Comparative Measure of Income Volatility of Farm Households in Uyo, Akwa Ibom State, Nigeria: GARCH - CV Approach

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Abstract

The study measured income volatility of farming households in Uyo, Akwa Ibom State, using GARCH and Coefficient of variation approach. Farming household's socioeconomic conditions were assessed. Ninety (90) farming households were sampled from Uyo zone of Agricultural Development Programme (AKADEP) using a multistage sampling procedure. Questionnaire was used as a tool for primary data collection. Generalized Autoregressive Conditional Heteroskadascity (GARCH) and Coefficient of Variation (CV) methodologies were used to measure income volatility. Giving the peculiarity nature of agriculture in the study area, both on and off season's income was used for the study. Result reveals that 71.1% of the respondents were between the ages of 35-44 years, 93.4% were married while 59% completed primary education, and 88.9% were farmers whose household size are between 5-9 people respectively. About 37.8% had up to 15-19years farming experience, 50.2 % had monthly income of about N19.999.00. The GARCH approach of measuring income volatility gives a better result as compared with coefficient of variation in both seasons. The CV measure from the mean score shows an explosive result. The GARCH measure shows persistency. The study recommended among others the intra-diversification within crop and livestock production which will enhance relative stability in farming household's income.

Keywords: Measure, Income, Volatility, GARCH-CV Approach, Farm Households

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Introduction

Agriculture accounts for about 30.9 percent of the Gross domestic product (GDP) and 70 percent of employment but contributes only about 2.5 percent of export earnings. Nigeria is Africa's

largest producer of petroleum and seventh largest in the world. Petroleum products accounts for about 15.0 percent of GDP, 71.0 percent of export earnings and 79 percent of government revenue. Abolagba *et al (*2010) reported that in Nigeria, agriculture is one of the most important single activities in the nation's economy, with about 70% of the total population engaged in and accounts for the largest population of total labour employment and is a vital source of foreign exchange in its export orientation. This growth is yet to impact positively to the lives of the poor citizens. Typical of most neoliberal economies in developing countries, it has been a paradox of growth with increasing poverty, unemployment and inequality, (AAN, 2014). Across the 36 state, the disparity between the rich and the poor continues to grow at an alarming rate. Between 2004 and 2010 Nigeria's Gini index – a measure of how unequal income is shared – rose from 42.9 to 48.8. Nigeria is therefore one of the most unequal nations in the world. It is estimated that poverty incidence in Nigeria increased from to 69 percent in 2010 from 54 percent recorded in 2004. (NBS, 2011). There are now 102 million poor people in Nigeria, an increase of 22 million since 2004. The bottom quintiles are living on between ₦70 and ₦150 per person per day, (World Bank, 2012). Globally, average income is about $2.5 or ₦390 per person (UNDP, 2012). In Nigeria and Akwa Ibom State in particular more than 65% of the rural poor live under $2 or ₦312 per day (threshold poverty) while two-third (2/3) lived under or around $1.25 or ₦195 a day (extreme poverty), World Bank (2011), UNDP (2012). De Janvry and Elizabeth (2011) submitted that most countries in Asia and Latin America have experienced rapid reduction in rural poverty. The situation in sub-Sahara Africa heightened because of increased volatility in income both in rural and urban areas.

Recent review of the global welfare measures reveals that, Nigeria is one of the most unequal nations in Africa in terms of income distribution and Akwa Ibom State is one of the states in Nigeria with the highest income inequality peaking at over 0.54 for the self-employed (predominantly farmers), and 0.44 for the employed-salary paid/wage earners, (UNDP, 2012). Akwa Ibom is the third state with the highest poverty rate of 27.1% within the south-south zone after Cross River State (31.2%) and Bayelsa state (32.5%), (UNDP, 2012) Eugene (2012) and World Bank (2010). National Bureau of Statistics (201) reported that Akwa Ibom State has the second highest unemployment rate of over 25.8% after Delta state in the south-south zone, but leads other states in the zone in terms of income generating opportunities. Adebayo (2002) and Batchelder (2010) showed that, income volatility exists in some rural and urban areas in Nigeria

