Effect Of Weather Variability On Selected Arable Crop Insurance In South-Western Region Of Nigeria (1990- 2014)

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Abstract: Farmers have been employing various ways of adaptation to the effect weather variability. Agricultural insurance is seen as one of the best strategies to address farm risks and encourage the affected farmers to get back to business and achieve better and quality yields. This study assessed the effect of weather variability on crop insurance payout method of the Nigerian Agricultural Insurance Corporation (NAIC). The framework used consists of crop yield models, crop yield variance and the insurance payout estimation methods employed to help the affected farmers with the challenges. Primary and secondary data were used for this study. The insured farmers were randomly selected from the insurance policy register of NAIC while the uninsured farmers were selected from the Federal Ministry of Agricultural, Ibadan branch. The secondary data includes weather variables and crop yield data in South- West, Nigeria from 1990 to 2014. The data were collected from the Nigerian Meteorological Station (NIMET). The results showed that the changes in weather affected crop yield levels and variability, rainfall and temperature increases are found to increase yield level and variability. On the other hand, the decrease in yield was caused by heat stress; this is a function of reduced rainfall days induced by the temperature rise. The results also identified that the insured farmers are less productive than the uninsured farmers in term of crop production. This shows that the insured farmers took insurance policies as a pre- requisite to obtain credit from the financial institution which might have been diverted into another thing. An adjusted R^2 indicated the proportion of the variation in output of both insured and uninsured farmers. A value of 93.52% was obtained for the specify function of the insured farmer as compare to 84.38% of the uninsured farmer and 90.66% for the pooled result of the two groups of farmers.

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1. Introduction

Weather variability problem in Nigeria indicate the ways in which weather has affected crop producing farmers. These include: increased likelihood of crop failure; increase in diseases and mortality of livestock, and/or forced sales of livestock at disadvantageous prices; increased livelihood insecurity, resulting in assets sale, indebtedness, out-migration and dependency on food aid; and downward spiral in human development indicators, such as health and education. Such impacts will further aggravate the stresses already associated with subsistence production, such as isolated location, small farm size, informal land tenure, low levels of technology and narrow employment options (Enete and Alabi, 2011).

Most Nigerian cities are facing major stresses on water availability. Particular stress related to issues of supply scarcity, contamination and salt water infiltration (Enete, 2008; Enete and Ezenwaji, 2011), higher demands, and growing dependency on external supply. The impacts of weather variability on health are another area of concern, including air pollution, heat island effects, and spread of disease vectors. The consequences on human settlements due to sea-level rise or coastal and inland flooding are a further concern that could lead to serious disruption in the transportation and infrastructure service (Enete, 2008). Increase in global temperatures, rising energy demands (Enete and Alabi, 2011) and increased heat island effects (Enete and Ijioma, 2011), are identified as other issues of primary concern. It is considered very likely that increasing global temperatures will lead to higher maximum temperatures, more heat waves and fewer cold days over most land areas. Disruption of sensitive ecosystems, loss of biodiversity and food security problems will be witnessed. Wildfire is dramatically escalating in frequency and extent. Forest could be lost due to frequent and more intense fire (Reid et al., 2007). Other weather variability impacts include shifting ranges and seasonal behaviors, changes in growth rates, in the relative abundance of species and in processes like water and nutrient cycling and in the risk of disturbance from fire, insects and invasive species (Johnson and Moghori, 2008).

Adaptation can be both autonomous and planned. Autonomous adaptation is the ongoing implementation of existing knowledge and technology in response to the changes in weather experienced; and planned adaptation is the increase in adaptive capacity by mobilizing institutions and policies to establish or strengthen conditions that are favourable to effective adaptation and investment in new technologies and infrastructure. Autonomous adaptations are highly relevant to smallholder farmers. Mostly located in areas of ecological fragility, they tend to have an extensive knowledge base to draw upon in coping with adverse environmental conditions and shocks. Autonomous adaptation options can be, for example: changing inputs such as crop varieties and/or species and using inputs with increased resistance to heat shock and drought; altering fertilizer rates to maintain grain or fruit quality consistent with the climate; and altering amounts and timing of irrigation and other water management practices; making wider use of technologies to 'harvest' water, to conserve soil moisture (e.g. crop residue retention) and to use water more effectively in areas where there is a decrease in rainfall; utilizing water management to prevent water logging, erosion and nutrient leaching in areas where there is an increase in rainfall; altering the timing or location of cropping activities; diversifying income by integrating into farming activities additional activities such as livestock raising; and using seasonal weather forecasting to reduce production risk. However, while many of these measures are effective against a degree of climatic variability, they may become insufficient in the face of accelerating weather variability; therefore a longer-term planned approach for adaptation is therefore needed to secure sustainable livelihoods of farmers. It has to incorporate additional information, technologies and investments, infrastructures and institutions and integrate them with the decision-making environment. Insurances, safety nets and cash transfers to reduce vulnerability to shocks are also part of the solution.

