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# SPATIAL IMPACT AND VARIATION OF FARM INCOME AMONG FARMERS IN ABIA STATE, NIGERIA

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**Abstract**
The significant influence of location on agricultural production has not been largely investigated. Due to the paucity of empirical evidence of this influence, this study was designed to analyze the impact of spatial difference on farm income among farmers in Abia State, Nigeria. A multi stage randomized sampling procedure was used to select 80 farming households in two Agricultural Zones (Ohafia and Umuahia) in the State. Primary data were collected by the use of the cost route approach with the aid of a well-structured questionnaire. Data were analyzed using descriptive statistics, multiple regression and Chows' test. The results showed that the income of farmers in Ohafia Agricultural Zone (OAZ) was higher than the income of farmers in Umuahia Agricultural Zone (UAZ). Chow's test showed that the difference in income of the farmers was due to spatial difference between the two zones. The results of the multiple regression also showed that education, labour availability and farm size were significant drivers of farm income. A consideration of spatial differences in the environment of agricultural production is important in the design, development and introduction of improved agricultural technologies and in the planning and implementation of agricultural development programmes.

**Keywords: Location, Farm income, and Cost-route**

## Introduction

Location is clearly an important factor in agricultural production. Agricultural production is an occupation that is not only location specific but also location sensitive in both physical and social terms. In physical terms, it is dependent on environmental and climatic factors such as the soil, rainfall, sunlight and subject to the influence of altitude, slope, erosion, flood and the presence or absence of pests and diseases in the environment. In social terms, agricultural production is influenced by the customs, traditions and land tenure practices that obtain in the project environment or community. These physical and social factors, in combination with other variables such as the personal attributes of the farmer, modify the farm firm's input-output relationship and consequently influence its output and income. Most of the studies on the factors that influence the income of farmers have focused mainly on a plethora of socioeconomic factors that include; farm size, age of farmer, level of education, household size, level of technology adoption, input and output prices, interest and exchange rates, irrigated area, off-farm income, hired labour, tractor ownership, land holding, agricultural expenditure, contact with the extension service, property income and access to credit (Mafimisembi, 2008; Ghafoor *et al.,* 2010; Ibekwe, 2010; Ibekwe *et al.*, 2010; Quasin, 2012; Fadipe *et al.*, 2014; Talukder, 2014; Jayson *et al.*, 2015; Osondu *et al.*, 2015; Meena *et al.*, 2017). A few other studies have also investigated the effect of the relative distance of farms from the farmers' homestead on farm income and the effect of the distance of the farm to the market on farm income (McCall, 1985 and Kassali *et al*., 2009).

The literature showed a paucity of empirical evidence of the impact of spatial difference on farm income. Spatial difference (a proxy for location) is in this study non - relative and comprises distinct set of heterogeneous factors in terms of social, economic, educational, cultural, traditional, soil, climatic and demographic factors. As a result, an attempt was made to select two distinct and heterogeneous study areas, such that farmers in one area are completely and absolutely different from farmers in the other area. As indicated earlier, the impact of spatial difference on farm income has largely not been investigated. This demands an investigation of the drivers of the farm income among farmers located in two or more heterogeneous areas. This study is designed to fulfill this need. In addition to some of the personal attributes of the farmers, which probably vary with location, this study will include location (proxy for spatial difference) as an explanatory variable in the model to identify the significant drivers of farm income. Chows' test will also be used to

investigate the impact of spatial difference on farm income. Specifically, this study determined and compared the socioeconomic characteristics of farmers (age, level of education, household size, and farm size) from two agricultural zones in the State. The study also determined and compared farm income, factors that influenced the farm income and the impact of spatial difference on the farm income of the farmers.