and in United States of America respectively and appears to be rising over time thereby making farming household income to be increasingly unstable. David, Bryant and John (2008) reported that inflation volatility in Akwa Ibom State is about 0.9615 (96%). Michael (2012) reported that across the 36 states and the Federal Capital Territory (FCT), inflation volatility peaked at 96% in Akwa Ibom and 53% in Borno States respectively and found a very wide disparity in income among farming households which was imminent and wider for some sectors. Rural-urban strata show that there is higher burden or dependency ratio (53.34%) in rural areas of Akwa Ibom State than the urban areas (45.62%). Majority (69%) of the farming households in Akwa Ibom State are facing income uncertainties both market related (price fluctuations) as well as non-market related (output variation). These uncertainties do not only induce substantial income risk, but are detrimental to the farming household's income and welfare. Kareen (2010) in a study on rising income volatility and its implications in United States of America (USA) reported that many households suffer devastating income uncertainties which have led to the introduction of market oriented economic reforms thereby exposing farming households to global market conditions. Escobal (2011) submitted that the rising income volatility and its effects on well-being. In view of the above stated problems, the study therefore answered the following questions. What are the socio-economic conditions of farming households in Uyo, Akwa Ibom State? What is the appropriate method of measuring income volatility of farming households in Akwa Ibom State? The study objectively assesses the socioeconomic conditions of farming households and comparatively measure income volatility among farming households in the study area.

Review of Empirical Literature

Several studies (Dunn and Williams 2000) estimated a positive relationship between farm size and net farm income volatility. Purdy, Langemeier and Featherstone (1997) found that farm size had no effect on the risk/return tradeoff. Walker *et al*., (2004) in similar study reported illiteracy levels of farm households at 42%. Idowu *et al* (2011) in Nigeria found that about 64% of the household heads were male with few household size of 4 people on average and 11years as average years of experience in farming, 32% of the sampled households had arable crops and tree crops farms while 59% practiced mixed farming (rearing of livestock and planting of crops) All the sampled households (100%) involved in farming activities but 37%

had their income solely from farming activities while 63 percent of the households depended on non-farm incomes, (Ruben and van den Berg 2001; de Janvry and Sadoulet, 2005 and Zvyagintser, Shick, Shrova and Lerunam *(*2008). Babatunde and Adedoyin (2011) showed somewhat unexpected significant though negative education coefficient in the crop income an additional year of schooling reduces crop income by almost 500 naira.

Wary *et al.,* (2008) found that volatility component models have received much attention recently, not only because of its ability to capture complex dynamics through a parsimonious parameter structure but ability to handle well-structured breaks or non-stationary in price volatility and maintained that, the prime focus has been on the GARCH (p, q) model – or GARCH (I,I) – originated by Bollerslev in 1986. Autoregressive Conditional Heteroskedasticity (GARCH 1, 1) is the simplest and most robust of the family of volatility models. The classical symmetric GARCH model has found wide use and applicability. The asymmetric GARCH models including the EGARCH model of Nelson (1991), the TARCH model or Threshold ARCH attributed to Rabemananjara and Zakoian (1993) and Glosten, Jaganathan and David (1993) are used in measuring volatility of earnings. Karlsson (2012) obtained a volatility index of 0.87 in a study on the theoretical survey, model implementation and robustness analysis of farmers. Similarly, Nany (2011) obtained a volatility index of 0.69 in the financial asset market in USA. Jean-Fraugoise (2010), concluded that asymmetric GARCH models are relevant for modeling commodity prices and obtained a measure of 0.93, 0.63 and 0.73 volatility indices of farming families in USA, Germany and France respectively.

Engle and Lee (1999) introduced a GARCH model with a long and short run component. The volatility component model of Engle and Lee (1999) decomposed the equity conditional variance as the sum of the short-run (transitory) and long-run (trend) components. The appeal of component models is their ability to capture complex dynamics via a parsimonious parameter structure. Christos (2008) in a study on modeling volatility in Egypt and Israel used the GARCH-type model to analyzed volatility in financial market risk and found that the sum of ARCH and GARCH coefficients (volatility indices) was very close to one indicating that volatility shocks are quite persistent.

Ahmed and Suleiman (2011) in Sudan modeled stock market volatility using GARCH models and found that the conditional variance process is highly persistent (in some cases explosive) and provided evidence on existence of risk premium for the Khartoum Stock Exchange index return

series which support the expected stock returns. The findings showed that the asymmetric GARCH models provided better fit than the symmetric GARCH models, which confirms the presence of leverage effect. In contrast, Hamilton and Susmel (1994) and Lamoureux and Lastrapes (1990) highlighted the forecasting difficulties of conventional GARCH models by showing that they can provide more multiple-period volatility forecasts than constant – variance models. Xiaohong *et al.,* (2011) in China, used GARCH model to evaluate the volatility of the listed SME's stock prices and the volatility index of 0.86 was added into the growth evaluation system of the listed SME's. The coefficient of variation measure is widely used in related literatures such as Michelson, Jordan-Wager and Watoon (1975). It is calculated as the standard deviation of individual's series of income earned divided by the mean of the absolute values. Petrovic *et al.,* (2002) reported that the earnings persistent of current earnings reduce earnings volatility increases.