2. Empirical Related Literatures

Petit-Maire (1992) opined that if the increase in precipitation should be associated with increased rainfall intensity, then a quality and quantity of soil and water resources would decline, for instance through increased run off and erosion, increased land degradation processes and a higher frequency of floods and possibly droughts. Drought is one of the side effects of climate variability.

According to Ake *et al*. (2001) it is a creeping phenomenon, characterized by extended period with rainfall below average, prolonged periods of dryness, high temperature and evapotranspiration, very low humidity, and reduced stream flow as well as reservoir water level. Kebbi, Sokoto, Katsina, Kano, Jigawa, Borno, Gombe, Adamawa and Niger are the states prone to drought in Nigeria. Madiyazhagan *et al*. (2004) carried out a study on water and high temperature stress effects on crop production in Australia, they observed that high temperature (greater than 38º C) compounded by water stress occurring at the same time decrease kernel set under dry land environments. Akintola (2011) in a study on the comparative analysis of the distribution of rainy days in different ecological zones observed that the rainy days in the Southern zone shows relatively less variability than those in the central (middle belt) and the Northern zones.

Adeleke and Goh (1980), climate is the average atmospheric conditions of an area over a considerable time. It involves systematic observation, recording and processing of the various elements of climate such as rainfall, temperature, humidity, air pressure, winds, clouds and sunshine before standardization of the climatic means or averages can be arrived at. In a study on crop yield variability as influenced by climate, Chi-Chung *et al*. (2004) submitted that precipitation and temperature are found to have opposite effects on yield levels and variability of corn (maize). Furthermore, they reasoned that more rainfall can cause yield levels to rise, while decreasing yield variance and that temperature has a reverse effect on some crop production. Bancy (2000) study on the influence of weather variability on maize production in semi-humid and semi-arid areas of Kenya explained that in order to counter the adverse effects of climate change in maize production, it might be necessary to use early maturing cultivars and practice early planting.

The impact could, however, be measured in terms of effects on crop growth, availability of soil water, soil erosion, incident of pest and diseases, sea level rises and decrease in soil fertility (Adejuwon, 2004). The issue of weather variability has become more threatening not only to the sustainable development of socio-economic and agricultural activities of any nation but to the totality of human existence (Adejuwon 2010). As further explained by Adejuwon, the effect of weather variability implies that the local weather variability which people have previously experienced and adapted to is changing and this change is observed in a relatively great speed. The threat that weather variability pose to agricultural production does not only cover the area of crop husbandry but also includes livestock and in fact the total agricultural sector. African farmers also depend on livestock for income, food and animal products (Benin, 2007).

Weather affects livestock both directly and indirectly (Adams *et al*. 1999; Manning and Nobrew, 2001). Direct effects of climate variables such as air, temperature, humidity, wind speed and other climate factors influence animal performance such as growth, milk production, wool production and reproduction. Climate can also affect the quantity and quality of feed stuffs such as pasture, forage, and grain and also the severity and distribution of livestock diseases and parasite (Niggol and Mendelsohn, 2008). The northeast region of Nigeria is increasingly becoming an arid environment at a very fast rate per year occasioned by fast reduction in the amount of surface water, flora and fauna resources on land (Obioha, 2008). Consistent reduction in rainfall leads to a reduction in the natural regeneration rate of land resources (Fasona and Omojola 2005). This makes people to exploit more previously undisturbed lands leading to depletion of the forest cover and increase on sand dunes/Aeolian deposits in the northern axis of Nigeria. Climate change is the most severe problem that world is facing today. It has been suggested that it is a more serious threat than global terrorism (King 2004). The southern area of Nigeria largely known for high rainfall is currently confronted by irregularity in the rainfall and temperature is gradually increasing in the Guinea savannah zone of the country. In addition, the northern zone faces the threat of desert encroachment (FME 2011).

3. Methodology

Both primary and secondary data are used for this study. The primary data include socio-economic characteristics of both insured and uninsured farmers' their production and insurance information. This information was obtained through interview schedule and administration of a structured questionnaire. The secondary data cover weather related data such as rainfall and temperature as well as state-level data on food crop production in from 1990- 2014.

Data on weather variables were obtained from Nigerian Meteorological Station (NIMET) Lagos State branch while food production data were be obtained from Osun State Agricultural Development Programme (OSSADEP).

The summary statistics of the crop production in Osun state is represented in table 1 below.

