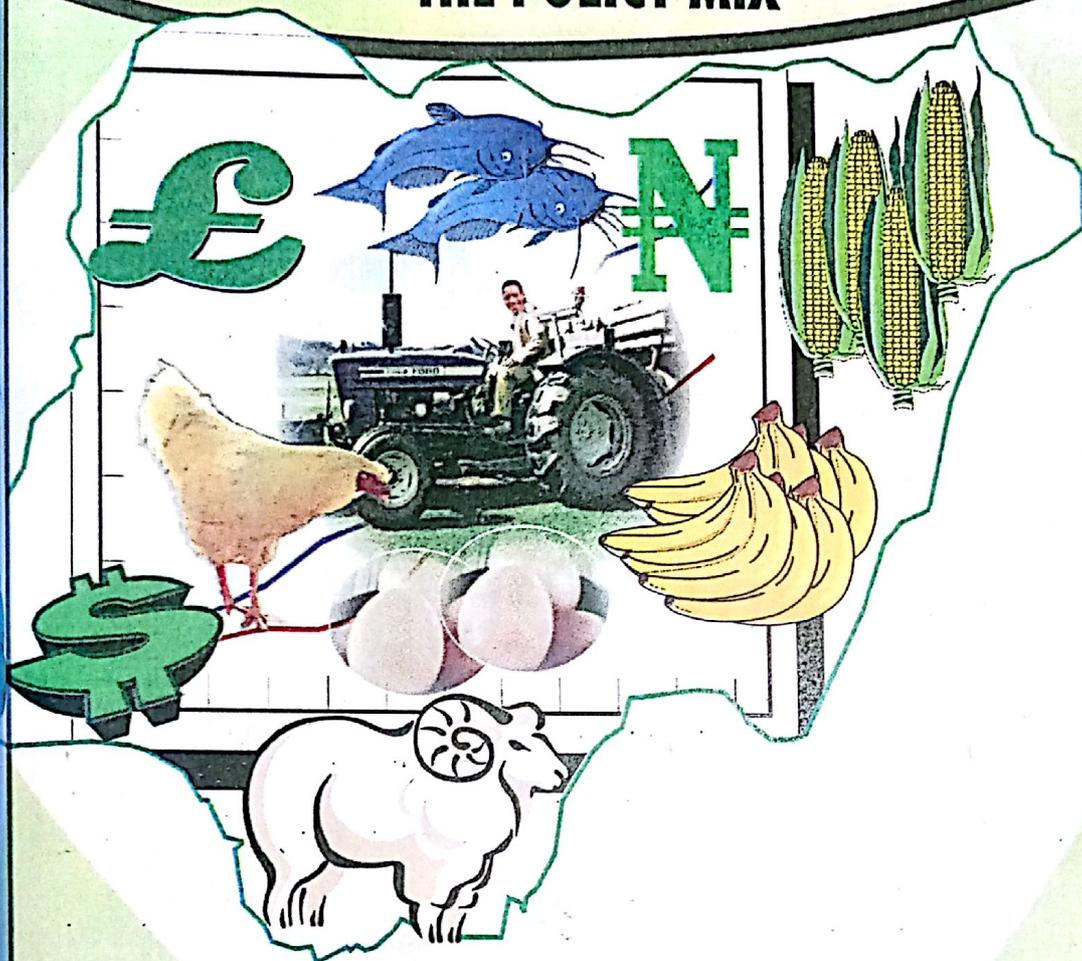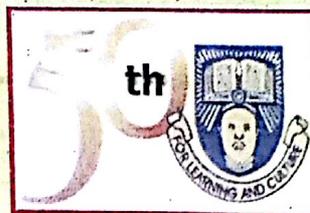# AGRICULTURE

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FARM SIZE AND NIGERIA AGRICULTURE: A META-ANALYSIS

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ABSTRACT

This study investigated the Meta factors that accentuate farm size over a nine year period (2003-2011) using data obtained from final year projects report in Department of Agricultural Economics and Extension Technology, Federal University of Technology, Minna. The model was estimated through OLS on four functional forms. The result indicated that the variation of farm size was not adequately captured by the model although studies conducted in Zone 1 of Niger State and average farm income were found to give a higher and significant increase in farm size while data year and number of observations used in the base research are found to reduce farm size significantly. Farmers in other zones of Niger State as well as other parts of Nigeria should strive towards larger farm size and move towards commercialisation.