Awoyemi (2009) first used the Coefficient of Variation (CV) approach to measure rice price variability in Nigeria and found that the CV measure for rice was 54.23% which revealed that, price of rice fluctuate at important levels in 1990-2004, yield fluctuated due to seasonality in production and the effect of some variables which are not under the control of producers and the fluctuation in either yield or price affect gross income of farmers. This in part led to the submission by Olatona (2007) that, in developing economies over 84.08% of income variation is caused by market and non-market related factors and also are the main determinants of rural income variations.

Research Methodology

The study was conducted in Akwa Ibom State, Nigeria. According to NPC (2006), the state has an estimated population of 3.92 million people. Geographically, it is located between latitude $4^{o}32^{1}$ and $5^{o}33^{1}$ north, longitude $7^{o}25^{1}$ and $8^{o}24^{1}$ east and occupies a land area of 8,412 square kilometers. The study targeted farm households in Uyo, who engage in farming as major source of income and livelihood,. The instrument used for primary data collection was structured questionnaire.

Sampling Procedure and Sample Size

The selection of respondents was based on the Akwa Ibom State Agricultural Development Programme (AKADEP) framework as shown in figure 1. A multi-stage sampling method was used to select the respondents. First, the Uyo zone was purposively selected for the study. The second stage involved a simple random sampling (by ballot) of nine (9) out of 27 blocks from the zone while the third and fourth stages deployed the use of simple random sampling for the selection of 90 farming households.

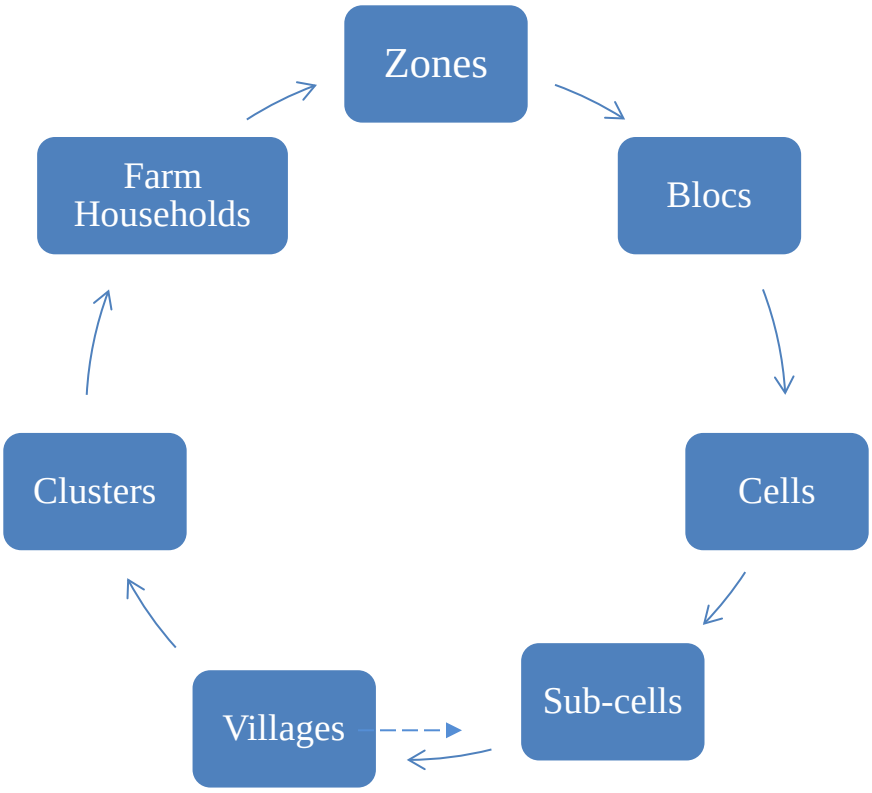

Figure 1: An organogram of AKADEP structure in Akwa Ibom State.
Source: Author's design, 2015

