Determinants of agricultural intensification among crop farmers in Ikwuano Local Government Area of Abia State, Nigeria

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ABSTRACT

This study was designed to examine the determinants of agricultural intensification among crop farmers in Ikwuano Local Government Area of Abia State of Nigeria. Primary data, collected from a random sample of 70 crop farmers with structured questionnaire, were analysed by simple statistical tools and the multiple regression model. Results showed that farm output, number of soil management practices, farming experience, and years of education positively influenced agricultural intensification; while household size negatively influenced it. Farmers in the study area applied at least six soil management practices with bush fallowing, which has a mean of 5.15 years, taking the lead. Farm size was small, with a mean of 1.40 ha; while household size was large, with at least six persons. It was recommended that the farmers should be encouraged to use appropriate soil management practices,while appropriate educational facilities should be provided to further enhance human capacity building and skills acquisition by the farmers. Policies and programmes for counselling farm households on family planning, birth control measures, and soil conservation techniques were recommended.

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Introduction

Nigeria is an agrarian economy with over 70 per cent of its populace engaged partially or completely in one form of agricultural production or the other (FMARD, 2001). This is carried out by the rural farmers on smallholder bases, and their products constitute about 95 per cent of the total agricultural production in the country (World Bank, 2007). Nigeria has a land area of 98 million hectares, of which nearly three-quarters is arable (Olayide, 1980). This gave the impression that Nigeria has abundant land resources for agricultural development. Surplus land was considered to have played a significant role in food crop and export crop expansion (Eicher & Baker, 1970). However, recent developments and experiences have indicated that serious constraints are posed by land unavailability. For instance, FAO (1987) posited that a much smaller area of land is available for cultivation, leaving little room for agricultural expansion. As a result, great difficulties are being faced in producing enough food to sustain the present and future populations (Adedipe *et al.*, 1997), especially as the deleterious impact of land tenure insecurity on agricultural production heightens. This underpins the report from FMARD (2001) of a decrease in the total area of land cultivated in the country from 84,985 ha in 1981 to 71,900 ha in 1996.

Thus, Africa is often cited as the only developing region where agricultural output and yield growth are seriously lagging behind population growth (Savadogo, Reardon & Pietola, 1994; Islam 1995). Several daunting problems were associated with this. Nwaru (2004) observed that the problem of acute shortage of rural resources has been complicated by gross inefficiency in resource use. Moreover, the increasing pressure on available agricultural land indicates that expected increase in agricultural output could hardly be by land area expansion as much as from applying higher levels of entrepreneurship manifested in the optimal use of available farm production inputs. Hence, Effiong (2004) posited that population density, access to market and their interactions were the major forces for agricultural intensification. The World Bank (1992) observed that in developing countries like Nigeria, population doubles every 25 years while agricultural productivity has in fact declined from 1.9 to 1.5 per cent during the past 15 years. Pingali & Binswanger (1987) noted that factors such as shortened fallow periods, topography of land, soil fertility, access to farmland, and population pressure on a fixed land resource base are likely to promote several competitions for resources and drive agriculture progressively toward intensification.

Here, the intensification of agricultural production has been considered an appropriate path to agricultural growth in the face of the growing population (Negatu, 2005), and for meeting national food demands in the face of rapid urbanization (Hazell, 1995). This involves intensive use of land through forest clearing, encroachment into areas traditionally used as pasture land, and shortened fallow periods; thus, making external inputs necessary to maintain soil fertility (Okike *et al*., 2001). Therefore, agricultural intensification involves additional inputs of capital, labour, skills and other materials against land (Mefzner, 1982). It entails a multidimensional process of response to increasing population density, technological change, and commercialization. It is characterized by substitution of labour for land in the initial stages, and a shift from forest fallow, through bush and grassland fallow, to a more continuous cropping and systems of crop rotation complemented by soil improvement practices including green and animal manures and compost. These are followed by soil improvement and addition of yield-enhancing inputs such as chemical fertilizers, insecticides, use of draft animals or machinery to till the soil, and high-yielding seed varieties (Geertz, 1963; Boserup, 1965; Netting, 1968; Waddell, 1972; Pingali & Binswanger, 1987).

