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Invited paper presented at the 5th International Conference of the African Association of Agricultural Economists, September 23-26, 2016, Addis Ababa, Ethiopia

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Acknowledgement: the Authors wish to acknowledge the BiomassWeb project of the Globe2: Global Food security of the Federal Ministry of Education and Research, Germany for providing Funding for the Survey.

Abstract
Although cassava economic and development significance is gaining ground in Nigeria, the smallholding nature of production, processing, marketing and utilization persists. The smallholding and subsistence nature of most agricultural households in Nigeria means that welfare attributes may not be achieved. Operating within the concept of an economic based biomass value web is expected to increase both the productive capacity and food security outcome of the smallholders in the cassava web. The study examined the extent to which smallholders in the cassava system are involved in its biomass value web using a sample of 260 cassava smallholder households selected through a multistage sampling procedure in Edo state, Nigeria. The extent of participation in the value web was done using the composite score method; food security status of households was determined using the Foster, Greer and Thorbecke framework and covariates of food security determined through a probit regression. The results showed only about 28% of the smallholders are high level participants in the value web. While about 84% of the respondents are food insecure; food insecurity level is lowest among high level of participation in the value web. The probit regression shows that increasing levels of participation in the value web, education, and high monthly income increases food security, while household size, marital status and male headed household headship reduces food security. Policy implications suggests provision of infrastructure that help promote multiple involvement in the cassava value web.

Key Words: Cassava, Food Security, Biomass Web, Smallholders, Nigeria

INTRODUCTION

The cassava revolution in Nigeria is such that the crop has grown to be one of the major crops both for food and non-food purposes in Nigeria, (IFAD, 2013). Nigeria is currently the largest producer of cassava worldwide, (IITA 2014), mostly on smallholding enterprises and in almost all the ecological zones of the country, (Odemero, 2015). Cassava processing and marketing has recently developed to stages where small pockets of medium to large scale enterprises have taken up the activities using improved semi- mechanized technology (ISMT) and Improved Fully Mechanized Technology (IFMT). However, the largest proportion of the activities in the cassava value web is done by smallholders, (Nweke, 2005). Consequently, there is usually low marketable surplus; and where available, the quality is usually not to the standard that would encourage competitive advantage and high remuneration. Thus, there is low level income generation and low attainment of many welfare attributes, especially food security.

Food security has been defined in many ways with shifting paradigms over the years. The conventional definition is however that of the Food and Agricultural Organization (FAO), which defined food security as ‘access at all times by all people to the food they need for a healthy and active life’, (FAO, 1996; FAO, 2006). This definition encompasses dimensions of food availability, food access, food utilization and sustainability/stability of food security, (Barrett,

2002). Increased production through better cultural practices and technologies of production lead to increased food availability. However, income and or assets are the main determinants of access to food and the ability to take highly nutritious food (food utilization). Stability of food security means that food availability, access and utilization are being maintained for more than one reference period. Ensuring that all these dimensions of food security are achieved entails not just policy interventions from the government, but also enhanced capability of the households to maintain livelihood sources that will ensure that they are food secure over time, (Pinstrup-Anderson, 2009).

In Nigeria, food security frameworks and policies have been put in place over several administrations. Such policies and programmes usually target increased agricultural production and increased income to the poor and low capital based enterprises. Some of these include National Accelerated Food Production programmes (NAFPP) of 1972, the Agricultural Development Programme (ADPs); Agricultural policy in Nigeria, 1988, which was later revised in 2001 to give the Agricultural Policy Thrusts of 2002. Other policy measures are the National Seed Policy of 1992, the National Fertilizer Policy for Nigeria of 2006, National Policy for Integrated Rural Development of 2001, National Policy on Food and Nutrition and the establishment of the National Food Reserve Agency. In recent times, the Presidential initiatives of the Federal Government has programmes and projects targeted at different crops; livestock and agricultural enterprises to improve income and food security of the actors and to ensure that food production is greatly increased in the country, (Anyawu *et al.*, 2011). In spite of all these, food insecurity is still prevalent, (Ojo and Adebayo, 2012; Kuku- Shittu *et al.*, 2013) and alternative interventions are needed to resolve the situation. The need for market based interventions with only oversight function from the governmental side has been put forward in the case of many agricultural development policies over the years. In 2012, the Growth Enhancement Scheme of the Agricultural Transformation Agenda of the Federal Government of Nigeria was put forward to supply subsidized inputs directly to agricultural actors through mobile device, thereby cutting off fraudulent government interventions, (Federal Ministry of Agriculture and Rural Development, 2012). The effects however have not been so forthcoming. A biomass based value web concept within the prevailing policy and economic framework of individual countries has been advocated in making this possible.