Table 1: The descriptive statistics of Crop Production 1990 and 2014

	Unit	Mean	St .Dev	Min	Max
Cassava yield	Tons/ ha	9.69	1.22	7.03	11.87
Cowpea yield	Tons / ha	0.69	0.17	0.28	0.99
Cocoyam yield	Tons /ha	3.85	1.46	0.42	5.70
Maize yield	Ton/ha	1.54	0.41	0.61	2.76
Melon yield	Ton/ha	0.59	0.29	0.23	1.41
Okro yield	Tons /ha	1.37	0.49	0.5	2.45
Sorghum yield	Tons /ha	1.05	0.28	0.68	1.89
Pepper yield	Ton /ha	1.71	0.57	0.1	2.31
Tomato yield	Tons /ha	2.55	0.83	0.97	4.68
Yam yield	Tons /ha	13.24	2.57	9.37	18.89
Vegetable yield	Tons /ha	1.62	0.69	0.54	3.49
Trend		11	6.20	1	21
Temperature	^{0}C	31.75	0.47	30.9	33.3
Rainfall	Mm	114.5	37.3	75.4	221.1

Source: Osun State Crop Production Data

Model Specification

The Just-Pope production function was estimated from panel data relating yield to exogenous variables. This procedure estimates the impacts of the exogenous variables on yield levels and the variance of yield. Following Just and Pope (1979) and Saha et.al this study estimate production functions of the form:

$$Y = f(X,\beta) + h(X,\alpha)\varepsilon \quad \text{………………. (1)}$$

Where Y is crop yield (cowpea, sorghum, cassava, maize, cocoyam, okro, pepper, cassava, vegetable, melon and yam), *f(≡)* is an average production function, and X is a set of independent explanatory variables (climate, location, and time period). The functional form h(≡) for the error term ui, is an explicit form for heteroskedastic errors, allowing estimation of variance effects.

Estimates of the parameters of f(≡) give the average effect of the independent variables on yield, while h(≡) gives the effect of each independent variable on the variance of yield. The interpretation of the signs on the parameters of h(≡) are straightforward. If the marginal effect on yield variance of any independent variable is positive, then increases in that variable increase the standard deviation of yield, while a negative sign implies increases in that variable reduces yield variance.

The basic model is thus specified as:

$$y_{it} = \exp(\alpha_0 + \sum_{k=1}^{k} \alpha_k x_{kit}) + \varepsilon_{it}\sqrt{\beta_0 + \sum_{m=1}^{m} \beta_m x_{mit}} \quad \text{………………………(2)}$$

Where y_{it} is the crop output in region i at time t; x_{kit} is the input quantity of factor k in region i at time t, and $\alpha_j, j = 0,1........k$, are the parameters to be estimated. x_{mit} denotes a factor which can influence the risk level and β_m is the corresponding coefficient. ε In turn is a stochastic disturbance term following the standard normal distribution. Thus, we find that the expected output (often also referred to as mean output) and the variance of output are determined by separate functions, which can algebraically be denoted as

$$E(y_{it}) = \exp(\alpha_0 + \sum_{k=1}^{k} \alpha_k x_{kit})$$ and

$$V(y_{it}) = \beta_0 + \sum_{m=1}^{m} \beta_m x_{mit} \quad \text{.................... (3)}$$

Given the assumption that production risk in this framework takes the form of heteroskedasticity in the production function, the second term on the right-hand side of equation (2) can be interpreted as a heteroskedastic error term for the purpose of estimation.

Module for insurance payout estimation

A simple insurance scheme (Ray 1967; Hazell et al. 1986; Abbaspour 1994) was used to simulate the insurance payout in the state. The insurance payout in the *i*th state in *j*th year, is as follows:

$$Payout_{i,j} = \nabla Y_{i,j} \times Area_{i,j} \times P\_crop \quad \text{....... (6)}$$

Payout *i*, *j*, is given by the functions of the insured yield loss, $\nabla Y_{i,j}$ is change in output crop in jth year. $Area_{i,j}$ = production/yield and price of crop, P crop while i represent crop and j represent year.

Model of production practices by insured and uninsured farmers.

To assess the operation of Nigerian Agricultural Insurance cooperation this study use econometric analysis as a basis to compare production practices between insured and uninsured farmers in the study area. Production functions project a physical relationship between inputs or factors of production and the resulting farm output represented as the dependent variable. A typical production function can be implicitly represented as ***Q = f(X)*** where Q is the homogeneous output representing the endogenous variable and X, then-dimensional vector of homogeneous inputs represented as explanatory variables. For this study different functional forms were tested on the cross-sectional data collected, but the **Cobb-Douglas** function was chosen as the basis of result presentation because it enjoys a wider application in this type of study and because of the added information implied by its parameter estimates. It has been emphasized that linear and quadratic functions which were commonly used as alternatives are better suited to the analysis of experimental data than to the analysis of cross-sectional data

The statistical estimates obtained were used to compare production performance between the identified groups of respondents. The function is thus used to examine production performance and resource productivity between insured and uninsured farmers.