**Methodology**

The study was conducted in Abia State, Nigeria. The state has an estimated population of 3.7m with a land area of 6,320km$^2$ (NPC, 2016 and NBS, 2016). The state has a tropical rainforest climate with a temperature range of 20$^o$C – 36$^o$C and an annual rainfall of about 2400mm. Majority of the people live in the rural areas with agriculture as the primary occupation. There are three agricultural zones in the state namely: Aba, Ohafia and Umuahia. A multistage random procedure was used in selecting respondents. Two of the agric. Zones: Ohafia and Umuahia were randomly selected for the study. The zones consist of five (5) Local Government Areas (LGAs) each. Two LGAs were randomly selected from each zone. Bende and Isuikwuato LGAs were selected from Ohafia zone while Ikwuano and Umuahia South LGAs were selected from Umuahia zone. The LGAs consist of autonomous communities. Due to the cost-route method of data collection, one community was selected from each LGA to give a total of four (4) communities. From each community, 20 households were randomly selected giving a total of 80 households. Primary data were collected from the households using the cost-route approach, with the use of a questionnaire administered on the respondents by enumerators selected among the extension agents (EAs) of the State Agricultural Development Project (ADP) and who reside in the communities. Data were analyzed using frequency distributions, means, percentages, regression analysis and Chows' test. The regression model was specified explicitly as follows:

$$Y = bo + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 \quad \ldots\ldots 1$$

Where,

Y = farm income in naira

$X_1$ = age of the farmer in years

$X_2$ = level of education of the farmer in number of years spent in school

$X_3$ = farm size in hectares

$X_4$ = sex (dummy variable; male =1, female =0)

$X_5$ = labour in man-days

$X_6$ = value of planting materials in Naira

$X_7$ = value of fertilizer in Naira

$X_8$ = location (dummy variable; Ohafia =1, Umuahia =0)

The Chows' F+ statistics for testing for the equality of the coefficients from the fitted regression equations was computed as follows;

$$F^+ = \frac{\Sigma e_3^2 - (\Sigma e_1^2 + \Sigma e_2^2)/K_3 - (K_1 + K_2)}{\Sigma e_1^2 + \Sigma e_2^2 / (K_1 + K_2)} \quad \ldots\ldots 2$$

Where,

$\Sigma e_3^2$ = Pooled unexplained variation or pooled error sum of squares (Sum of squared residuals from combined data)

$\Sigma e_1^2$ = Unexplained variation or error sum of square from sample 1

$\Sigma e_2^2$ =Unexplained variation or error sum of square from sample 2

K = Degree of freedom

$K_1 = n_1 - m$

$K_2 = n_2 - m$

$K_3 = n_1 + n_2 - m$

$n_1$ = number of observations for the first sample

$n_2$ = number of observations for the second sample

m = number of regression estimates including $b_0$

Chow's F+ statistics for testing for the homogeneity of the intercepts of the fitted equations was computed as follows:

$$F^+ = \frac{\Sigma e_3^2 - \Sigma e_4^2 / K_3 - K_4}{\Sigma e_4^2 / K_4} \quad \ldots\ldots 3$$

Where,

$\Sigma e_4^2$ = error sums of squares for the pooled sample with dummy variable

$K_3 = n_3 - m$

$K_4 = n_4 - m$

$n_3$ = number of observations for the pooled sample without dummy variable (location)

$n_4$ = number of observations for the pooled sample with dummy variable (location)

m = regression estimates including $b_0$

**Results and Discussion**

***Socio-economic characteristics of the farmers***

Table 1a shows that 95% of the farmers in Ohafia Agricultural Zone (OAZ) were at least 50 years old compared with about 65% of farmers in Umuahia Agricultural Zone (UAZ). This indicates that most of the farmers in OAZ were older than most of the farmers in UAZ. The mean age of the farmers was about 62 years in OAZ and about 56 years in UAZ indicating that on the average farmers in OAZ were older than the farmers in UAZ. Elderly farmers are likely to be more experienced and this will probably and positively influence output and income. This is also an indication that farmers in OAZ will probably earn higher income than farmers in UAZ. According to Obike *et al*., (2017) age was a positive and significant driver of the output (income) of farmers in Ekiti State, Nigeria. Most of the farmers in UAZ (92.5%) spent at least six (6) years in school compared with 62.5% of farmers in OAZ. The mean number of years spent in school was about 7 years for farmers in OAZ and about 12 years for farmers in UAZ. This implies that on the average farmers in UAZ were more literate or better educated than farmers in OAZ. Educated farmers are likely to be less conservative and less risk averse and consequently, be in a better position to adopt new technologies that lead to increase in yield. Such farmers are likely to earn more income. The implication is that the income of farmers in UAZ, are