Therefore, the objective of this study was to examine the determinants of agricultural intensification among crop farmers in Ikwuano Local Government Area of Abia State. Among the strategies implemented by farming communities to improve their income is the intensification of agricultural production (Pape-Christiansen, 2001). The need to secure incomes that ensure the well-being of the growing rural and urban populations gives imperatives to the process. This study became relevant because of the observation from the World Bank (1992) that in developing countries like Nigeria, population doubles every 25 years, while agricultural productivity has in fact declined from 1.9 to 1.5 per cent during the past 15 years. This study sought for answers to the following questions: To what extent have the farmers responded to this existential problem through production process intensification? What are the factors that influence this? How are they adopting and using soil conservation practices, a concomitance of agricultural intensification?

Literature review

Agricultural intensification refers to any practice that increases agricultural productivity per unit of land area (Boserup, 1965). Intensive agricultural production could be expressed as increase in the use of inputs of labour or capital on a small landholding, for increasing the value of output per hectare (Tiffen, Mortimore &

Gichuki, 1994). The FAO (2004) observed that agricultural intensification entails an increase in agricultural production per unit of labour, land, time, fertilizer, seed, feed, or cash. The intensification process, in practice, results from: (i) an increase in the gross output in fixed proportions due to inputs expanding proportionately, without technical changes; (ii) a shift toward more valuable crops, or (iii) technical progress that raises land productivity (Carswell, 1997).

Agricultural intensification has often occurred in response to creating new markets after separating consumption and reproductive objectives from those relating to production. That is, they are stimulated by market incentives. Consequences of the intensification process can be an increased dependency of production processes on input and output markets, and on capital markets to facilitate related investments (Pape-Christiansen, 2001). For instance, Rosegrant & Binswanger (1994) reported that the development of markets for tradable water rights and collector well technologies found in parts of Pakistan and India improved access of land-poor farmers to irrigation who did not have the financial resources to invest on their own wells, or who did not have groundwater access on their land.

African agrarian systems have been characterized by a relative abundance of land and critical seasonal scarcities of labour. Reporting on population pressure, land use and productivity of agricultural systems in Northern Nigeria and Northern Benin Republic in West Africa, Freeman (1994) indicated that population increase and improved market access, shielded by improved technology and a favourable policy environment, are the two major driving forces of agricultural intensification. The result shows that the two determinants have different consequences for farmers' welfare, cropping patterns, intensity of purchased input use, and productivity of farm resources.

In population-driven agricultural intensification, household food security is a major concern because of the low crop yields. Household food security is not a major problem in market-driven agricultural intensification, because household food needs are met through either high yield in crop production or food purchases. The major concern in these areas is to attain a modest increase in crop yields or sustain yield at current levels because of the potential problems associated with the physical deterioration of soils, which threatens the long-run farm productivity. In population-driven intensification, farmers have limited cash resources. So they are unlikely to adopt technologies that require high levels of purchased inputs, but rather technologies that permit modest yield increase without large amounts of external inputs. In a market-driven intensification, farmers will adopt technologies that require external inputs if they are profitable.

Research shows that when the opportunity cost of land is high, farmers have more incentives to invest in technologies that maintain soil productivity (Smith *et al.*, 1994). When the returns to land is low, farmers may be unable to invest in technologies that maintain soil productivity, although they may be aware of the negative impact of soil degradation on crop productivity (Barbier, 1990). Thus, the relationships between farm resources, agronomic production systems, and investment behaviour of farmers are important determinants of farm profitability and long-run sustainability of agricultural production systems under different soil and land management practices.

Land use intensity, which measures the allowance farmers give their farmland to fallow, is a widely used indicator of agricultural intensification (Ruthenberg, 1980; Okike *et al.*, 2001). Okike *et al.* (2001) noted that labour use intensity, manure use intensity, fertilizer use intensity, and intensity of animal traction are other indicators that could be used. Oyekale (2007) observed that some Nigerian farmers resorted to continuous cropping as family size increased and agricultural land became increasingly scarce.