Keywords: Meta-analysis, Box-Cox transformation, Data year

INTRODUCTION

Nigeria's economy is dominated by Agriculture which accounts for 41.59% of the Gross domestic product (National Bureau of statistics (NBS), 2011). Although the oil sector has become more dominant, agriculture still plays significant roles in economic development. It serves as a source of food for the ever growing population and raw materials for industries (Awotide and Agbola, 2010). Nigeria is endowed with enormous arable land which is a major factor of production and a key asset to the rural poor as they depend on it for their livelihoods, usually far more than people who are better off (Human Development Report (HDR), 2006). She also has a good coastal region, appreciable area of mangrove, and able bodied human resources capable of producing enough food for the country and even for export to other countries.

Nigeria has a total land area of about 98.3 million hectares out of which about 71.2 million hectares are cultivable but only about one third is presently in cultivation (Daramola, 2004). However, Agricultural land in Nigeria as reported by World Bank (2010) was 775,000km^2 and 745,000km^2 in 2008 and 2009 respectively. This shows there was a decrease in agricultural land by 4% during that period. The mere presence of land to cultivate has never been a serious problem of agricultural development. However, land availability for agricultural cultivation has posed a serious problem. Land availability for agricultural production involves a complexity of interacting variables such as population, land tenure system, level of technology and the stage of the country's development (Ojo and Afolabi, 2003). As a result of this, small holder farmers who operate a number of small and scattered farms dominate the agricultural sector (Kakwagh et al. 2011). They operate farm sizes of between 1 and 5 ha and therefore put the food import bill on the increase. What is more worrisome is that Nigeria may not be able to meet its food production and poverty reduction goals without a significant and sustainable production increase in the agricultural sector. Studies have shown that land being an important factor of production needs to be used wisely if agricultural output is to be increased. Kakwagh et al. (2011) examined the effect of land fragmentation on agricultural development and he found out that, small sized farms prevents farmers from producing large quantities and therefore hinders them from earning income that can satisfy their basic needs and also encourages idleness . Also Ojo (2010) is of the view that more lands should be opened up and used for large scale agricultural production instead of re-allocating land already in use by small scale farmers. To this end, there is a need to examine land use for agricultural purposes since agricultural output can be increased by either increasing the use of resources or adjusting the production system to be more efficient so as to make appropriate policies for agricultural development. This study will therefore provide answers to the following questions based on a meta-analysis of dataset covering a period of 9 years i.e. what is the average farm size cultivated in Nigeria during this period? Is there a difference in average farm size across zones and crops? What factors influence the size of farm lands put into Agricultural use in Nigeria? The broad objective of the study was to examine the trend of agricultural farm land by specifically describing the size of land used for agricultural production in Nigeria, examining the difference in farm size across crops and zones and determining the factors that influenced the size of farm lands put into agricultural use.

Meta-analysis has found relevance in present day economics as it is often used to make generalizations based on findings from existing literature. It involves the combination of findings from independent studies (Rosenthal

and DiMatteo 2001). Although, a major concern about meta-analyses is the extent to which they mix studies that are different in kind (heterogeneity).

Meta-regression is a technique which allows researchers to explore which type of study design factors contribute to heterogeneity (Borenstein et al. 2007). The simplest type of meta-regression uses summary data from each study to relate the size of effect to one or more characteristics of the studies involved. In other words, it explores sources of heterogeneity. Meta regression has some limitations which include bias introduced as a result of incomprehensive search strategy, publication assessment bias and failure to test for heterogeneity and putting it into consideration.

The above limitations can be overcome by carrying out a sensitivity analysis. This explores the ways in which the main findings are changed by varying the approach to aggregation. A good sensitivity analysis investigates the effect of excluding various categories of studies.

DATA SOURCE AND DESCRIPTION

The data used for this research was sourced from the final year research project of those who obtained B. Tech (Agriculture) Agricultural Economics and Extension Technology option at Federal University of Technology, Minna, Nigeria during the period 2003-2011. At least, 10 project reports were randomly selected per year and data was collected yielding an initial sample size of 100. However, only 43 of the sample were used in the final analysis because of missing data in many of the reports. All the sampled project reports employed cross-sectional data to achieve the stated objectives in their various studies. Table 1 contains the properties and summary statistics of variables used for the meta-regression analysis while the variables are adequately defined in equation 1. As shown on the table, the mean data year was 2007 with mean number of observations of 95 while the mean household size was 9 persons and mean age was 40 years. This implies that the study respondents were in their economic active age and should be able to involve in large scale production. Furthermore, with the number of persons in the household, household labour will be available for use in various production activities if provided with the necessary resources. Also shown on the table 1 is the fact that agricultural lands in Nigeria are used for the production of food crops, industrial crops and other enterprises such as animal farms, processing centres etc. However, the study revealed that lands were used mostly for food crop production though further analysis showed that there was no significant difference in farm size across enterprises.

