize into different marketable products so as to earn additional income which can be used to purchase other food stuffs to augment own production.

Table 6: Correlation Matrix of Residuals and Breusch-Pagan Test

Variable	Economic Security	Food Security	Health Security	Education Security	Empowerment Security
Economic Security	1				
Food Security	0.0174	1			
Health Security	0.0258	-0.0533	1		
Education Security	-0.0359	0.005	0.0131	1	
Empowerment Security	-0.0719	0.0968	-0.038	-0.0128	1
Breusch-Pagan test Chi-square	**12.13**				
P-value	**0.1261**				

Source: Data Analysis (2019)

It can be deduced from Table 6 that, the correlation matrix of residuals from the seemingly unrelated regression was non-singular. The non-singularity of the correlation matrix affirms that the error terms from the seemingly unrelated regression analysis are not perfectly correlated. Also, the insignificant chi-square value of the Breusch-Pagan test validates the homoskedasticity assumption (that is, no heteroskedasticity) of the model.

5 CONCLUSION

The study has shown that intensified usage of maize within the biomass value web can significantly contribute to the improved livelihood security of rural households in the country. The study also shows that majority of the households in the study area had low Economic, Health, and Education Security, while Food Security Index contributes the most to the composite household livelihood security out of the five domains of livelihood security analyzed. It can further be concluded from the study that, the level of involvement in maize biomass value web positively and statistically influence the Economic and Food Security domains of households. From all the analysis of the study, intensified involvement in the biomass value web has been identified as a key factor that can improve the livelihood of the citizens of Nigeria, especially the rural poor. It is however obvious that the majority of the poor households in the country are yet to tap into the potentials of the biomass value web concept, despite its enormous contribution to livelihood security in the country. The study recommends farmers should be encouraged to come together in groups to make a bulk supply of their output to local and international companies, considering the fact that none of the sampled household supplies maize for industrial use. Also, sensitization programmes should be organized by the government and NGOs through seminars and workshops, in an attempt to encourage household diversification into various enterprises (especially non-food) within the maize biomass value web to improve economic security and overall livelihood security of rural poor in Nigeria.

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