Three factors that influence land use intensity are user's rights on land, farm yields, and access to farmland (Osemeobo, 1993). However, the measure of land use intensity is reflected in cropping period, fallow period, and farming systems adopted. Osemeobo (1993), using the expression by Ruthenberg (1980), reported that between 1989 and 1990, land use intensity in Edo and Ogun States of Nigeria was 16 per cent for the rainforest zone (Ogun) and 14 per cent for the savanna zone (Edo). This implied that 86 per cent of farmland in the savanna zone was under fallow and could be converted into productive use. Osemeobo (1993) further reported that the length of fallow, which reflected the rate of natural regeneration of the land, varied between 4 and 5 years in the savanna zone.

The induced innovation concept of Boserup (1965) asserts that increasing population stimulates increasing demand for agricultural products. As land becomes more costly compared to labour, the incentives for more intensive agricultural production systems emerge. In those parts of Africa where some unexploited virgin bush still exist, land use per household can be varied. The economic optimum policy is to operate an extensive system with a large land: labour ratio. This would imply low labour inputs and, hence, low yield per hectare. For instance, under the long fallow, shifting once all available land is in use as part of crop rotation, increased labour inputs must mean intensifying the system of land use to produce more per hectare.

Materials and methods

This study was carried out in Ikwuano Local Government Area (LGA) of Abia State of Nigeria. The LGA has a land area of 600 km^2 with a population of 60,000 people, according to the 1991 census. It is surrounded by Bende and Umuahia LGAs in the North, Isiala Ngwa LGA in the West, Ikoro and Obot Akara LGAs of Akwa-Ibom State in the East, and Cross River State in the South. It lies between longitudes 7°32' East and latitude 5°28' North. It is 122 m above sea level. Ikwuano LGA comprises four autonomous communities, namely Oboro, Ibere, Oloko and Ariam. Farming is the main occupation of the people. The soils are fertile, which often makes the use of fertilizers secondary. The food crops grown by the people include cassava, yam, cocoyam, maize, beans, rice, melon and various vegetables; while cash crops grown include cocoa, oil palm, raffia palm, kola nut, orange, plantain, and banana. Additionally, various kinds of livestock are raised by the people.

The Oboro Autonomous Community was purposively selected because arable crops are grown. A multi-stage random sampling technique was used to select 70 arable crop farmers. The list of villages in the Oboro Autonomous Community was collected from Ikwuano LGA. The list formed the sampling frame for the random selection of seven villages: Umuariaga, Umudike, Amaoba-Ime, Awom na ebo, Oru-gwe, Oru-Oboro, and Agbolo-ozu. For each selected village, the list of farmers was collected from the respective village heads. These formed the sampling frame for the random selection of 10 farmers, giving a total sample size of 70 farmers. Data were generated with structured questionnaire that was administered on the respondents. Attempts were made to elicit information from the respondents on the relevant parameters that determine agricultural intensification such as sex, occupation, household size, level of education, farm size, fallow period, and yield.

Data were analyzed using descriptive statistical tools such as frequencies, percentages, and the multiple regression analysis in which the dependent variable was taken as land use intensity used as a proxy for agricultural intensification (Ruthenberg, 1980; Okike *et al*., 2001):

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, e_i) \quad (1)$$

where Y is agricultural intensification proxied by land use intensity = C/L × 100/1 (Ruthenberg, 1980); C is cropping years on land; L is length of cycle of land cultivation (i.e. cropping years plus fallow year); X_1 is the output which was measured in kg ha^{-1}; X_2 is the number of soil management practices used by the farmer; X_3 is the farming experience in years; X_4 is the years of formal education; X_5 is the age of the farmer in years; X_6 is the household size measured by number of people living with the respondents; and e_i is the error term that follows the assumptions of the classical linear regression model. Four functional forms of Equation (1), namely linear, double-log (Cobb-Douglas), semi-log and exponential, were tried and that with the best fit was chosen as the lead equation.

