

*Review articles***EFFECT OF ROAD INFRASTRUCTURE ON AGRICULTURAL OUTPUT AND INCOME OF RURAL HOUSEHOLDS IN DELTA STATE, NIGERIA**

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Abstract

Using household agricultural production and income data from 288 rural dwellers, the paper examined the effect of road infrastructural development on agricultural output and income of rural households in Delta State, Nigeria. The results indicate that rural roads have a significant positive effect on agricultural output, reduce transportation cost, stimulate demand for rural labour and improve rural income. Road quality instigated a strong positive response on output and income as a 10% improvement in road quality caused a 12% and 2.2% increase in agricultural output and total household income respectively. Furthermore, road infrastructure promotes inter-sectoral linkages between the agricultural and non-farm sector that enhances income diversification strategies among rural households. Since increase in the distance variable and poor road quality reduce household income, a policy thrust that will cut down distance to markets through investment in transport infrastructure should be pursued vigorously, by both the State and local government authorities in collaboration with the private sector, in order to reduce rural poverty and accelerate the process of rural transformation.

Key words: road infrastructure, agricultural output, rural households, agricultural and non-farm income, Delta State, Nigeria

INTRODUCTION

Rural infrastructure, comprising of rural roads, markets, irrigation systems, water supply, telecommunication facilities, health and educational facilities, are basic to quality of life in rural areas, and are important facilitators of economic growth and development (Ahmed and Donovan, 1992). According to Binswanger et al. (1993), investments in rural infrastructure have resulted in phenomenal growth in agricultural production and productivity, while rapid growth in agricultural productivity has led to a significant trickle down benefits for the rural poor (Fan et al., 2000). Developing countries in sub-Saharan Africa have also invested in the rural areas to boost agricultural production, improve rural incomes and the quality of life as well as to stem rural-urban drift.

Rural infrastructure plays a very significant role in accelerating agricultural production and product marketing. A good road network accelerates efficient delivery of farm inputs, reduce transport cost, and enhance spatial agricultural production and distribution. In addition to market infrastructure, good network of roads will expand the distribution of agricultural goods as well as open up additional opportunities for agricultural trade. According to Fan and Hazell (1999), improved marketing facilities contribute to the goal of agricultural development indirectly through an efficient marketing system. They noted that inefficiencies in processing, storing and transporting agricultural products cause loss of products and saving these commodities will increase the supply available for

consumption just as does an increase in production. Improvement in marketing facilities can also facilitate increased production largely through direct and indirect effects of higher producer prices.

The importance of rural transport infrastructure for agricultural growth and development has been well established in the literature. In a study in Bangladesh, Ahmed and Hossain (1990) found that in villages with better access to roads, fertilizer costs were 14 percent lower, wages were 12 percent higher and crop output was 32 percent higher. Also in a study in India, Fan et al. (2000), found that public investment in rural roads had a very high positive impact on agricultural productivity growth; while similar studies in China and Thailand by Fan et al. (2004), found road investments to have contributed significantly to non-farm income and overall agricultural growth.

The availability and quality of road infrastructure also influence access to trade and food prices in developing countries. Li mao and Venables (1999), in a study of transportation costs in sub-Saharan Africa showed that roads are significant determinants of transportation costs, and that when a region is landlocked, transport costs can increase by 50 percent. They reported that most of Africa's poor trade performance was the result of weak infrastructure. In a study on the effect of road infrastructure on food prices in the then Zaire (Congo Democratic Republic), Minten and Kyle (1999) found that transportation costs was responsible for observed differences in food prices among producer regions. They further asserted that road quality was an important factor in determining transportation costs; transportation

costs were on the average two times higher on dirt roads than on paved roads.

Apart from increased agricultural output, another way by which road infrastructure can help the rural poor is through their impact on the rural non-farm sector. Investments in rural roads will promote the development of small non-farm enterprises, which will stimulate demand for rural labour thereby improving income. Khandker (1989), found that government investment in roads had a positive effect on crop output, rural non-farm employment and agricultural wages, which benefited the poor in India. Similar findings were reported by Fana and Rao (2002) who explored the impact of roads on rural non-farm employment and the consequences for the poor. According to them, one of the important economic opportunities generated by road infrastructure in the rural areas is income diversification occasioned by a vibrant non-farm sector.