likely to be higher than the income of farmers in OAZ. Ibekwe *et al*., (2010) reported a significant and positive relationship between education and farm income which indicated that farm income increased as the level of education increased. Household size was at least five (5) for 77.5% of farmers in OAZ compared with 62.5% of farmers in UAZ, with a mean household size of about 6 and 5 respectively. This implies that farmers in OAZ had larger households. Larger households imply more family labour and this will probably positively influence output and farm income. As a result, the income of farmers in OAZ is likely to be higher than the income of farmers in UAZ. Most of the farmers (100% in OAZ and 60% in UAZ) had land holdings (farm size) of less than one (1) hectare with a mean farm size of 0.16 ha and 1.27 ha respectively. On the average, farmers in UAZ had larger land holdings than farmers in OAZ. Consequently, farmers in UAZ are likely to produce more with higher income than farmers in OAZ. In general, farmers in Abia State are constrained by limited access to land given the mean farm size of at most 1.27 ha in the study areas. The mean farm income (Table 1b) was higher (₦335,843.63) for farmers in OAZ than for farmers in UAZ (₦319,023.33). Farmers in OAZ probably had the comparative advantage of more farming experience due to age and experience gained over the years. Farmers in UAZ probably had the comparative advantage of better education due to number of years spent in school and larger land holdings (farm size).

**Table 1: Socio-economic characteristics of the farmers in Abia State (n=40)**

| | Ohafia Agricultural Zone | | Umuahia Agricultural Zone | |
|---|---|---|---|---|
| | **Frequency** | **%** | **Frequency** | **%** |
| **Age** | | | | |
| ≤29 | 0 | 0.00 | 0 | 0.00 |
| 30-39 | 0 | 0.00 | 3 | 7.50 |
| 40-49 | 2 | 5.00 | 11 | 27.50 |
| 50-59 | 10 | 25.50 | 11 | 27.50 |
| ≥60 | 28 | 70.00 | 15 | 37.50 |
| **Mean** | 62.25 | | 56.13 | |
| **Level of education** | | | | |
| ≤ 5 | 15 | 37.50 | 3 | 7.50 |
| 6-10 | 13 | 32.50 | 12 | 30.00 |
| 11-15 | 8 | 20.00 | 16 | 40.00 |
| ≥ 16 | 4 | 10.00 | 9 | 22.50 |
| **Mean** | 7.32 | | 11.53 | |
| **Household size** | | | | |
| 1-4 | 9 | 22.50 | 15 | 37.50 |
| 5-8 | 25 | 62.50 | 22 | 55.00 |
| ≥9 | 6 | 15.00 | 3 | 7.50 |
| **Mean** | 6.18 | | 5.48 | |
| **Farm size** | | | | |
| ≤ 1.00 | 40 | 100.00 | 24 | 60.00 |
| 1.01-1.99 | 0 | 0.00 | 7 | 17.50 |
| 2.01-2.99 | 0 | 0.00 | 3 | 7.50 |
| 3.01- 3.99 | 0 | 0.00 | 2 | 5.00 |
| ≥ 4.01 | 0 | 0.00 | 4 | 10.00 |
| **Mean** | 0.16 | | 1.27 | |

**Source: Field survey, 2019**

**Table 1b: Farm Income of farmers from OAZ and UAZ**

| Variables | Mean | Mean Difference | Standard deviation |
|---|---|---|---|
| **OAZ** | 335843.6250 | | |
| | | 16820.30000 | 93086.32889 |
| **UAZ** | 319023.3250 | | |

**Source: Field survey, 2019**

**Determinants of farm income among farmers in Ohafia and Umuahia Agricultural Zones**

The regression results of the determinants of farm income among farmers in OAZ are shown in Table 2. The double-log (Cobb- Douglas) model was chosen as the lead equation based on the magnitude of the coefficient of multiple determination ($R^2$), the number of significant variables, the F-ratio and the signs of the regression coefficients as they conform to a priori expectation. The result showed that the independent variables included in the model accounted for about 71% of the variation in the dependent variable (farm income). The coefficients of sex, level of education, labour and value of planting materials were significant determinants of farm income. The coefficients for sex of the farmer and labour were positive, while the level of education and value of planting materials were negative determinants of farm income. These results imply that farm income was higher for male farmers than for female farmers and that farm income increased as labour increased. The use of more labour presupposes the use of more of other inputs and this will probably and positively influence output and hence farm income. This result is supported by the result in Table 1a which showed that farmers in OAZ probably had access to more family labour due to their large households. Farm income decreased as the level of education of the farmers increased. This does not conform to *a priori* expectation and may suggest that as the level of education increased, the farmers engaged more in other non-farm occupations which adversely affected farm income. Farm income decreased as value (cost) of planting materials increased. The higher the cost of planting material, the lower the quantity that the farmers can buy and use, and this will adversely affect output and consequently farm income.