Theoretical and Analytical Framework

The study was based on the theoretical propositions that an individual effort to earn income occurs within a certain physical, economic and social environment. The socio-spatial

environment consists of a set of activities, services, opportunities and contracts. It is the interaction of the individual with this environment that produces commodities to society and generates income for the individual. The income of individual consisting of earnings of both labour and property income can therefore be accommodated in the model as requiring exploitation of the social resources of some space. Engle (1982) and Bollerslev (1986) introduced the Generalized Autoregressive Conditionally Heteroskedasticity (GARCH) models which have been extensively used to estimate the volatility of financial variables. The success of GARCH models is largely attributed to its ability to capture several stylised facts of financial data, such as time-varying volatility, persistence and clustering of volatility, and asymmetric reactions to positive and negative shocks of equal magnitude. Given the empirical success of GARCH processes in the modeling of univariate volatility and since it is now widely accepted that financial volatilities move together over time across assets and markets, a natural extension has been the use of multivariate GARCH models to measure the dynamic volatilities and correlations of large dimension. Income volatility for each household was measured using the Generalized Autoregressive Conditional Heteroskadesticity (GARCH p, q), and the coefficient of variation (CV) approaches. The primitive GARCH model was assumed to follow a primitive (normal) first order Autoregressive (AR) (1) process as shown in equation (1).

$$\log\left(Y_t\right) = \lambda_0 + \lambda_1 \Delta \log\left(Y_{t-1}\right) + V_t \quad \ldots \quad (1)$$

Where; Y_t is income volatility indices generated through GARCH using conditional variance (∂_v), λ_0 is constant, V_1 is the stochastic error term from which the conditional variance was used to derived the volatility indices. The general assumption is that disturbances from equation (1) were not auto correlated. Therefore equation (2) is the mean equation from which the GARCH process was derived as shown in equation (1).

$$VI_t = \partial + \alpha \sum \varepsilon_{t-1}^2 + \beta \sum h_{t-1} \quad \ldots \quad (2)$$

$$VI_t = \partial + \alpha \sum \left|\varepsilon_{t-1}^2\right| + \beta \sum h_{t-1} \quad \ldots \quad (3)$$

Equations (2) implies that the conditional variance of the error term in equation (1) which is a proxy of income volatility indices (VI_t) at period "t" was explained by the past shocks or square of the error term (ARCH) i.e. ε_{t-1} as described in equation (2) and past variance or volatility

term (the GARCH term - h_{t-1}). For equations 2 and 3 to be stationary $\partial > 0$, $\alpha \geq 0$, $\beta \geq 0$ and the persistent of volatility shocks $(\alpha + \beta)$ should be less than 1. Comparatively, the coefficient of variation (CV) was used to measure the volatility indices of farm household's income in Uyo, Akwa Ibom State. The coefficient of variation CV is stated thus;

$$CV = \frac{\sqrt{\frac{\sum X_j^2}{n} - \left[\frac{\sum X_j^2}{n}\right]}}{\frac{\sum X}{n}} \times \frac{100}{1} \quad \ldots \quad (4)$$

Equation (3.7) is reduced as: $CV = \frac{S}{X} \times 100$ ....(5)

Where, CV - coefficient of variability, S - standard deviation, n - number of observations and X_j - number of households.

Results and Discussion

Table 1: Socio-Economic Characteristics Of Farm Households

Sex of Household Head	Freq		%
Male Headed	64		71.1
Female Headed	26	28.9	
Total	**90**		**100**
Age			
15-24	1		1.1
25-34	3		3.4
35-44	25		27.8
45-54	46		51.1
55-64	13		14.4
65+	2		2.2
Total	**90**		**100**
Marital Status			
Married	84		93.4
Single	3		3.3
Separated	3		3.3
Total	**90**		**100**
Educational Status			
Non Formal Edu.	4		4.4

Primary Edu.	31	34.4
Secondary Edu.	53	59
Tertiary Edu.	2	2.2
Total	**90**	**100**
Occupation		
Farming	80	88.9
Non Farming	10	11.1
Total	***90***	***100***
Household Size		
0-1	0	0
2_4	19	21.1
5_9	65	72.2
10_20	6	6.7
20+	0	0
Total	***90***	***100***
Farm Size		
0.1-0.5	25	27.8
0.6-1.0	38	42.2
1.1-1.5	16	17.8
1.6 - 2.0	8	8.9
>2.0	3	3.3
Total	***90***	***100***
Years In Farming		
5_9	16	17.8
10_14	28	31.1
15_19	34	37.8
>20	12	13.3
Total	***90***	***100***