In Africa, rural road construction has also been found to be associated with increases in agricultural production, expanded use of agricultural credit, increases in land values, proliferation of small shops and expansion of rural markets (Anderson *et. al.*, 1982; Jacoby, 2000). Although, the social benefits of road construction in Nigeria are very well known, studies on the impact of rural roads on agricultural output and income are scarce.

However, given the increased budgetary allocation to States and Local Government Areas in the present democratic dispensation, and the massive roads infrastructure development undertaken by the Delta State Government since 1999, such an investigation becomes timely and pertinent.

The objective of the study therefore, is to examine the effect of rural roads on agricultural output and income of rural households in Delta State, Nigeria.

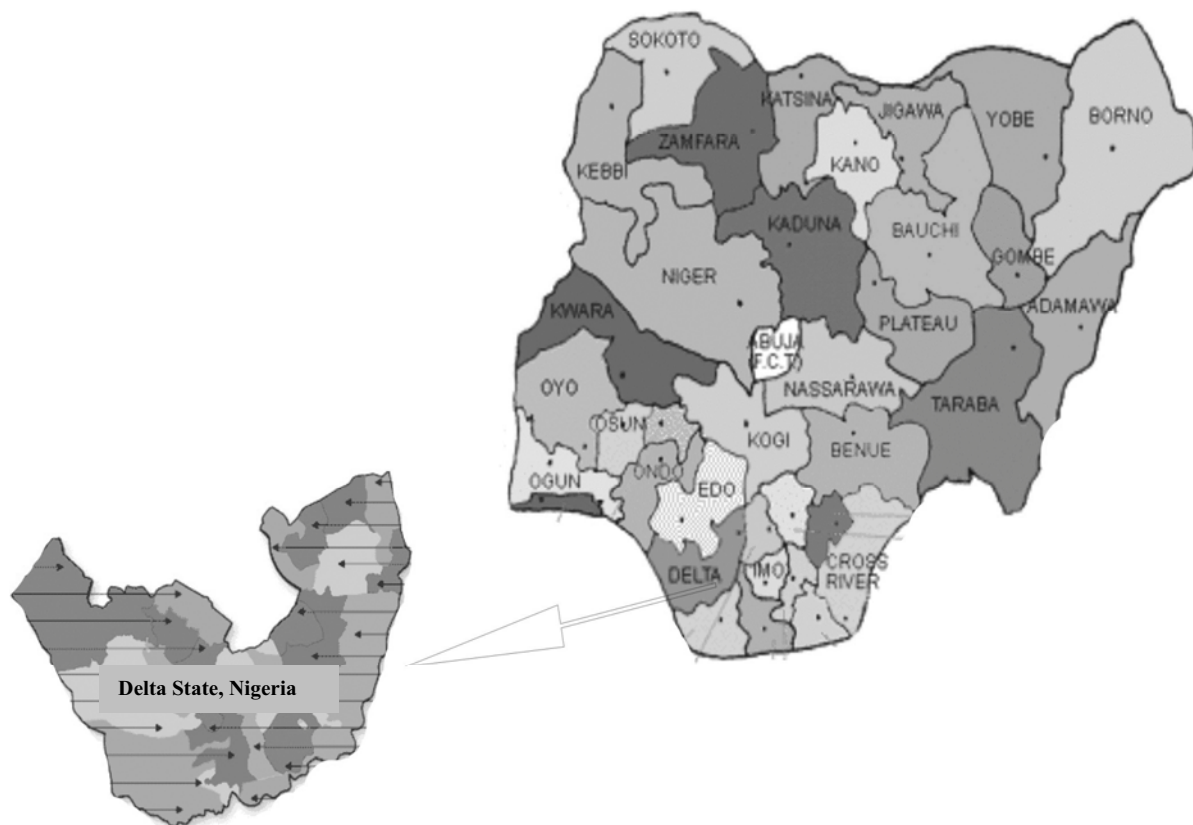
RESEARCH METHODOLOGY

Sampling methods and data collection

The study was restricted to 21 Local government Areas (LGAs) that have predominantly rural populations in Delta State, Nigeria (Figure 1).