The Cobb-Douglas function can be implicitly presented as:

$$Q = AX^b X^{(1-b)} \quad \text{........................... (7)}$$

Where **A** is a positive constant term and *b* a positive fraction. **Q** and **X** are the variables, the relationship between which are examined by the equation. However, in order to specify the equation, the above implicit equation must be explicitly expressed by taking the log transformation of both sides as shown below;

$$\ln Q = \beta_0 + \beta_1 \ln X1 + \beta_2 \ln X2 + ...\beta_9 \ln X9 + \mu \quad \text{.................. (8)}$$

Where the respective variables in the equation are represented as follows:

Q is the dependent variable is the value of the farm output; value of planting seeds, ***X1*** and capital borrowed or used (***X2***), fertilizer ***(X3)*** and farm size ***(X4)*** and value of labour employed on the farm ***(X5)***. Other variables include expenditure on agro-chemicals such as herbicides and pesticides ***(X6)***, expenditure on farm asset ***(X7)***, value of farm assets ***(X8)*** and ***(X9)***, a dummy variable used to represent the holding of an insurance policy. β_0, β_1 ... β_9, are the parameters (coefficients) to be estimated that respectively measured the relationship between the inputs and output in the production process, for the ninth inputs. μ is the error term which is assumed to be normally distributed with mean zero and constant variance. ***ln*** is the natural logarithm of the respective variables included in the equation. The essence of the log transformation is in recognition of the existence of error in the included variables, by the transformation the error is made to be nearly and normally distributed without any pattern in its relationship.

4. Results And Discussion

Trend of Crop Production

Over the entire analysis period (1990 – 2014), the dominant crops produced were yam, cassava, sorghum, cowpea, cocoyam, melon, maize, tomato, vegetable, Okro and pepper. A higher yield of yam and cassava with 9.37- 18.89 tonnes per hectares and 7.03-11.87 tonnes per hectare respectively was recorded in Osun state in the year 1991 and 1992 with an average rainfall of 114.1mm and 31.6^{o}C temperature (Olatunbosun, 1995).

The graph below in fig 1, shows that S.A.P still has greater influence on Cassava production until 1992, but rapidly decline thereafter and begin to fluctuate because of poor sales due to price instability. The trend reveals that Sorghum continued to rise and fall between 1990 to 2004, hoping that its increase during the period 2005 will be maintained but a drastic fall was experienced which is still on fluctuation up till today, probably because of high cost of human labour, lack of fertilizer or lack of modern farming equipment.

Cowpea increased after the mid-1995, and its average production became unpredictable since then because of crop damage and poor storage facilities, poor sales of food stuff due to price fluctuation, or government interventions.

Maize also showed a high rate of increase, but it started only at the end of the 2008.

Some variables which are responsible for this might are high cost of human labour, high cost of transport to the market/urban centers, and lack of fund/credit facilities. Olatunbosun (1995) emphasized that transportation, information dissemination, storage, food processing, and standardization problems are the main constraints and causes of fluctuation of food production especially in the rural areas of the country.

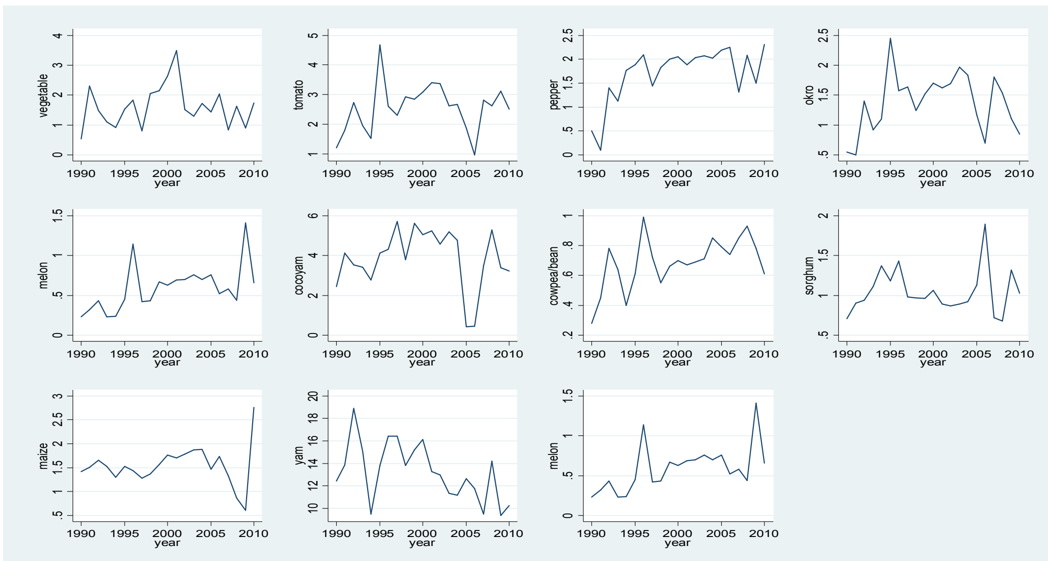

Fig 1: Trend of crop production in Osun State between 1990 and 2014

More recently, Fatulu (2007), Tunde (2007) and Yahaya (2009) indicated that transportation, poor credit accessibility, insecurity and high cost of human labour and farm inputs represent the most serious constraints to agricultural development in Nigeria. So varied are the reasons advanced for the instability of food crop production in the study area.