A biomass based value web is a concept that focuses on the values of both food and non-food biomass of agricultural crops in order to increase returns to the actors, (Virchow *et al*., 2015). The concept of the BiomassWeb was advocated to improve food security in Africa through focusing on biomass based value web using certain pilot crops of cassava, maize, plantain, bamboo and enset at this infant stage of the project. The biomass based value web is a system of interlinked value chain in which food, fodder, fuel, raw materials and even waste from agricultural products are produced, processed and traded, (Knauf and Lubekke 2007). The aim of the biomass web is thus that smallholders can exploit different links within the agricultural system in which they act; diversifying their livelihood bases and hence improving income and

food and nutrition security. Central to the focus of the biomass web concept is the rationality of agricultural actors, in which decisions are made based on the best production possibility frontier as perceived by the agricultural household based on the technologies and other resources available to them, (Mankiw, 2012). Household level decisions are based on both production and consumption maximization in the face of certain constraints. Appealing to this rational nature thus means that a smallholder will continue on a production possibility curve that gives him the highest profit until he sees a better one. Based on this concept, therefore, it is believed that if cassava smallholders are able to exploit the different products that can be obtained from the cassava biomass, in an efficient manner, then their income and livelihood and thus food security will be significantly improved. The aims of improving food and nutrition security is the need to ensure that the dimensions of food security are not just attained, but that they are sustained over time. This is the aim which a biomass value web based agricultural system is expected to make possible.

In view of the above, this study set out to find answers to the following research questions:

i. To what extent do smallholder households in the cassava value web system participate in the cassava biomass based value web?
ii. What is the food security status of the smallholder households in the study area?
iii. To what extent does different level of participation in the cassava biomass based value web affect food security status of the smallholders in the study area?
iv. What are the factors that influence the food security of households in the study area?

OBJECTIVE OF THE STUDY

The main objective of the study is to assess the effect of a biomass value web concept in the cassava system on the food security status of small-holders households in Edo state, Nigeria.

The specific objective are as follows:

1. To determine the extent of participation of the smallholder households in the cassava value web in Edo state
2. To classify households into food security status
3. To assess the extent to which the different levels of participation in the cassava value web affects the food security status of the households
4. To isolate the factors influencing food security in the study area.

CONCEPTUAL FRAMEWORK

The Concept of the Biomass Value Web

The increasing demand for non-food biomass of the agricultural system has brought to the fore the need to ensure that the food need of developing countries are not compromised in the bid to supply biomass for industrial use. According to Virchow *et al*., (2014), the rising demand for food and non-food uses of agricultural biomass and the recent tendency towards post-harvest losses and waste reduction to maximize profit in many countries will lead to a merging of value chains of an agricultural biomass. For example, in the cassava value web; the production of starch alone may be profitable on its own; but the demand for animal feed, starch and garri may lead to a synergized production/processing/marketing matrix in which the waste that is generated needs to be drastically reduced. Thus, the smallholder is encouraged to produce garri, from a proportion of the cassava roots available. Because he also wants to produce starch, he uses another proportion of his roots and then processes his garri in such a way as to extract as much starch as he could from the process. He also ensures that the peels and chaff from his activities are maintained in such a way that it can be sold as feedstuff to the livestock industry. The stem and waste water and other solid wastes could also be used to produce organic manure, (Omilani *et al*., 2015). This need for 'zero waste' means that there will be merging of various value chains, both of the main crop (cassava) and of linkages with other crops, (e.g, maize); (see figure 1 for a simplified model of a value web). Consequently, the isolated and linear analysis of the value chain becomes insufficient for such a system and the concept of the biomass based value web becomes important.