Multi-stage random sampling technique was used to draw samples for the study. Firstly, the study area was stratified into three agricultural zones of Delta North, Delta Central and Delta South that comprised the State. From each of the three zones, 3 LGAs were randomly selected to give a total of 9 LGAs covered by the survey. The nine (9) LGAs were Aniocha North, Oshimili North and Ika North (in Delta North;

Figure 1: Map of Nigeria, showing Delta State, the location of the study



Ughelli South, Ethiope East and Udu in Delta Central; and Patani, Isoko North, and Isoko South in Delta South agricultural zone. Furthermore, 36 farmers were chosen randomly from each of the 9 LGAs to give a total sample size of 324 farmers from which relevant data were obtained. However, due to non-response and inadequate information supplied by some respondents, 36 copies of the questionnaire were discarded, and data analysis was based on a sample of 288 farmers.

In order to obtain data for the study, structured questionnaires were administered randomly to household heads and these were completed through interview schedules by the researchers. Data collected included agricultural output data, production input data, labour use, produce prices, availability of rural roads and markets, access to rural markets, distance to markets, road quality, sources and level of household income as well as household social characteristics. The survey was conducted between June and October, 2006.

Model specification and estimation

The following econometric models were specified and subsequently estimated in order to examine factors that determine output and income amongst rural households in Delta State, Nigeria.

$$OUPT = f(LAND, CAPT, DMKT, EDUC, HHSZ, RQTY, u) \tag{1}$$

Where:

OUPT = the volume of annual agricultural output of a particular household

LAND = the size of land holding

CAPT = other capital assets of a household

DMKT = mean distance from home to three major produce markets

EDUC = the level of education attained (no formal education = 1; primary school = 2; secondary school = 3; tertiary education = 4)

HHSZ = number of persons in workforce

RQTY = road quality (paved road = 3; non-paved all season road = 2; seasonal road = 1)

u = error term.

$$YINC = f(LAND, CAPT, LSTK, DMKT, EDUC, HHSZ, RQTY, u) \tag{2}$$

Where:

YINC = the total income of household per annum,

LSTK = livestock unit owned.

Other variables are as defined earlier in equation (1)

Economic theory does not indicate the precise mathematical form of the relationship among the variables, therefore different functional forms of the above model such as the linear, semi-logarithm, logarithm and exponential functions were fitted. However on the basis of economic, statistical, and econometric criteria, the exponential function was chosen as the lead equation for the output model, while

the logarithmic function was the lead equation for the income model. The linearised forms of the output and income models are as follows:

$$\ln OUPT = \psi + \beta_1 \ln LAND + \beta_2 \ln CAPT + \beta_3 \ln DMKT + \beta_4 \ln EDUC + \beta_5 \ln HHSZ + \beta_6 \ln RQTY \tag{1a}$$

$$\ln YINC = \zeta + \delta_1 \ln LAND + \delta_2 \ln CAPT + \delta_3 \ln LSTK + \delta_4 \ln DMKT + \delta_5 \ln EDUC + \delta_6 \ln HHSZ + \delta_7 \ln RQTY + v \tag{2a}$$

The Ordinary Least Squares (OLS) technique was used to estimate the relevant parameters.

RESULTS AND DISCUSSION

Socio-economic characteristics of households

The socio-economic characteristics of respondents in the survey are presented in Table 1. Agricultural production is the major occupation of most rural households in Nigeria, and women dominate smallholder production activities. Therefore, 68% of the respondents were women while 32% were men. According Chukwuji and Oyaide (2005), a good number of women in Delta State, Nigeria own and manage farms alongside men, beside their contribution to the productive farm labour force either as paid labourers or more importantly as unpaid helpers or co-managers of family farms.

The educational status showed that 34% of the rural dwellers had no formal education, while 64% of them had some form of formal education, a non-observation which tends to refute the alarming rate of illiteracy prevalent in rural communities. The mean level of educational attainment of 2.07 implied that on the average every respondent had primary education. A high level of educational attainment is expected to affect positively the productivity of rural dwellers, as educated farmers are more likely to adopt modern agricultural practices (Biswanger, 1989).