Olatona, (2007) explained that the bulk of food crop production in Nigeria takes place under the traditional system without the use of mechanical power. Such a peasant agricultural system is usually characterized by poverty. Holdings are small, simple implements are used to cultivate hectares of land and land fragmentation is on the increase. The existing fragmentation and fractionalization are not only due to land tenure system, but also to soil catena characteristics (Olawepo, 2008).

In view of these, it has been variously observed that the trend of food production appears to increase or decrease with increasing or decreasing gap between the rural and urban sectors of the economy which in turn is related to the increasing trend of rural-urban migration. In as much as a large proportion of food consumed in the urban centers are being produced in the rural areas, migration to the urban area will drastically decrease food crop production. In summary, most of the fluctuation of food crop production experienced in Osun State is as a result of inadequate modern farming equipment, scarcity of human labour or high cost of human labour, inadequate fertilizer, lack of funds or credit facilities, variation in climate variables like rainfall and temperature, high crop damage due to poor storage system, high cost of transport to urban centres, poor sales of food stuff due to price fluctuation, problems of pests and diseases, poor accessibility to extension services etc.

The Regression Result of Weather Variable and Crop Production

From the result in the table 2 below, the significant sign on temperature is negative for three crops (cassava, cowpea and sorghum), this indicates that this crop yield increases with more rainfall.

Table 2: Estimated Parameter for average crop yield production (f(X,) under linear function

Crop	Temperature	Rainfall	Year	Constant
Cassava	-0.7102 (-0.1674)	0.40433 (0.5225)	0.34459 (-1.043)	9.8511 (0.7120)
Cocoyam	0.33951 (1.578)	0.8122* (3.242)	0.13226* (3.250)	-9.4102 (-1.310)
Cowpea	-0.2760 (-1.040)	0.1909** (2.312)	0.1962* (4.053)	1.1226 (7.169)
Maize	0.13529 (1.256)	0.32788* (4.265)	0.12455*** (1.840)	-3.2360 (-0.9340)
Melon	0.8935 (1.113)	0.1472*** (1.852)	0.2313* (2.951)	3.0453 (0.5467)
Okro	0.50283 (0.5325)	0.78550** (2.730)	0.39616* (2.662)	-1.5479 (-0.4749)
Pepper	0.2769 (1.196)	0.49785* (3.582)	0.62799* (3.906)	-3.6299 (-1.007)
Sorghum	-0.4120* (-71.38)	0.15304 (0.1038)	0.14014 (0.1444)	2.0861 (1.450)
Tomato	0.33199*** (1.650)	0.14560* (4.447)	0.70559* (4.208)	-10.433 (-1.472)
Vegetable	0.19374 (1.059)	0.2285 (0.8280)	0.1850 (0.7591)	-5.0972 (-0.8158)
Yam	0.27603 (0.5119)	-0.94700 (-0.8529)	-0.30241* (-4.111)	15.73 (0.8139)

***** indicates significant at 10%, ** indicates significant at 5% level, *indicate significant at 1%.**

Yam and tomato have a positive significant for temperature which implies more yield with more temperature. For rainfall, the results shows that cocoyam, cowpea, melon, Okro, pepper and tomatoes have a high positive response to rainfall which means with more rainfall, the yield of these crops will increases. It is also observed that crops have a positive response with time trend, which indicates that if the amount of rainfall supplied increases with time, there is tendency for increase in yield of the specified crops in the region.

Results of Yield Variability Over Time

The results in table below reveal the way crop yield variability responds to changes in temperature and rainfall. In these cases, increases in rainfall also increases yield variability for cocoyam, melon and tomatoes but decreases for yam, vegetables and pepper simultaneously, higher temperatures increase the variance of yam yields, but decrease variability for cocoyam, cowpea, melon, okro and pepper. Such results are not surprising if one looks at the characteristics of the locations where these crops are grown coupled with common crop cultural conditions.

Sorghum is generally grown in higher temperature and lower rainfall conditions, and the results show lower temperatures or more rainfall increase variability. It is not inconsistent with the finding that variability increases as temperature and rainfall are reduced.