Results and discussion

Table 1 presents a summary of some socio-economic characteristics and agronomic practices of the respondents. Following Ruthenberg (1980), agricultural land use intensity ranges from 13.70 to 93.10 per cent, with a mean of 48.10 per cent. This implies that on the average, 61.90 per cent of land in Ikwuano LGA was under fallow and could be converted into productive use; or is waste-land and could be recovered through land reclamation. The result is at variance with Osemeobo (1993), who reported that between 1989 and 1990, land use intensity in Edo and Ogun States of Nigeria was 16 per cent for the rainforest zone (Ogun State), and 14 per cent for the savanna zone (Edo State).

Table 1 further shows that fallow period (years), which reflected the rate of natural regeneration of the land, ranged from 1.70 to 20.00 with a mean of 5.15 years. This is comparable to what Osemeobo (1993) further reported, that the length of fallow varied between 4 and 5 years in Edo and Ogun States of Nigeria.

The number of soil management practices ranges from 6.00 to 11.00, with a mean of 7.70. Ogbonna (2004) opined that applying soil conservation technologies such as alley cropping, minimum tillage, mulching, and manuring is the only solution to soil degradation problems when fragile and highly susceptible lands are brought under cultivation. Farm size

TABLE 1

Summary Statistics of Sample Farmers

Variable	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Index of intensity	48.10	22.62	13.70	93.10
Investment on soil management practices (N ha^{-1})	14165.40	4044.51	7040.00	22000.00
No. of soil management practices	7.70	1.36	6.00	11.00
Output/hectare (kg ha^{-1})	220.50	69.36	62.35	390.91
Farming experience in years	24.97	3.57	2.00	60.00
Period of education (years)	9.09	4.92	2.00	17.00
Fallow period (years)	5.15	2.53	1.70	20.00
Farm size (ha)	1.40	0.40	0.60	2.00
Distance of home to farm (km)	4.07	1.94	1.00	9.00
Age of the farmer (years)	52.70	13.90	24.00	86.00
Household size	6.79	2.21	1.00	11.00
Total income (N)	366526.20	108494.30	11000.00	9298220.00
Amount spent on labour (N)	7659.29	1779.03	4500.00	12400.00
Years of continuously cropping	5.73	4.91	1.00	27.00

Source: Summarised from survey data, 2007.

ranges from 0.60 to 2.00 ha, with a mean of 1.40 ha. This conforms to earlier reports that farms in Nigeria are largely small-scaled and generally less than 5.00 ha. For instance, Nwaru (1993) reported that the average farm size for cooperative and non-cooperative farms in Imo State of Nigeria was 2.03 and 2.37 ha respectively. Nwaru & Ekumankama (1999) reported that women operated farms averaged 1.47 ha, while men operated farms averaged 2.15 ha.

Table 2 presents a summary of the estimated determinants of agricultural intensification. The linear functional form was chosen as the lead equation, based on the value of R^2, F-ratio and conformity of signs of the coefficients to *a priori* expectations. The F-ratio is statistically significant at 1 per cent, indicating that the estimated model is adequate for use in further analysis. The regression result shows R^2 value of 0.4715, indicating that 47.15 per cent of the total change in agricultural intensification is explained by output, soil management practices, farming experience, years of education and age, and household size of the farmer.

Output (measured in kg ha^{-1}) has a coefficient that is highly significant (at 1%) and positive. Given a non-decreasing unit output price, this implies that as output increases, farm income per hectare increases, leading to increased intensification of the agricultural production systems. Farm and family income is defined as the residual benefit of family resource inputs like labour, capital and land (Pape-Christiansen, 2001). The residual benefit is an expression of the efficiency of resource use. Therefore, it could be concluded that farmers who are more efficient in using the core resources in the rural economy, namely land and labour and perhaps capital, tend