**Table 2: Determinants of farm income of farmers in OAZ**

| Variables | Linear | Double log+ | Semi-log | Exponential |
|---|---|---|---|---|
| **Constant** | 252035.313 | 16.500 | 2997752.337 | 11.583 |
| | (0.937) | (4.508)*** | (2.614)** | (14.101)*** |
| **Age ($x_1$)** | 3060.685 | -0.018 | -157064.794 | 0.015 |
| | (0.750) | (-0.026) | (-0.731) | (1.171) |
| **Level of education ($x_2$)** | -22658.801 | -0.778 | -290876.292 | -0.063 |
| | (-2.524)** | (-3.982)*** | (-4.749)*** | (-2.310)* |
| **Farm size($x_3$)** | 27969.236 | -0.219 | -70837.147 | 0.006 |
| | (0.084) | (-1.648) | (-1.704)* | (0.006) |
| **Sex ($x_4$)** | 324075.915 | 1.158 | 357141.667 | 1.068 |
| | (4.390)*** | (5.915)*** | (5.824)*** | (4.739)*** |
| **Labour ($x_5$)** | 31.439 | 0.178 | 64737.855 | 0.000 |
| | (0.671) | (2.046)* | (2.375)** | (0.708) |
| **Value of planting materials ($x_6$)** | -3.553 | -0.355 | -116102.286 | -1.036E-005 |
| | (-2.189)* | (-3.089)*** | (-3.226)*** | (-2.090)* |
| **Value of fertilizer($x_7$)** | -1.186 | -0.117 | -104594.033 | 2.406E-006 |
| | (-0.630) | (-0.728) | (-2.076)* | (0.418) |
| **$R^2$** | 0.576 | 0.708 | 0.689 | 0.636 |
| **$R^{-2}$** | 0.483 | 0.645 | 0.621 | 0.556 |
| **F – ratio** | 6.206*** | 11.107*** | 10.134*** | 7.977*** |

**Source: field survey 2019 Figures in parentheses are t-ratios, *** = significant at 1%;** = significant at 5%;**

*** = significant at 10%, + = lead equation**

The regression result of the determinants of the farm income of farmers in UAZ is shown in Table 3. On the basis of the magnitude of the coefficient of multiple determination ($R^2$), the number of significant variables, the F-ratio and the signs of the regression coefficients as they conform to a priori expectation, the linear model was chosen as the lead equation and used for further discussion. The independent variables included in the model accounted for 81% of the variation in the dependent variable (farm income). The coefficients of age and level of education of the farmer, farm size (land holding) and labour were the significant factors that influenced the farm income of farmers in UAZ. The age of the farmer was negatively related to farm income indicating that farm income increased as the age of the farmer decreased. Younger farmers are likely to be less conservative and less risk averse and as a result be in a better position to adopt and use improved technologies that lead to an increase in output and consequently an increase in farm income. Studies have shown that older farmers are less productive (Onyewuchi and Ezebuike 2016; Ibekwe *et al*., 2010). The level of education of the farmer was negatively related to farm income . This implies that farm income decreased as the level of education of the farmer increased. This is as explained earlier in relation to the farm income of farmers in OAZ. Farm size was positively related to the farm income of farmers, indicating that farm income increased as farm size (land holding) increased. The larger the farm size, the more the farmer's investment. The more the investments on the farm, the greater the scale of production, and the higher the output, and farm income.

The study of Parvin and Akteruzzaman (2012) supports this result. This result is supported by the data in Table 1a which showed that farmers in UAZ had larger holdings than farmers in OAZ. Farm labour was positively related to farm income, indicating that farm income increased as labour increased. This is as explained earlier in relation to OAZ. Obike *et al*., (2017), also reported a positive relationship between labour and farm income.