A biomass web approach uses a multidimensional framework of a 'web' to analyse the linkages between and among different value chains and the institutional and governing structure driving it. The web does not examine just one product, rather it captures the many products which are and can be derived from one biomass raw product, assessing the whole product mix produced by family farms/enterprises, the different value chains the households participate in and how they are and could be linked. The perspective of the value web enables research to do the following:

i. Explore synergies between value chains, identify inefficiencies and potential for sustainably increasing in the entire biomass-based value web of a defined local, national or international system.
ii. Identify actors that participate in the web and establish the missing link.
iii. Identify cooperation and networks between and among the participants (producers/processors/marketers/consumers/industry and government) in the web and how to build capacity for improved productivity
iv. Identify benefits accruing and constraints facing the different actors within the web.

The biomass based value web concepts requires political and policy commitment by the government of countries concerned to ensure its sustainability. Government support in terms of provision of infrastructure, protection of smallholding farm families from exploitative tendencies of international competition and ensuring that the food need of the nation is not pushed aside are important as the governing and institutional framework within the emerging biomass based web concept.

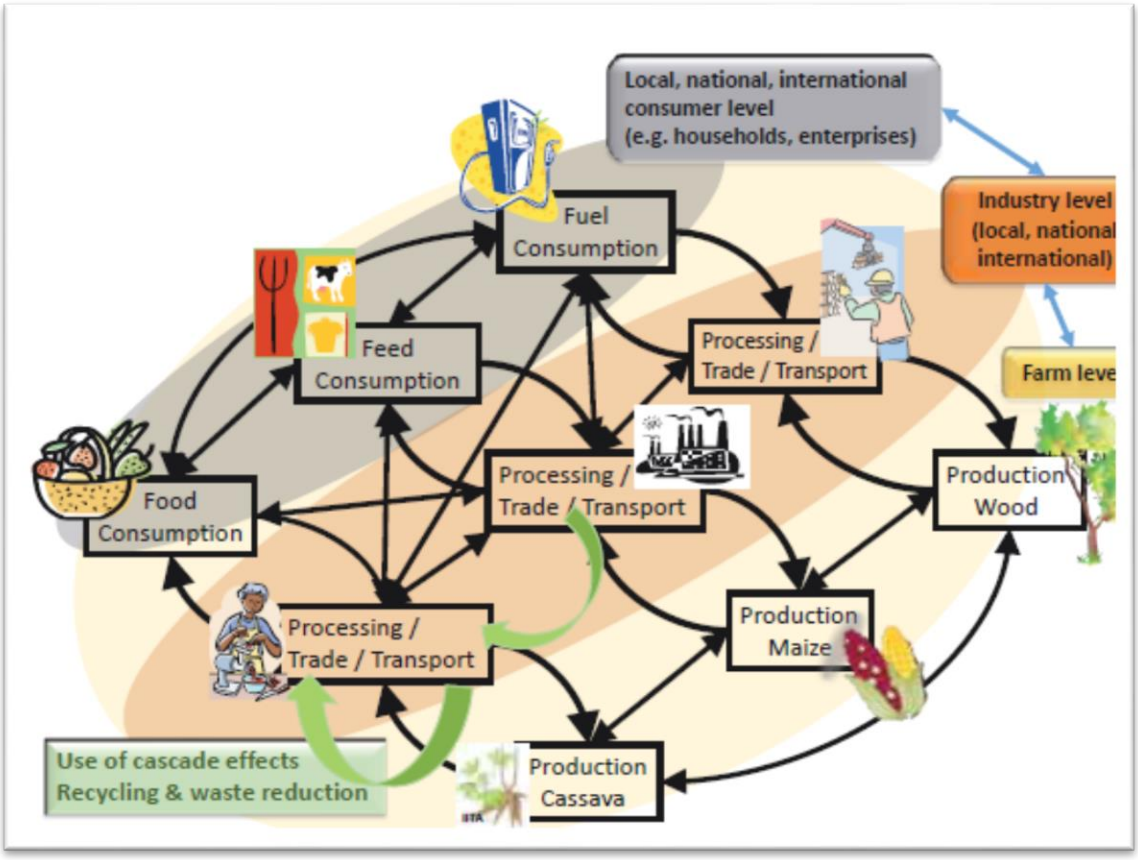

Fig. 1: The Biomass Web Concept
Source: Virchow *et al*, 2014

METHODOLOGY:

Study Area and Sampling Procedure

The study was carried out in Edo state, Nigeria; a state in the forest agro- ecological zone in Nigeria. Edo state, with Benin as the state capital is bordered by Kogi state to the North and East, Ondo state to the West and Delta state to the south.