TABLE 2

Determinants of Agricultural Intensification

Variable	*Linear*$^+$	*Exponential*	*Semi-log*	*Double log*
Intercept	3.157 (6.85)***	3.155 (6.36)***	3.237 (7.29)***	2.665 (1.81)*
Output (kg ha^{-1})	0.019 (3.24)***	-0.001 (-0.42)	0.757 (2.80)**	-0.457 (-3.27)***
Soil management practices	18.157 (2.92)**	-0.008 (-0.21)	-6.728 (-0.50)	-0.087 (-0.31)
Farming experience	0.774 (2.80) **	0.015 (3.29)**	17.947 (2.83)**	0.481 (3.59)***
Years of education	0.476 (3.61) ***	18.157 (2.92)**	-0.663 (2.60)**	-0.010 (-0.12)
Age	-0.113 (-0.41)	0.001 (0.25)	-2.548 (2.50)**	1.942 (1.73)*
Household size	-1.245 (-1.81) *	0.019 (0.73)	-2.518 (-0.47)	-0.064 (-0.56)
R^2	0.4715	0.3423	0.3858	0.3744
R^{-2}	0.3791	0.2796	0.2673	0.3148
F-ratio	5.10***	4.49***	4.70***	6.28***

Source: Field survey, 2007. + = Lead equation. Figures in parenthesis are the t-ratios
***, ** and * = Significant at 1, 5 and 10% test levels.

to practice intensification of their crop production systems more. For instance, Pape-Christiansen (2001) reported a strong positive correlation between irrigated crop production and farm income, while rainfed crop production showed no significant correlation with farm income.

Increasing the intensity of land use, without a corresponding improvement of the systems for restoring soil nutrients, may result in declining soil fertility; and ultimately, loss of soil structure and soil erosion. Therefore, a concomitance of agricultural intensification is the adoption and use of soil conservation practices. Investment in soil management practices has a coefficient that is statistically significant at 5 per cent and positive, implying that farmers who practice agricultural intensification must invest more in soil management practices. Application of soil management practices improves soil fertility, leading to higher output. Ogbonna (2004) opined that applying soil conservation technologies such as alley cropping, minimum tillage, mulching, and manuring is the only solution to soil degradation problems when fragile and highly susceptible lands are brought under intensive cultivation. Farmers in the area showed proper knowledge of this. Hence, the number of soil management practices they used ranged from 5 to 11 with a mean of 7.70; while the concomitant expenditure on soil management practices ranged from N7040.00 to N22000.00, with a mean of N14,165.40 ha^{-1} (Table 1).

Farming experience was statistically significant at 5 per cent and positive, implying that experienced farmers practice agricultural intensification more. Nwaru (2004) opined that experience is the knowledge and skill gained by contact with facts and events. The number of years a farmer has spent on the business of farming may indicate the practical knowledge he has acquired (Olomola, 1988), which would reflect on a higher level of agricultural intensification by the farmer. Therefore, policies to boost food production in high population rural economies and curb the deleterious effects of agricultural intensification on the environment should be targeted more at the experienced farmers.

Years of education has a coefficient that is highly significant (at 1%) and positive, indicating that education is directly related to agricultural intensification. The result agrees with *a priori* expectations that education enhances the farmers' ability to understand and evaluate new production techniques, and is consistent with the results of Onu, Amaza & Okunmadewa (2000) and Nwaru (2007). Moreover, Jaja, Chukwuigwe & Ekine (1998) and Nwaru & Iheke (2010) viewed education and training as being of utmost importance in any attempt to enhance farmers' ability to understand and accept technological innovations in economic activities, which would ultimately lead to increased and sustainable agricultural production. A more intensive market-oriented production would require special management and marketing skills (Pape-Christiansen, 2001), which higher and more appropriate education offers. However, Azhar (1991) and Bravo-Ureta & Evenson (1994) contend that elementary education (4-5 years of formal schooling) does not have much effect on agricultural productivity. Results from Antiporta (1978) and Cotlear (1986) agree with the assertion.