MODEL SPECIFICATION

To achieve the objectives of the study, the following model was specified:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}) \qquad (1)$$

Where Y = average farm size in year t, t = 2003 -2011

$X_1 - X_5$ are continuous variables while $X_6 - X_{11}$ are dichotomous binary variables, the details of which are as follows:

X_1 = Year data was collected (2003 – 2011)
X_2 = number of observations per each dataset
X_3 = Average Farm Income per dataset in ₦
X_4 = Average house hold size per dataset
X_5 = Average age of the respondents
X_6 = Dummy (1 if data was collected in Niger state, 0 otherwise)
X_7 = Dummy (1 if data is collected in Zone 1 of Niger state, 0 otherwise)
X_8 = Dummy (1 if data is collected in Zone 2 of Niger state, 0 otherwise)
X_9 = Dummy (1 if data set is on food crop, 0 otherwise)
X_{10} = Dummy (1 if data set is on Industrial crop, 0 otherwise)
X_{11} = Dummy (1 if data set is on other enterprises, 0 otherwise)

To estimate parameters of equation 1, the data was analysed by trying it on the various forms of OLS, truncated regression as well as Box-Cox transformation technique (Box and Cox, 1964). Tobit regression was also tried when the data was censored at minimum average farm size. It was observed that the truncated regression in the present study was not robust as neither the χ_2 nor any of the estimated parameters were significantly different from zero. Although, in the case of Tobit regression, the χ^2 was significantly different from zero, the number of significant parameter estimates was not better than the log transformed OLS estimates. In addition, Box-Cox transformation only suggested that the linear form of this model is not very efficient and any of the log transformations (i.e. $\lambda = 0$) provided a more efficient and robust parameter estimates. All the estimations were achieved using Stata Statistical/Data analysis 11.2 software (Stata, 2009).

The coefficient estimates of the model is presented on Table 2 showing that double-log functional form gave the best fit with adjusted R^2 of 28.24% and F-ratio of 2.65 which was significant at 1% level. indicating that more than 50% of the variation in farm size over the period of the study is left uncounted for. This may be attributed to the large number of insignificant variables in the specified model or the sampling frame of the base research from where this dataset was obtained is not a true representation of the population under study since various model specifications were tried and the double log still returned the best estimates and the overall specification is significant at 1%. Perhaps this issue may be clearer when the contribution of individual parameters is discussed presently.

Of the eleven variables specified. Data Year, Number of observation. Zone 1. Average Farm Income were significant in explaining the variation in farm size in the period under study although the signs on Data Year and Number of observation were not according to a priori expectation. The estimates show that over time, a higher and significant average farm size is

Table 1 Summary statistics of all variable

variable name	storage type	display format	Obs	Mean	Std. Dev.	Min	Max
Data Year	int	%8.0g	43	2006.93	2.557858	2003	2011
2003							
2004							
2005							
2006							
2007							
2008							
2009							
2010							
2011							
Number of observation	int	%8.0g	43	95.39535	32.56798	40	170
Niger	byte	%8.0g	43	.4418605	.5024855	0	1
Zone 1	byte	%8.0g	43	.2790698	.4538503	0	1
Zone 2	byte	%8.0g	43	.3255814	.4741373	0	1
Food Crop	byte	%8.0g	43	.4418605	.5024855	0	1
Industrial Crop	byte	%8.0g	43	.0930233	.2939026	0	1
Other Enterprise	byte	%8.0g	43	0	0	0	0
Average Age of Respondent	float	%8.0g	43	39.76744	6.375501	25	60
Average Farm Income	float	%8.0g	43	49629.86	150763.1	2916	1006132
Average house hold size	byte	%8.0g	43	9.395349	4.354196	5	24
Average Farm Size	float	%8.0g	43	4.827209	8.502368	.2	45.3

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Variable	Type	Format	N	Mean	SD	Min	Max
Log of average farm Size	float	%8.0g	43	.9280936	1.038502	-1.609438	3.813307
Log of data Year	float	%8.0g	43	7.604361	.0012745	7.602401	7.606388
Log of number of Observations	float	%8.0g	43	4.500878	.3460525	3.688879	5.135798
Log of Niger	float	%8.0g	43	.3062743	.3482964	.0	.6931472
Log of Zone 1	float	%8.0g	43	.1934364	.314585	0	.6931472
Log of Zone 2	float	%8.0g	43	.2256758	.3286469	0	.6931472
Log of food Crop	float	%8.0g	43	.3062743	.3482964	0	.6931472
Log of industrial Crops	float	%8.0g	43	.0644788	.2037178	0	.6931472
Log of other Enterprises	byte	%8.0g	43	0	0	0	0
Log of average Age	float	%8.0g	43	3.670902	.1574501	3.218876	4.094345
Log of average Farm income	float	%8.0g	43	9.991588	1.004784	7.977968	13.82162
Log of average house hold size	float	%8.0g	43	2.143446	.4410404	1.609438	3.178054