A relatively large household size was found in the study, with a mean size of 9 persons per household. About 67% of the households have a family size that ranged between 8–16 persons, thus supporting the preponderance of large family sizes among the poor in rural areas of Nigeria (Eboh, 1995). Although a very large family size may constitute a social burden, larger households use their labour input to an advantage in farming and forest products exploitation. In fact, the intensity of forest products exploitation has been found to have a direct relation to household size (Baland et al., 2004)

Crop output ranged between 420–4224 kg, with an average annual output of 2058.93 kg. Although crop production was low, it was also subject to great variability with a standard deviation of 1041.53. About 63% of the farmers had an annual output of 1181–3463 kg, while only 8% of them produced crops worth

Tab. 1: Distribution of socio-economic characteristics of rural households (n = 288)

Parameter	Frequency	Mean (Mode)	Standard deviation
Gender			
Female	195 (67.7)*	(Female)	0.4684
Male	93 (32.3)		
Educational status			
No formal education (1)	98 (34)	2.07	0.9477
Primary school (2)	95 (33)		
Secondary school (3)	73 (25.3)		
Tertiary education (4)	22 (7.6)		
Household size			
1–2	58 (20.1)	4 persons	2.0
3–4	107 (37.2)		
5–6	76 (26.4)		
7–8	42 (14.6)		
9–10	5 (1.7)		
Crop output(kg)			
420–1 180	78 (28.8)†	2 058.93	1 041.53
1 181–1 941	50 (18.5)		
1 942–2 702	57 (21.0)		
2 703–3 463	64 (23.6)		
3 464–4 224	22 (8.1)		
Annual income (N,=)			
19 000–51 000	139 (48.3)	71 023.65	19 172.71
51 001–83 001	38 (13.2)		
83 002–115 002	51 (17.7)		
15 003–147 003	54 (18.7)		
147 004–179 004	6 (2.1)		

* Figures in parentheses () are percentages of respondents

† Only 271 households earned income from crop production

Source: Computed from survey data, 2006

3 464–4 224 kg. The low level of crop output may be attributed to the small land-holding and the use of inefficient and traditional farming implements. With a mean farm size of 0.87 ha, which are fragmented in some cases, output is bound to be low.

The average annual income was found to be N,= 71 023.65 showing that majority of the rural dwellers are low income earners. In fact about 62% of the rural households sampled earned an annual income ranging between N,= 19 000.00–N,= 83 001.00. Because most rural inhabitants lack assets and skills, they remain unemployed and unable to invest in high income generating activities, thereby remaining poor. This and other factors could be implicated for the low average income found in the study.

Sources of income among households

Households in the study are earned on the average a total income of N,= 71 023.65 per annum with agricultural activities being the most important sources of income (Table 2). Income from agricultural self-employment and agricultural wage labour constituted

77% of total household income, while the balance of 23% was from non-agricultural activities. Comparable results were reported by Reardon et al. (1998) and Sanchez (2005) that about 35% of rural households income is accounted for by non-farm activities. Crop production appeared to be the most important source of income as it constituted 50% total household income, followed by non-agricultural self-employment (15%), and agricultural wage labour (12%). The incidence of poverty in Delta State, Nigeria is quite high (45.35%) National Bureau of Statistics (2005) and majority of rural dwellers lack skills and economic assets, thus they are unable to seek off-farm employment and take advantage of income-generating activities outside farming. The dominance of crop production as the major source of income among rural households in Delta State, Nigeria may be attributed to this. It should be noted that though only 84 respondents participated in non-agricultural wage labour in the study area, the mean income (N,= 20 293.91) from this activity is higher than that of agricultural wage labour where 178 rural dwellers were engaged. The percentage contributions of

other income-earning activities are as presented in Table 2.

Tab. 2: Sources of income among rural households in Delta State, Nigeria

Source	Amount (N,=)	Mean	% of total income	No. of respondents
Total household income (N,=)	20 454 810.55	71 023.65	100	288
Agricultural income – Self employment	13 292 642.17	47 643.88	65	279
Income from crop production	10 233 866.29	37 763.34	50	271
Income from livestock production	1 195 156.16	6 603.07	6	181
Income from forest products	1 863 619.85	11 946.28	9	156
Agricultural income – Wage labour	2 524 138.24	14 180.55	12	178
Non-agricultural income – Self employment	3 066 174.99	27 376.56	15	112
Non-agricultural income – Wage labour	1 704 688.63	20 293.91	8	84

Source: Computed from survey data, 2006.

Regression results

Agricultural output

The results of the regression analysis of the determinants of agricultural output among rural households in Delta State, Nigeria are presented in Table 3. Among four functional forms fitted, the exponential function was the lead equation with an adjusted R² value of 0.80, implying that the independent variables jointly explained 80% of the variation in the dependent variable (agricultural output). Although the Durbin-Watson statistic indicated some level of serial correlation of errors, the model was significant at the 99% confidence level. Apart from value of capital assets, the sign and size of the regression coefficients are reasonable and are in consonance with *a priori* expectations. The results revealed that land area cultivated, capital assets, distance to market, household size, and road quality were statistically significant determinants of agricultural output among rural dwellers. While the effect of distance to market was negative, other variables had positive influence on output.