Agricultural labour demand is usually met through available family labour resources and hired permanent and seasonal labour. Large household size should ease labour constraints on the farm, thereby leading to increases in productivity and income of the farm household. Variations in household size and composition result in different labour capacities available to meet household labour requirements (Pape-Christiansen, 2001). The coefficient for household size was found to be statistically significant at 10 per cent and negative, reflecting an inverse relationship with agricultural intensification. The result is consistent with that of Nwaru (2007), who suggested that male-headed households might have used household labour beyond the point at which the marginal value product of labour was equal to the wage rate. Moreover, given the weak financial position of the farmers arising from their poor initial resource endowment and stagnating production and incomes (Nwaru, 2004), additional membership to the household would pose a stiff competition for resources that could have been channelled to manage agricultural intensification.

A concomitance of agricultural intensification is the use of appropriate soil conservation practices for maintaining soil structure, restoring soil fertility, and checking soil erosion. Table 3 shows that a total of 11 soil management practices were used by the farmers. Bush fallow was used as a major soil management practice by 97.1 per cent of the respondents, although the mean fallow period was 5 years (Table 1). The next most frequently used soil management technique was adequate tillage, with over 92 per cent of farmers applying it. That was followed by planting seeds at shallow depths; 90 per cent of the farmers applied it. The result agrees with that of Ruerd & Lee (2000) who reported that high cost of inorganic fertilizers and other agrochemicals often drives farmers to rely on locally available resources instead of purchased, externally produced inputs. They opined that low external input agriculture (LEIA) has spread rapidly to different parts of the globe as a challenging alternative; or, more frequently, a complement to Green Revolution technologies. The LEIA farming typically relies on cover crops, animal manure, and improved fallow management to maintain soil organic matter content; uses conservation measures (terraces, windbreaks, hedges, alley cropping, etc.) to control soil erosion; and applies cultivation methods (contour farming, minimum tillage, integrated pest management) to enhance environmental outcomes while contributing to household food security (Ruerd & Lee, 2000). Other identified soil management practices, in a decreasing order of importance, are planting two to four seeds, crop rotation, and organic manure; providing adequate drainage; applying crop residues and inorganic fertilizer; mulching, and

TABLE 3

Distribution of Respondents According to Soil Management Practices Used

Soil management practice	*Frequency*	*Percentage*
Planting seeds at shallow depths	63	90.0
Mulching	10	14.3
Applying crop residues	24	34.3
Keeping the soil moist	6	8.6
Planting two to four seeds	60	85.7
Providing adequate drainage	27	38.6
Organic manure application	41	58.6
Inorganic fertilizer application	20	28.6
Crop rotation	49	70.0
Bush fallowing	68	97.1
Adequate tillage	65	92.9
Total	433	618.7*

Source: Field survey, 2007
* Total of percentage exceeds 100, indicating that respondents gave multiple responses

keeping the soil moist. Mortimore (1992) stressed that land use intensification in most farming systems involves substituting manure for fallow as the principal means for maintaining soil fertility.

Conclusion

This study indicates that farm size was small, with a mean of 1.40 ha; while household size was large, with at least six persons. Fallow period, which reflected the rate of natural regeneration of the land, ranged from 1.70 to 20.00 with a mean of 5.15 years. The farmers applied at least six soil management practices, with bush fallowing being usually applied. Farm output, soil management practices, farming experience, and years of education positively influenced agricultural intensification; while household size adversely influenced it.

Appropriate economic policies are needed to refocus the farmers in agricultural intensification. Policies on functional educational facilities should be provided to further enhance human capacity building and acquisition of skills by the farmers. Through appropriate policies for land consolidation and redistribution, the farmers should be encouraged to make optimal use of their land resources, especially in the face of rising population pressure. Given that the mean rate of natural regeneration of the land is low, soil fertility augmentation measures should be seriously enhanced. This would require appropriate policies for optimum investment in soil management practices such as organic manuring, providing adequate drainage, applying inorganic fertilizers, and mulching. Government policies and programmes, and programmes of non-governmental organizations and local institutions should work toward checking rising household size, especially in the rural economy. Such policies and programmes should give prominence to mass literacy and counselling on birth control measures and family planning.

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