Household Monthly Income

	On Farm	Off Farm	Freq	%
≤ 19999	34	11	45	50.2
20000-29999	15	5	20	22.2
30000-39999	8	2	10	11.1
40000-49999	9	2	11	12.1
50000-59999	3	0	3	3.3
≥ 60000	1	0	1	1.1
TOTAL	**72**	**18**	**90**	**100**

Source: Field Survey, 2015

Socioeconomic Characteristics of Respondents

Table 1 present the socio-economic characteristics of the farm households in Uyo, Akwa Ibom State. The result revealed that, 71.1% of respondents were males while 28.9% were females. It follows that, majority of the respondents are households headed by men and more men were involved in income activities than women in the study area. The result revealed that 93.4% of the respondents were married, 3.3% single/separated. The result shows that, majority of the farm households in the study area were married men and woman with children. The age distribution of the respondents was analysed. The age ranges used in this study are in line with the nationally reported ranges by National Bureau of Statistics (2011). Most of the respondents(51.1%) were between the ages of 45-54 years, respondents with age range of 35-44, 55- 64, 25- 34years and 65 years and above are represented by 27.8%, 14.4%, 3.4% and 2.2% respectively. Several studies have shown that, age is one of the determinants of the choices of economic activities. This result therefore is consistent with the findings by Olayide (2011), Eboyei, Odekinda (2011), Adesehimwa, Makinde and Oladele (2003), Fakayode, Falola, Babatunde, and Adedeyin (2011) that 74% of farm household ages range between 20-49 as majority of the farmers were middle age. Age has serious implications on the choice of income generating activities. About 42.2% of the aged people were found to be involved in farming as an income generating activity. This may be as a result of either retirement from salary paid employment or displacement from certain off-farm activities by virtue of physical fitness or ability to continue with the activity. The educational status of the farming households was assessed. The result reveals that 59% of the respondents completed their secondary education, 34.4% completed their primary education while 4.4% had no formal education. Some household's members (2.2%) had tertiary education up to the Polytechnic/University levels. The implication is that farmers with no formal education were predominantly involve in farming as their major source of income and livelihood while farm households with higher educational attainment were involved in non-farming as their main income source (paid employment) either from the government or private firms. Similarly, 88.9% of the respondents depended on farming while 11.1% engage in non-farming as their major means of livelihood.

The result presented below shows that 72.2% of the farm households have household sizes ranging between 5-9 persons, while 21.1% and 6.7% had household size range 2 to 4 and 10 to 20 respectively. The implication is that, farm households with a large household size resort to farming as their main income activity as farming requires labour either from family or by hired.

On the other hand, farm sizes were assessed and the result shows that, farm households whose farm sizes range between 0.1 to 1 hectare constitute 70% in the study area while farm households with farm sizes between 1.1 to 1.5 and 1.6 to 2.0 are 17.8% and 8.9% respectively. Only 3.3% of the respondents had their farm size greater than 2.0ha. The implication is that, majority of the farm household are small householders farm growing mainly food crops while livestock's are raised domestically and in small- scale. It also implies that, household's whose farm sizes were small tend to diversify into off-farm activities as a means of their income. This result is consistent with Malla (2010) in Thailand, John, Iheanacho and Iretin (2011) in Nigeria had a contrasting result. The respondent's years in farming was assessed. Result revealed that 68.9% of the respondents have 10-19 years of farming experience in the study area, while households with years of experience 5-9 is 17.8% of the rural households. Households with over twenty years of farming represent 13.3%. This implies that farm households with greater years of farming experience tend to improve on their farming activities especially in crop production. More years in farming may lead to sustainability in the occupation as well as increased income and welfare of the rural farm households.

The result shows that most of the rural farm households earned less than or equal to ₦19, 999.00 as income from both on-farm and off-farm activities and is represented by 50.2%. From the result, over 75% of the total household income are from on-farm activities especially crops sub-sector (vegetables), plantain, cassava, palm fruit, yam and other crops) as well as rearing of livestock's (goats, piggery etc), while total off-farm household income constitute only 25% of the total household income in the study area. The off-farm activities carried out by households in the study area are; agro-processing of mostly cassava, palm fruit, maize and fish (mainly in the coastal areas selected for the study).

Farm households in the study area primarily depended on farming as their main source of livelihood while off-farm income serves as a buffer to household's response to shocks in the study area. The result is also similar to the findings obtained by Alberto, Kaita, Benjamin, Marinka and Winter (2009), stated that income from rural poor households constitute 88.2% in Abarica while non-farm income activities constitutes about 11.8% of the total household income. In contrast, Omonona and Udoh (2006) found that, 70% of households in Ibarapa North Local Government Area of Oyo State, Nigeria earn income ranges between ₦1,000 to ₦2,000 per

capita every month, while households with income of ₦ 6100 and above constitute only 5% per capita.