**Table 3: Determinants of farm income of farmers in Umuahia agricultural zones**

| Variables | Linear+ | Double log | Semi-log | Exponential |
|---|---|---|---|---|
| **Constant** | 479912.272 | 14.457 | 4573316.211 | 10.920 |
| | (1.665) | (3.714)*** | (2.208)* | (11.528)*** |
| **Age ($x_1$)** | -7589.276 | -0.577 | -1024093.946 | 0.002 |
| | (-1.916)* | (-0.772) | (-2.575)** | (0.188) |
| **Level of education ($x_2$)** | -22738.113 | -0.036 | -255998.140 | -0.020 |
| | (-2.102)* | (-0.092) | (-1.234) | (-0.560) |
| **Farm size($x_3$)** | 200643.090 | 0.725 | 219559.844 | 0.587 |
| | (4.143)*** | (4.122)*** | (2.345)** | (3.692)*** |
| **Sex ($x_4$)** | 169957.889 | 0.321 | 259165.649 | 0.310 |
| | (1.564) | (1.071) | (1.628) | (0.868) |
| **Labour ($x_5$)** | 2539.674 | -0.007 | 221216.687 | 0.001 |
| | (4.214)*** | (-0.039) | (2.344)** | (0.409) |
| **Value of planting materials ($x_6$)** | -1.382 | 0.002 | -47721.945 | -4.639E-007 |
| | (-0.913) | (0.015) | (-0.571) | (-0.093) |
| **Value of fertilizer($x_7$)** | -0.262 | 0.066 | 27165.057 | -1.021E-005 |
| | (-0.047) | (1.034) | (0.802) | (-0.557) |
| **$R^2$** | 0.814 | 0.664 | 0.510 | 0.611 |
| **$R^{-2}$** | 0.774 | 0.591 | 0.402 | 0.526 |
| **F – ratio** | 20.068*** | 9.037*** | 4.752*** | 7.194*** |

**Source: Field survey, 2019**
**Figures in parentheses are t-ratios, *** = significant at 1%;** = significant at 5%;**
*** = significant at 10%, + = lead equation**

**Impact of Spatial Difference on Farm Income of Farmers in Ohafia and Umuahia Agricultural Zones**

The regression result of the impact of spatial difference on farm income of farmers in OAZ and UAZ is presented in Table 4. The linear model was chosen as the lead equation based on the econometric criteria earlier enumerated. The independent variables accounted for about 68% of the variation in the farm income of the farmers. The sex of the farmer, level of education, farm size, value of planting materials and the focus variable-location were significant determinants of the farm income among farmers in OAZ and UAZ. The sex of the farmer, farm size, and location were positive determinants, while the level of education of the farmers and the value of planting materials were negative determinants. These relationships have been explained earlier. The focus variable (location, as a proxy for spatial difference) was positively related to farm income indicating that farm income was higher for farmers in OAZ than for farmers in UAZ. OAZ is more rural than UAZ and probably produces more output than UAZ. The mean farm income of farmers in OAZ (₦335,843.63) compared with UAZ (₦319,023.33) provides empirical evidence of the higher income of farmers in Ohafia Zone.