Table 3: Result of Estimated yield variability (h, (x, α))

Crop	**Temperature**	**Rainfall**	**Year**	**Constant**
Cassava	1.1502** (2.356)	0.117 (1.541)	-0.402 (-1.289)	-36.386 (2.303)
Cocoyam	-1.3994* (-3.058)	0.8316* (3.001)	0.20763) (2.813)	45.438 (3.065)
Cowpea	-0.9038* (-2.009)	-0.1292 (-0.9489)	0.2425 (-0.3102)	0.30324 (1.859)*

Crop	Temperature	Rainfall	Year	Constant
Maize	-0.2652 (-0.8661)	-0.1522 (-1.061)	-0.8573* (3.014)	0.85443 (0.8666)
Melon	-0.2204* (-0.2952)	0.1048* (2.086)	0.1728 (0.8230)	0.71184 (1.912)
Okro	-0.7232** (-1.916)	0.11899 (0.7147)	0.74088 (0.9683)	2.2500 (1.682)
Pepper	-0.11687 (-2.385)	-0.15855* (-2.302)	-0.79846 (-0.9897)	4.1166* (2.379)
Sorghum	-0.65024 (-0.2844)	-0.72089 (-0.2510)	0.7208 (-0.1266)	2.2407 (0.3901)
Tomato	-0.11493 (-0.9143)	0.51878* (2.497)	0.24552* (1.974)	-0.13923 (-0.3456)
Vegetable	-0.49283* (-3.052)	-0.7497* (-2.949)	-0.63607* (-2.909)	17.695* (3.061)
Yam	-4.8763* (-2.82)	-0.57300* (-2.379)	-0.54874* (-2.6841)	172.18* (2.799)

**indicates significant at 5% while * indicates significant at 1% level.

Crop Yield Production Function Estimates

The sign on rainfall is positive for all crops and is negative on temperature. This indicates that crop yields increase with more rainfall and decrease with higher temperatures, holding acreage constant and after controlling for a deterministic time trend that may serve as a proxy for the non-stochastic portion of the advance of agricultural technology.

Higher temperatures positively affect sorghum yields (Cobb-Douglas estimate insignificant). The coefficients on the deterministic time trend are positive and significant as expected for all crops, except the Cobb-Douglas estimates for sorghum and cassava. This may come from the tendency of Cobb-Douglas functional forms to pick up curvature because they are nonlinear over a wide range of parameter values, and may indicate a declining rate of increase in the effect of technology on yield rather than an actual negative impact of technology.

The coefficients for rainfall and temperature can be converted to elasticities by multiplying by sample average climate and dividing by average yield. Elasticities for the other crops are mixed, with uniformly high elasticities being measured for both rainfall and temperature on sorghum.

Regression of Production practices for Insure and Uninsured Farmers

When considering the result above, it is observed that for the insured farmers, value of assets owned by the farmer and the labour employed on the farm was significant. It is also observed that output obtained by the farmer is directly influenced by the input exerted. Likewise, the value of fertilizer also has a significant impact on crop production among the insured farmer.

All other variables included have a significant influence on crop production by an insured farmer except the use of agro chemical, value of seed and expenditure incurred on adaptation techniques adopted. Some of the included explanatory variable like value of expenditure incurred on adaptation technique, the value of seeds, fertilizer, and value of labour use were significant for the uninsured farmer. This implies that they exert a great impact or influence on the level of production achieved by the uninsured famer.

The pooled result shows that the value of seed used for planting, labour, the value of expenditure on adaptation technique, use of fertilizer and the holding of insurance policy were significant. The result shows that they contribute positively to the output of farmer but at a different rate. It is also observed that agrochemical used is not found to be significant in any of the results specified.

The R^2 indicated the proportion of the variation in output of both insured and uninsured farmers. An R^2 value of 93.52% was obtained for the specified function of the insured farmer as compare to 84.38% of the uninsured farmer and 90.66% R^2 was obtained for the pooled result of the two groups of farmers. The adjusted R^2 value was obtained to allow comparison the R^2 value of the different result obtained from each group of farmers. The efficiency of the result used can be generated among the farmers group from the pooled result. As it is known that the higher the efficiency, the more efficient the farmer is. This study use the sign of the parameter estimate of the dummy variable in the pooled result to measure the efficiency of resources used between the farmers group. The sign of the dummy reveal a positive sign coefficient which indicates that the efficiency moves toward the insured farmer which has the largest integer of coded variables, where a negative coefficient measure tends towards the uninsured farmer. The negative sign of the coefficient in this result shows that uninsured farmers were more efficient in resource use than the insured farmers. But it is noted that insurance policy have no significant relationship between insured farmer and the crop output obtained. Therefore insurance decision does not guarantee higher output level of crop productivity.