Agriculture is the predominant occupation of people in this State and the state is known for the production of both food and cash crops. The major cash crops produced are rubber, cocoa and palm produce. The food crops grown in the state include yams, cassava; rice, plantains, guinea-corn, and fruits and vegetables. Edo state is one of the states in the South South Region of the country said to have highest levels of cassava production/processing and marketing activities, (Odemero, 2015).

Data and Sampling Procedure

Primary data was collected for this study through structured questionnaires. Data was collected on household socioeconomic characteristics, seven day recall of food consumption, and participation in the cassava web.

A multistage sampling procedure was used to survey smallholder households involved in the cassava value web. Edo state has 4 ADP zones; out of which 2 zones were purposively selected- EDO CENTRAL and EDO SOUTH. Using the two ADP zones, 4 local government areas were randomly selected from the two ADP zones each. From each local government areas, cells were selected proportionate to the size of the local government and cassava based smallholder household were selected proportionate to size of the cells. A total of 260 smallholder cassava households were sampled in the study. They involve actors in various activities of production, processing and marketing in the cassava value web in the state.

Smallholder households are defined as those whose main activities rely on family labour, (IFPRI, 2006). Thus whether in production, processing or trade activities in the value web, the survey focused on households with low level capacity in terms of farm size (at most 3 ha), low to medium scale processing facilities, low level technology of production/processing/marketing and low level access to market infrastructure.

Data Analysis

The analytical techniques used in this study include descriptive statistics, Composite score, Foster, Greer and Thorbecke Food security measure, and Probit regression analysis.

The **descriptive statistics** was used to show the distribution of the households based on their socioeconomic characteristics. This includes the use of tables of frequencies and percentages.

The Composite Score

The extent of participation of the smallholders in the cassava biomass value web was carried out with a composite index. The respondents were asked to supply responses to a series of 13 questions that covered different products value chain in the cassava web. Based on the responses, respondents were grouped into Low, Medium and High level participants in the value web.

The composite score used employs the Unit weighted approach; using the mean and standard deviation of responses to the items. The score is based on a scale of 0-10. The basis for the classification is as follows**:**

Low level: Mean-Standard Deviation to 0 point

Medium level category: Mean (upper and lower categories)

High level: 10 points to (Mean+ Standard Deviation)

Foster Greer and Thorbecke Food Security Measure

The smallholder households' food security status was determined using per capita expenditure on calorie consumed within a seven day recall in the study. Foster, Greer and Thorbecke (1984)

(FGT) class of poverty measures was adopted with slight modification, following FAO (2003); Omonona and Agoi, (2007). This is defined as:

$$Pi = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha}$$

Where,

$Gi = \left[\frac{Z - Y_i}{Z}\right]$ = food expenditure deficiency of household i

Z = food security line (2/3 mean per capita food expenditure),

q is the number of households below the food security line,

N is the total number of households in the total population,

Yi is the per capita calorie expenditure of household *i*,

P is the extent at which a household is food insecure (food insecurity gap short fall index)

And α is the degree of food insecurity. When α=0, then P is a measure of the poverty headcount, i. e the number of food insecure in the sample

When α=1, P is the measure of Food insecurity gap; and

When α=2, P measures the severity of food insecurity

Households are classified into food secure and food insecure groups by comparing them with the food security line. Households with calorie expenditure greater than or equal to the food security line are considered as food secure; while households with calorie expenditure less than the food security line are considered as food insecure.

Probit Regression Analysis

The probit model is used for discrete choice variables in statistical analysis, (Oluyole *et al*., 2007). It is used when the dependent variables are not continuous, but rather dichotomous or polytomous. For dichotomous variables, the Binary Probit Model is specified and the Ordered Probit model is specified for polytomous variables with ordered characteristics.

In this study, the dependent variable is dichotomous, for 0= Food insecure and 1= Food secure households and thus, a Binary Probit model is specified as follows:

$y^* = \beta_i x_i' + \varepsilon_i$;

y* is the unobserved latent variable ranging between 0 and 1; for 0= Food insecure households and 1= Food secure households

Xi's are the independent variables,

ε_i is the vector of error terms.