**Table 4: Impact of spatial difference on the farm income of farmers in OAZ and UAZ**

| Variables | Linear+ | Double log | Semi-log | Exponential |
|---|---|---|---|---|
| **Constant** | 269214.694 | 14.253 | 3209006.288 | 10.776 |
| | (1.216) | (5.513)*** | (2.666)** | (17.336)*** |
| **Age ($x_1$)** | -4407.875 | -0.377 | -622259.101 | 0.004 |
| | (-1.387) | (-0.690) | (-2.444)** | (0.487) |
| **Level of education ($x_2$)** | -17078.534 | -0.257 | -133206.543 | -0.040 |
| | (-2.269)* | (-1.316) | (-1.466) | (-1.915)* |
| **Farm size($x_3$)** | 328251.631 | 0.445 | 136159.164 | 0.699 |
| | (10.803)*** | (3.895)*** | (2.563)** | (8.192)*** |
| **Sex ($x_4$)** | 326403.073 | 0.698 | 252292.053 | 0.715 |
| | (4.569)*** | (3.670)*** | (2.850)** | (3.567)*** |
| **Labour ($x_5$)** | 44.189 | 0.069 | 106911.724 | 0.000 |
| | (0.720) | (0.710) | (2.349)** | (0.675) |
| **Value of planting materials ($x_6$)** | -3.915 | -0.043 | -48574.035 | -3991E-006 |
| | (-3.487)*** | (-0.404) | (-0.985) | (-1.266) |
| **Value of fertilizer($x_7$)** | -0.556 | -0.039 | -10848.028 | 2.712E-006 |
| | (-0.236) | (-0.766) | (-0.457) | (0.410) |
| **Location** | 344962.678 | 1.181 | 76222.113 | 1.158 |
| | (3.770)*** | (3.204)*** | (0.444) | (4.509)*** |
| **$R^2$** | 0.675 | 0.589 | 0.411 | 0.613 |
| **$R^{-2}$** | 0.639 | 0.543 | 0.345 | 0.569 |
| **F – ratio** | 18.444*** | 12.724*** | 6.204*** | 14.047*** |

**Source: Field survey, 2019**
**Figures in parentheses are t-ratios;*** = significant at 1%;** = significant at 5%**
*** = significant at 10%, + = lead equation**

**Test for shifts in the coefficients and difference in the intercepts of the fitted equations**

Chows' test was used to determine if the coefficients of the fitted equations were equal. The residual sum of squares obtained from the double-log regression results of the determinants of farm income in OAZ, UAZ and OAZ and UAZ pooled together as presented in Tables 2, 3 and 4 respectively were used to compute Chows' F-statistic. The computed F* (chow) statistics was 6.32. With v1= 8 and v2 = 64 degrees of freedom, f0.05=2.09. This implies that F*> f. This indicates that the coefficients of the fitted equations are not equal indicating that location induced structural shifts in production parameters (Table 5). To test for differences in the intercepts, a dummy variable, location with the value zero for UAZ and unity for OAZ was introduced into the model for OAZ and UAZ pooled together as presented in Table 4. The residual sum of squares was obtained as shown in Table 8. The computed F*(chow) statistic was 12.724 showing that F* > f . This implies that the intercepts are heterogeneous that is, differ significantly indicating significant differences in farm income between the two (2) locations, that is the difference in the income of farmers in OAZ and UAZ is due to location.

**Table 5: ANOVA result of the determinants of farm income**

| **ANOVA result of the determinants of farm income in OAZ** | | | | |
|---|---|---|---|---|
| **Item** | **Sum of Squares** | **Degree of Freedom** | **Mean Square** | **F-ratio** |
| **Regression** | 20.373 | **7** | 2.910 | **11.107*** ** |
| **Residual** | 8.385 | 32 | 0.262 | |
| **Total** | 28.758 | **39** | | |
| **ANOVA result of the determinants of farm income in UAZ** | | | | |
| **Regression** | 47.438 | **7** | 6.777 | 9.037*** |
| **Residual** | 23.998 | 32 | 0.750 | |
| **Total** | 71.437 | **39** | | |
| **ANOVA result of the determinants of farm income in OAZ and UAZ without location** | | | | |
| **Regression** | 57.820 | **7** | 8.260 | 11.584*** |
| **Residual** | 51.338 | 72 | 0.713 | |
| **Total** | 109.159 | **79** | | |
| **ANOVA result of the determinants of farm income in OAZ and UAZ with location** | | | | |
| **Regression** | 64.307 | **8** | 8.038 | 12.724*** |
| **Residual** | 44.852 | **71** | 0.632 | |
| **Total** | 109.159 | **79** | | |

**Conclusion**

In the light of the foregoing results, this study concluded that spatial difference was a significant driver of the farm income of farmers in Abia State and that the difference in the income of farmers in OAZ and UAZ was due to spatial difference (location). Other elements of spatial difference that significantly influenced the farm income of farmers included the level of education of the farmer, labour availability and land holding (farm size). It is recommended that policy makers should take into consideration spatial differences in the environment of agricultural production in the design, development and introduction of improved agricultural technologies and the planning and implementation of agricultural development programmes.

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