Table 4: Result of production practices by insured and uninsured farmers

Variable	Insured	Uninsured	Pooled Result
Constant	3.4167 (2.60)	9.096 (11.18)	5.1724 (12.72)
Value of Seed (X1)	0.886 (0.84)	0.760* (5.51)	0.1569* (3.38)
Capital Borrowed or Used (X2)	0.0982* (4.94)	$5.4X10^{-4}$ (0.98)	0.049 (0.972)
Fertilizer (X3)	0.0550* (2.04)	0.875* (4.78)	0.1842* (2.661)
Farm Size (X4)	0.1316* (3.41)	0.121 (0.61)	0.4855** (1.814)
Labor (X5)	0.0374** (1.94)	0.881* (2.78)	0.1275* (2.331)
Agro- chemical used (X6)	0.727 (0.40)	0.374 (0.84)	0.0815 (0.381)
Value of farm Asset (X7)	0.1072* (5.96)	0.743 (0.24)	0.0641 (0.287)
EXP on Adaptation Technique (X8)	0.136 (0.671)	0.875* (2.29)	0.0537* (5.180)
Dummy Variable			0.4866* (1.87)
R^2	0.9352	0.8438	0.9066
R^{-2} (adjusted)	0.9293	0.9007	0.6416

**indicates significant at 10% while * indicates significant at 5% level.

Apart from the fact that insured farmers embraced modern Farming practices, possibly because of their accessibility to farm credit, their farm output does not make them better farmers than the uninsured farmers. The operation of agricultural insurance should not be limited to climatic variability but the government should complement their operations by making farm inputs readily accessible to farmers and that farmers are enlightened about their use. There are times when many of the Farm input are scarce and difficult to obtain in the open market. As a result of these problems, it may be difficult for an average peasant farmer to safeguard the correct use of these inputs that are time and quality specific for best performance.

The impact of insurance is worthy to be noted here because this study reveals that it does not contribute substantially to farm output. Even among the insured farmers that used more of input, it actually contributed negatively to farm output. The two groups of farmers sampled for this study operate in a similar and contiguous area and they displayed some striking differences in their farm operations. The insured farmers are more commercially oriented in the choice of their enterprise combinations and in the inputs they used on the farm. They used more modern farm inputs and choose enterprises that are more market oriented than the uninsured farmers. However, the uninsured farmers are found to be more productive and efficient in the use of their farm inputs.

The majority of the Osun state farmers are illiterate and with large scale poverty they have little knowledge about an insurance markets. It is on the basis of this understanding that farmers are encouraged to patronize agricultural insurance and with the assurance that it will increase their accessibility to a range of farm inputs and a further help to share the burden of risks so that they would still meet their basic obligations.

Crop Insurance Payout Estimation

Equations Frequently Used As A Simple Insurance Scheme (Ray 1967; Hazell Et Al. 1986; Abbaspour 1994) were used for the module for the crop insurance payout estimation to simulate the crop insurance payout in a prefecture. The insurance payout in the *i*th prefecture

in *j*th year, Payout*i*, *j*, is given by the functions of the insured yield loss, *Yi*, *j*, insured acreage of crops, Area *i*, *j*, and price of crop, as follows:

$$Payout_{i,j} = \nabla Y_{i,j} \times Area_{i,j} \times P\_crop$$

On the other hand, the insured yield loss, *Yi*, *j*, is given by

$$Y_{i,j} = \phi \bar{Y}i - Y_{i,j} \text{ if } Y_{i,j} < \phi \bar{Y}i$$

$$\nabla Y_{i,j} = 0, \text{ if } Y_{i,j} \geq \phi \bar{Y}i$$, Area= production / yield

Where $Y_{i,j}$ is the yield in a given year, $\bar{Y}i$ is the standard yield, and ϕ is the insurance coverage.