Land is one of the critical inputs upon which crop production depends because it is on land that crops are grown. Although, there is no arithmetic relationship

between output and area cultivated, output is expected to increase the larger the land area put under cultivation. This is particularly so among rural small-holder farmers who rely mainly on traditional methods of farming due to lack of knowledge and credit to adopt modern technology of production. In such systems, increased output can only be brought about by increase in land area cultivated. However, the response of output to land is somewhat low as a 10% increase in area cultivated will cause only a 2% increase in output (Table 4). Because majority of rural households are small-scale, subsistent farmers, the lack of, and inadequate use of output-enhancing inputs such as fertilisers and pesticides, may have dampened output response to land area cultivated.

The impact of capital assets is also positive and significant implying that the more capital assets a household owns the greater the output of crop production will be. The physical and financial assets a family owns will enable her acquire the relevant inputs needed for increased crop production at the right time, in view of the seasonality of agricultural production. Thus households that have a high stock of assets to draw from will be able to expand output. This condition may have accounted for the positive effects of household assets on

Tab. 3: Regression results of determinants of agricultural output among rural households in Delta State, Nigeria

Variable	Estimated coefficient	t-statistic	p-value
Land area cultivated	0.21	3.27	0.00**
Value of other assets	0.00000086	2.02	0.05*
Distance to market	-0.08	-4.95	0.00**
Educational attainment	-0.03	-1.51	0.13
Household size	0.02	2.39	0.05*
Road quality	0.54	6.78	0.00**
Constant	6.20	6.1	0.00
F-statistic = 198.91 (0.00)**			
D-W statistic = 1.89			
Adjusted R-squared = 0.80			
n = 288			

**significant at less than 1% level; *significant at the 5% level

Source: authors' calculation

Tab. 4: Elasticity of agricultural output with respect to specified independent variables in Delta State Nigeria

Independent variable	Elasticity estimate
Land area cultivated	0.19 [†]
Value of other assets	0.05 [†]
Distance to market	-0.21 [†]
Educational attainment	-0.06
Household size	0.09 [†]
Road quality	1.21 [†]

[†] Variables that had statistically significant effects on output

Source: authors' calculation

agricultural output found in the study. The elasticity of agricultural output with respect to household assets was very low, as a 10% increase in value of assets will result in paltry 0.5% increase in output. Agricultural produce in Delta State, Nigeria, have experienced incessant fluctuation in prices due lack of storage facilities and perishability. This condition has made many rural households channel their assets to income-generating activities outside agriculture, thereby occasioning the low output response.

Distance to market is the only variable that exerted a strong and negative impact on output. The longer the distance to markets where agricultural products can be sold by farmers, the lesser the incentive to produce more. Many producing centres in rural Delta State, Nigeria are still remote and connected by seasonal roads, thus making it difficult for farmers to transport their produce to markets for sale. The situation is even worsened due to the bulky nature of most agricultural produce. Therefore in agricultural zones with difficult terrain where longer distances are covered in order to bring produce to market, farmers are wary to expand the level of their production since a great deal of their produce are wasted due to inability to move them to markets on time. The elasticity estimate indicated that a 10 percentage increase in distance to market, will depress output by 2%. Therefore in order to sustain agricultural growth, a policy thrust to open up the rural areas through the development of roads and market infrastructure must be pursued by government at all levels.

Household size, showing the number of persons in the workforce had a positive influence on output. This implies that the larger the size of the rural household, the higher the level of agricultural output will be. Larger families are able to cultivate larger land area and also carry out other farming activities efficiently than households with fewer members in the workforce. The remote nature of many crop producing zones also warrants the availability of extra human efforts to transport produce to market, an advantage possessed by larger households.

The quality of road infrastructure is an important explanatory variable on agricultural output. As indicated in Table 3, road quality had a positive and significant effect and it elicited the greatest output response among the independent variables. A 10% increase in the quality of rural roads will raise output by 12%. The availability of well-paved roads that will guarantee all-year round movement of agricultural produce from the hinterland to regional output markets is an incentive needed by farmers to expand their production base. Therefore, improvement in the quality of rural road networks, and the extension of their coverage will boost agricultural output and sustain the income of rural households. According to Satish (2006), rural roads almost inevitably leads to increases in agricultural production and productivity by bringing new land into cultivation or by intensifying existing land use to take advantage of expanding market opportunities. The high response of output to road quality found in the study may be due to the foregoing.