GARCH-CV Measure of Income Volatility

Table 2: Result of GARCH and Coefficient of Variation Measure of Income Volatility in Uyo AKADEP Zone

Income Volatility Indices	ON-SEASON Frequency GARCH	CV	Percentage GARCH	CV	OFF-SEASON Frequency GARCH	CV	Percentage GARCH	CV
≤ 0.40	5	0	16.7	0	14	0	46.6	0
0.41 – 0.50	7	2	23.3	6.7	6	0	20.0	0
0.51 – 0.60	4	16	13.4	53.3	5	11	16.7	36.7
0.61 – 0.70	7	11	23.3	36.7	4	12	13.4	4.0
0.71 – 0.80	3	1	10	3.3	1	7	3.3	23.3
0.81 – 0.90	1	0	3.3	0	*0*	*0*	*0*	*0*
≥ 0.91	3	0	10.0	0	*0*	*0*	*0*	*0*
Total	30	30	100.0	100	30	30	100	100
Minimum	*0.13*	*0.49*			*0.13*	*0.52*		
Maximum	*1.31*	*0.73*			*0.72*	*0.76*		
Mean	*0.60*	*0.62*			*0.44*	*0.70*		

Source: Computed by the Author from the analyzed data, 2015

Table 2 shows the result of GARCH and CV measures of income volatility during on-season period in Uyo zone, Akwa Ibom State. The GARCH result reveals an income volatility clustering within 0.01 to 0.40, 0.41 to 0.50, 0.51 to 0.60 and 0.61 to 0.70 as represented by 16.7%, 23.3%, 13.4% and 23.3% respectively. Consistent volatility indices between 0.41 to 0.50, 0.61-0.70 and 0.71 to 0.80, greater than 0.91 representing 23.3% and 10% respectively were obtain. The result also reveals that, 16.7% of income volatility indices were found in the range of ≤ 0.40. The result obtained from CV measure of income volatility indices, shows volatility indices clustering of 0.51 to 0.60, 0.61 to 0.70 representing 53.3% and 36.7% respectively. Other indices (0.41-

0.50 and 0.71 to 0.80) represent 6.7% and 3.3% in Uyo AKADEP zone. The GARCH measure of income volatility indices during off-season period in the zone. The result reveals income volatility indices clustering around ≤ 0.40, 0.41 to 0.50 0.51to 0.60 representing 46.6%, 20% and 16.7% respectively. Other indices (0.61-0.70 and 0.71 to 0.80) are 13.4% and 3.3% respectively. The result of CV shows none existence of volatility indices within 0.40 to 0.50 during off-season. Also, both (GARCH and CV) results reveal non-existence of income volatility greater than 0.80 during the period. It implies that, farming household's income is more stable in the peri urban and urban centres during off-season period. CV shows perfect stability in income among the farming households during off – season in the zone. The CV measure exhibited a volatility clustering of income indices between 0.51 to 0.60, 0.61 to 0.70, 0.71 to 0.80 representing-36.7% 40% and 23.3% respectively. The speed of adjustment to (stability) for GARCH measure is faster during on-season than off-season while that of CV measure is slow during the on-season but faster during the off-season periods. The implication to the findings is that, both approaches - GARCH and CV reveals that income volatility exists and is higher during on-season than off-season in the zone. The none-existence of volatility index of 0.81 and above has a lot of implications on welfare of farming households. It may demonstrate increased stability in income, improved living conditions among others. This result is consistent with Hertz, (2007) in USA. The GARCH maximum income volatility indices value for on-and-off-seasons is 1.31 and 0.73 respectively while the minimum values are 0.13 and 0.13 respectively. The CV maximum income volatility indices values for on-and-off seasons are 0.73 and 0.76 while the minimum income volatility values are 0.49 and 0.52 respectively. The mean values for GARCH and CV are 0.66 and 0.44 respectively.

Conclusion and recommendation

Increased volatility in income among farming households may increase the rate of diversification from farming to non-farm income activities, thereby reducing productivity in agriculture. It is recommended that appropriate policy measures aim at encouraging farmers should be introduced while improving upon the existing programmes. Such policy measures should be designed to accommodate the different categories of farmers.

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