The independent variables are the socioeconomic characteristics and the indices of cassava value web intensity of the respondents and are specified as follows:

X_1: Extent of participation of smallholder households in the cassava value web; 1=Low; 2=Medium, 3=High

X_2: Age of head of the household in years

X_3: Gender of the head of the household; 0= Female; 1=Male

X_4: Educational status of the household head; 1=Non formal education; 2= Primary; 3=Secondary; 4=Post-Secondary

X_5: Household Size

X_6: Average monthly income of the household; 1=<₦25, 000; 2=₦25, 001-50,000; 3=₦50, 001-75,000; 4=₦75, 001-100,000; 5>₦100, 000

X_7: Expenditure on non-food items (₦)

RESULTS AND DISCUSSION

A. Socioeconomic Characteristics of Smallholder Households in the Cassava Web in Edo state.

Tables 1 and 2 present a description of the socioeconomic characteristics of the respondents. The results shows that 64% of the households have male headed household heads, with 81% of the household heads in a marriage relationship. Moreover, about 20% of the smallholder household heads have no formal education, 36% have primary and secondary education, while only 7% have post-secondary education. Majority(38%) of the smallholder households earn between N25000 and N50, 000 monthly; while only about 7% of the smallholders earn above N100,000 monthly from their income generating activities.

In table 2, the mean household size is 7, ranging between 1 and 15 household members. The average number of dependent and income earners is 4 and 2 respectively. From this, the dependency ration is 0.6; meaning that there is at least 1 dependent for every one income earner in the smallholder households.

The average monthly expenditure on food and non-food items are given as ₦25, 573.08 and ₦16, 498.08 respectively. This further corroborates the theory that low income earners spend most of their income on food.

Table 1: Distribution of Households Socioeconomics Characteristics

Variable	Frequency	Percentage
Gender of household head		
Male	167	64.23
Female	93	35.77
Educational Status of Household Head		
Non formal	53	20.38
Primary	95	36.54
Secondary	95	36.54
Post- Secondary	17	6.54
Marital Status of Household head		
Married	210	80.77
Non- Married	50	19.23
Average Monthly Income		
<N25,000	42	16.15
N25, 001-50,000	98	37.69
N50,001-75, 000	69	26.54
N75, 001-100, 000	32	12.31
>N100, 000	19	7.31

Source: Author's Computation of Filed Survey Data, 2015

Table 2: Summary Statistics of Households' Profile

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
Age of household head	260	50.91	9.50	21	75
Household Size	260	6.67	2.05	1	15
Number of Dependents	260	4.35	1.71	0	10
Number of Income earners	260	2.32	1.15	1	8
Monthly Food Expenditure	260	25573.08	12303	4000	90000
Monthly Non- Food Expenditure	260	16498.08	11862.18	1500	60000

Source: Author's Computation of Filed Survey Data, 2015

B. Extent of Participation in the Cassava Value web.

The composite score was used to determine the extent at which smallholder are integrated into the cassava web. With the score, it is found that most of the smallholders are middle level participants in the value web. This implies that most of the smallholders have more than 3 areas of income generation from the cassava web. 27% and 28% of the smallholders are low level and high level participants in the cassava web in Nigeria.

Table 3: Extent of Participation of Smallholder Households in the Cassava Biomass Value Web

Extent of Participation	Frequency	Percentage
Low	70	26.92
Middle	118	45.38
High	72	27.69
Total	260	100

Source: Author's Computation of Filed Survey Data, 2015

Food Security Status of Smallholder Households

Using the Foster, Greer and Thorbecke poverty measure adapted for food security measure, and using the expenditure of calories consumed by the household in a seven day recall survey; the study was able to get a food poverty line of N1097. The results are presented in Tables 4 and 5 Based on the food poverty line, 83.9% of the smallholders households are classified as food insecure and only 16.2% are classified as food secure.

The food insecurity gap and severity estimates are given as 0.494 and 0.338 respectively.

From Table 5, the results revealed that a higher percentage of the food secure households (26.2%) are found among the high level participants in the cassava value web, followed by households in the mid- level participation group (23%). The households in the low level participation group are the least food secure group (9.5%).

Table 4: Food security Profile of Smallholder Cassava Households in Edo State

Food security Profile	Estimate	Standard Error
Headcount	0.838	0.045
Gap	0.494	0.130
Severity	0.338	0.172

Source: Author's Computation of Filed Survey Data, 2015

Table 5: Food security Status of Smallholder Cassava Households by Extent of Participation in the Cassava Biomass Value Web.