Table 5: Estimated Crop insurance payout

Year	Cassava (₦)	Yam (₦)	Maize (₦)	Sorghum (₦)	Cowpea (₦)	Cocoyam (₦)	Melon (₦)	Okro (₦)	Pepper (₦)	Tomato (₦)	Vegetable (₦)
year	Cassava	Yam	Maize	Sorghum	Cowpea	Cocoyam	Melon	Okro	pepper	Tomato	Vegetable
1990	39900	56000	720	1425	2040	10200	1260	225	2600	2900	4425
1991	63000	201600	1200	300	3960	3660	1540	4050	8450	4750	2075
1992	40950	152800	1040	1275	1680	720	2800	2160	1820	3950	925
1993	1400	222400	1840	1950	2880	3840	140	810	4225	2150	475
1994	10185	172000	1840	1425	2520	8160	2940	6075	715	15800	1525
1995	57400	104800	720	1875	4560	1080	9660	3960	1365	10350	750
1996	30100	0	1280	3375	3240	8400	10080	315	4225	1550	2550
1997	78400	103600	720	75	2040	11460	140	1800	2470	3150	3100
1998 1998	37100	55200	1600	75	1320	10920	3360	1260	1170	450	250
1999	81200	36000	1520	750	480	3420	560	810	325	1250	1200
2000	65450	114400	480	1275	360	1200	840	360	1105	1550	2150
2001	14350	11600	640	150	240	4020	140	315	975	150	4925
2002	66500	65200	720	150	240	3660	840	1260	260	3750	550
2003	14000	6000	80	225	1680	2580	840	630	325	250	1050
2004	50400	58000	3280	1575	720	25980	840	2970	1105	4000	725
2005	1400	35200	2080	5700	600	240	3360	2125	390	4500	1525
2006	9450	90000	3200	8775	1320	18060	840	4950	6110	9200	3025
2007	27650	187600	3680	300	960	10800	1960	1215	5005	900	1975
2008	11900	193200	2080	4800	1800	11280	13580	1890	3770	2400	1800
2009	12250	35600	17200	2175	2040	1020	10500	1170	5265	3000	2100
2010	30240	410400	22080	0	7320	19320	9240	3825	15015	12550	4350
2011	33250	4230500	320543	67800	5430	22750	9754	6540	15960	15500	4357
2012	16740	195000	43980	75500	5500	23700	9800	67900	16700	16500	4500
2013	27020	170720	26035	48500	82650	4032	3575	27650	950	750	4150
2014	29435	180120	28900	17000	43500	3285	12100	3450	11200	10340	1680

This crop insurance program is designed with the assumption that all farmers must participate. An objective of the program is to establish full participation by farmers (Yamauchi 1986). With this consideration, we used the total planted acreage as the insured acreage. The more the crop yield loss to climate change indices, the more the insurance payout which will help the farmer to get back to business. The insurance coverage varies depending on the prefecture and ranges from 0.7 to 1.0 in the National Agricultural Insurance Association (NAIA) insurance program (NAIA 2004).

For simplification herein, we took the value of 1.0 for all prefectures. There were three difficult issues for simulating the crop insurance payout: (i) the standard yield, (ii) the insured acreage of crops, and (iii) the price of crop.

In the insurance program, the standard yield is defined as the yield trend curve assuming normal weather conditions. The standard yield for a prefecture is calculated by the nonparametric regression method that uses the climate indices and the number of years as the explanatory variables (MAFF 1998). The calculated standard yield of a prefecture is broken into the municipalities with due consideration of their yield histories. However, because the future climate dataset for this study we used a simple method for calculating the standard yield instead of the existing method. The second issue is the insured acreage of crops. We were compelled to use the current values of planted acreage for the future period, although we believe that the planted acreage changes year by year as a result of the change in price under future conditions of demand and supply.

The third issue is the price of crops. Price is affected by economic factors, that is, demand and supply, including exports and imports; thus, the price in the future is perhaps unequal to the current one. However, we are compelled to use the mean price of crops. Our future projection of the crops insurance payout had the limitations mentioned above for the treatments of future economic factors (i.e., planted acreage and price). In future studies, the inclusion of applied general equilibrium models will help develop a framework and achieve a more realistic simulation

Conclusion

The results are found to be different by crops. For examples like maize, vegetables, tomatoes, melon and pepper, high temperature are found to have positive effects on yield levels and variability. More rainfall causes more yields to these crops while decreasing yield variance. As a result of yield variability due to loss through weather variability an analysis of crop insurance to mitigate the risk suggest that the insured farmers supposed to generate more output greater net profit by the assistance of an insurance cover to reduce risk. It is observed that most of the insured farmers do not take an insurance cover to bear losses but as a pre-requisite to obtain financial assistance from a financial institution and in clear sense, most of the farmers do not have a direct access to their insurer. There has not been any evidence of adequate and prompt payment of insurance payout of any crop yield loss incurred by the insured farmers in the study area.

Recommendation

Based on the information obtained through this study, the following recommendation is inevitable for a greater crop yield response despite the incidence of weather variability and its risk.

i. The government should understand that there is a great loss of crop yield as a result of weather variability and should help the crop farmers with effective adaptation strategies like providing irrigation facilities to cope with the challenges of inadequate rainfall

ii. The Nigerian Agricultural Insurance Corporation should restructured their policies and used the simple crop insurance payout techniques employed in this study to assist farmers to cope with the challenges of climate change and help those that are badly affected to get back to business

iii. In order to achieve the agenda of adequate food security, the government should provide incentives and financial assistance to farmers in order to eliminate the extortion of farmers by the financial institution.

iv. Apart from this insurance planned adaptation strategies, the extension agent should also help farmers with vital information on improved seed, planting dates, improved technologies and help provide markets during surplus harvest seasons to minimize loss of crop produce.

v. The farmers should also embrace the modern method of crop productions practices introduced to them by the extension agent and ignore their traditional ways of farming in other to get ahead of their so-called insufficiencies in production practices.

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