Table 2 Coefficient estimates of the various models

Variable name	Linear	Translog	Semilog	Double log
Data Year	-.1473896 (.4074345)	-.06816 (.0628489)	-1000.169 (1052.245)	-228.1192* (134.3165)
Number of observations	-.0529732 (.0295198)	-.0111686** (.0045536)	-9.190362*** (3.288165)	-1.32281*** (.4197262)
Niger	-.929073 (2.189901)	-.4819539 (.3378037)	-.9208976 (3.658577)	-.7388223 (.4670084)
Zone 1	2.081697 (2.864511)	.6926168 (.4418658)	7.530438 (4.754543)	1.328408** (.6069058)
Zone 2	2.920958 (2.726015)	.4824215 (.4205021)	4.556235 (4.780376)	.750406 (.6102034)
Food Crop	1.247657 (1.974416)	-.148071 (.304564)	-1.819067 (3.356448)	-.4882371 (.4284424)
Industrial Crop	-1.30372 (3.56706)	-.2811009 (.5502377)	-3.993127 (6.109141)	-.5098036 (.7798169)
Other Enterprise	(omitted)	(omitted)	(omitted)	(omitted)
Average Age of Respondent	.0176842 (.1564376)	.0200991 (.0241313)	8.498984 (8.333649)	1.624901 (1.06377)
Average Farm Income	.0000417***	2.84e-06***	5.333991***	.4839349***

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	(6.70e-06)	(1.03e-06)	(1.30283)	(.1663031)
Ave House Hold Size	.1314557 (.2654125)	.0079679 (.0409413)	1.67924 (3.106462)	.1253159 (.3965323)
Constant	300.1235 (817.9645)	137.7248 (126.1753)	7562.353 (7993.029)	1730.496* (1020.291)
F	5.75***	2.41**	3.19***	2.65**
Root MSE	5.8238	.89835	6.8921	.87976
Adjusted R^2	0.5308	0.2517	0.3429	0.2824
Sample	43	43	43	43

Note: values in parenthesis are standard errors while *P<.1 **P<.05 and ***P<.01

obtained when the dataset is from Zone 1 of Niger State in spite of the fact that only 37% of the 44% dataset from Niger Sate is from Zone 1. However, the entire Zone 1 is the world-bank assisted Bida Agricultural Development Project between 1975 and 1988. It is plausible to assert that the activities of the project must have impacted on the farmers to have larger farm size in consonance with their management capability and other associated socio-cultural and economic factors. Data from other states, i.e. 56%, though not significant, tend to have an inverse relationship with farm size in the period as attested by the coefficient (-.7388223).

The results on Table 2 also suggest that a higher and significant farm size correspond with increased average farm income of the respondents. The finding is very important as it is a direct measure of the efficiency and productivity of the farm lands. The indication here is that the income obtained from the farm is in direct proportion to the farm size, i.e. larger farm size tends to record higher farm income and vice versa. Increased farm size which reduces land fragmentation leads to increased income (Nwaru, 2004). Olomola (1988) and Ibekwe (2010) are also of the view that increase in farm size will lead to a significant increase in farm income since farmers with large farms are likely to enjoy economics of scale. The overall average farm size is 4.827209ha while the overall average farm income is ₦49,629.86 given an income of ₦10,281.27/ha. This conforms with Olawepo (2010) who found out that average farm income falls between ₦40,000 - ₦50,000 which he termed low. Farming has and still remains in the hands of small producers who according to Abubakar (2004) are farmers that cultivate less than 5 hectares of land. They actually see farming as part of life and not a business which has slowed down mechanisation and hence commercialisation. Finally, the estimates show that over time, a lower and significant farm size is obtained with Data Year and number of observations. The observed reduction in farm size over time can be attributed to a number of factors key of poor sampling procedure, low sample in relation to the population under study and errors in data collection. The results on whether there exist any differences with respect to farm size among food crops, industrial crops and other enterprises in Nigeria did not show any significant results.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, the study therefore concludes that an average Nigerian farmer operates on a small scale and the decision to cultivate small farm lands is influenced by the average farm income and the location of the farmer. Also, the year and nature of data collected plays a significant role in determining the farm size. The study thus recommends that efforts should be made to increase farm income by subsidizing farm inputs so as to encourage farmers to cultivate more lands and promote commercialization of agriculture. Furthermore, in carrying out researches, researchers should put in more efforts in order to minimize errors and ensure quality research that will enhance good and effective policies.

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