Total income

The regression results of the determinants of total household income, based on the double-log function are presented in Table 5. The fit of the model is reasonable with an adjusted R² value of 0.51 indicating that the independent variables accounted for 51% of the variation in the dependent variable. The regression coefficients are also properly signed. The results showed that livestock unit, distance to market, household size, and road quality exerted a statistically significant effect on household income according to *a priori* expectation. An additional unit of livestock unit owned will raise income by 17%. Small-holder livestock keeping is an important source of income to rural dwellers (Sastry et al., 1993), and a means of accumulating capital for investment in the rural economy. Because they are highly mobile capital goods, livestock can be liquidated easily if economic incentives are unattractive or during periods of crisis for the farm-family (Jarvis, 1993). Household size had a positive influence on total income. This implies that the larger the size of the rural household, the higher income will be. This is true because a larger household comprised of several persons in the workforce, have the capacity to generate income from several sources than a comparatively small-sized family. Increasing the workforce per household by an additional member will raise income by 11%.

The quality of rural roads is another variable that had a strong and significant influence on income. A 10 percentage improvement in road quality will increase income by 2.2%. Though road quality may not have a direct impact on income, it stimulated agricultural production by facilitating the haulage of agricultural products from producing centres to markets all through the year. Good road network in the rural areas also enhanced income diversification from agriculture to

non-agricultural activities in self-employment, and wage labour by facilitating movement of labour to areas of need within the rural economy and between rural and

Tab. 5: Regression results of determinants of rural households income in Delta State, Nigeria

Variable	Estimated coefficient	t-statistic	p-value
Land area cultivated	0.07	0.69	.49
Value of other assets	0.08	1.78	.08
Livestock units	0.17	3.03	.00**
Distance to market	-0.59	-8.77	.00**
Educational attainment	0.09	1.52	.13
Household size	0.11	1.96	.05*
Road quality	0.22	3.20	.00**
Constant	10.03	20.21	0.00
F-statistic = 19.08 (0.00)**			
D-W statistic = 1.50			
Adjusted R-squared = 0.51			
n = 288			

**significant at less than 1% level; *significant at the 5% level

Source: authors' calculation

adjoining urban centres. This finding is consistent with those of Smith et al. (2001) and Lanjouw et al. (2001) in Uganda and Tanzania respectively, where rehabilitation of roads fostered the expansion of non-agricultural rural job opportunities both in self-employment and waged activities.

Distance to market had a negative and statistically significant effect on income. This means that the longer the distance to market, the lower household income will be. This is particularly so, for those households where agricultural income constituted the greatest proportion of their total income. Apart from discouraging increased production in remote areas with seasonal roads, thereby reducing income from agricultural products, long distance will also discourage people from engaging in off-farm employment, and furthermore reducing the income-earning potentials of rural households. Furthermore in less accessible rural areas, probably with a low population concentration, it is difficult to establish rural enterprises due to inadequate derived demand and the fact that productive linkages can hardly be established. The response of income to distance-to-market however was very strong, as a 10% reduction in distance will raise income by 6%. Since longer distances is a product of poor road quality and the difficult terrain of many rural areas in Delta State Nigeria, improving rural road network will thus lower the production and marketing costs of farm produce, thereby enhancing the income of rural households.

CONCLUSION

Several studies have analysed the impact of rural infrastructure, particularly rural roads in enhancing the income of rural households and consequently reducing

rural poverty. This study however focused on the effect of roads on agricultural output and income among rural households. It was found that a significant share of total income of rural households in Delta State, Nigeria was derived from agriculture, although income obtained from nonagricultural self-employment was a very important component of total household income. The study also presented evidence of the twin effect of distance-to-market and road quality on agricultural output and income. Since increase in the distance variable and poor road quality reduce household income, a policy thrust that will cut down distance to markets by the expansion and rehabilitation of rural road network should be pursued vigorously, in order to boost agricultural output, enhance the income diversification strategies of households, and strengthen the linkages between the agricultural and non-farm sectors of the rural economy.

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