Extent of Participation/Food security status	Food insecure		Food Secure		Total	
	Frequency	***Percentage***	***Frequency***	***Percentage***	***Frequency***	***Percentage***
Low	66	30.28	4	9.52	70	26.92
Medium	91	77.12	27	22.88	118	45.38
High	61	27.98	11	26.19	72	27.69
	218	83.85	42	16.15	260	100

Source: Author's Computation of Filed Survey Data, 2015

C. Factors influencing the Food Security of Smallholder Households in the Cassava Web in Edo state, Nigeria.

The probit regression was used to isolate the other covariates that determine food security status of smallholder households in the study area. The log likelihood of -88.412 has a probability >chi square is significant at 1% implying that the model fits the data.

The results in Table 6 shows that education increases the probability of the smallholder households being food secure, (Ayantoye *et al.*, 2011). Moving from non-formal to primary education and from primary to secondary education and from secondary education to post-secondary education increases the probability of the smallholder households being food secure by 0.69, 0.67 and 1.4 respectively with significance at 10% and 5%.

Also, higher levels of minimum monthly income that accrues to the households increases the probability of their being food secure by 0.80 and 1.24 for households within the income bracket of N50,000-N75,000 and N75,000 - N100,000. The higher the income of the household, the better access the household has to purchase food that is needed for the family.

Household size has a negative relationship to the probability of the households being food secure. The result shows that an increase in the household size will reduce the probability of being food secure by 0.16. This follows other studies that show that the larger the household size, the less the food available to each individual especially when the households are in smallholders with low level income bases, (Amaza *et al*., 2007).

As expected, the magnitude of non-food expenditure is negative; that is an increase in the amount spent on nonfood expenditure per month reduces the probability of being food secure by 0.0004.

Age of the household head is also surprisingly negatively related to the probability of being food secure. The probability of food insecurity reduces with the age of the household head. The reason for this may be that the average household head is already 50 years of age, implying that

he/she is already approaching the 'retirement' age, where productivity is not as high as during the youthful age. This further goes to show why relative productivity among smallholder agricultural actors continue to be low.

The marginal effect (dy/dx) explains that for every unit change in all the variables in the probit regression, the probability of the households' being food secure changes by a factor of 0.86.

Table 6: Factors Influencing Food Security Status of Smallholder Households

Variables	**Coefficient**	**Marginal effect**
Extent of Cassava Value Web Participation		
Medium	0.966**	.166**
High	0.893*	0.183*
Gender of Household head (Base= Female)		
Male	-0.045	-0.007
Age of household head	-0.004	-0.001
Marital Status(Base=No Marriage union)		
Married	-0.367	-0.067
Education of household head(Base= Non formal)		
Primary	0.693*	0.125*
Secondary	0.666*	0.119*
Post-Secondary	1.395***	0.403**
Household Size	-0.165**	-0.026**
Average monthly income(Base:<N25,000)		
25,001-50000	-0.258	-0.389
50,001-75000	0.802*	0.162*
75001-100000	1.247**	0.329**
>100000	0.158	0.027
Nonfood Expenditure	-0.000***	-0.000***
Constant	-0.671	
Dy/dx		0.863

Source: Author's Computation of Field Survey Data, 2015

SUMMARY AND CONCLUSION

The study investigated the extent of participation of smallholder cassava households in the cassava value web; and the effect that their different levels of participation has on their food

security status. The study found that although the percentage of those in the high and low levels of participation are similar, it still shows that there is a significantly proportion of the actors in the cassava value web that practice on a subsistence level. Thus, their income and food security is not fully guaranteed. The results also showed that food insecurity is highest within the strata of low level participants in the cassava value web.

The study concludes that increased exploitation of the biomass found in the cassava system has the ability to improve the food security status of the households through increased food availability, food access and utilization through higher income.

POLICY RECOMMENDATION

Since it has been established from the conceptual framework that the biomass value web works within institutions and governance structure that determine its potential achievement; the study recommends that policy commitment is needed on the part of the government to ensure that the biomass based value web is able to reach its potential of improving food security of smallholders. Based on the understanding of the concept and the profile of the smallholders from the study, the following is recommended as some of the governance responsibility to ensure that the concept leads to sustainable food security among smallholders in the country:

i. policy oversight to prevent elite capture of this concept by a pocket of rich individuals,
ii. provision of rural infrastructure;
iii. proper financing and insurance cover
iv. stable policy environment for agricultural development will go a long way in enhancing the performance of this concept in Nigeria.

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