KSÜ Tarım ve Doğa Derg 26 (1), 126-131, 2023
KSU J. Agric Nat 26 (1), 126-131, 2023
https://doi.org/10.18016/ksutarimdoga.vi.975785

Crop Farm Diversification and Income Generation among Small holder: The Nigerian Experience

Celestina OKEZIE1✉, *Oghenero OVHARHE2, Christopher O CHUKWUJI3
Department of Agricultural Economics and Extension, Delta State University, Asaba Campus, PMB 95074, Asaba, Delta State, NIGERIA
1https://orcid.org/0000-0003-0745-4024, 2https://orcid.org/0000-0003-0732-2793, 3https://orcid.org/0000-0002-9501-0708
✉: drovharhe.oghenero@gmail.com

ABSTRACT
The study examined crop diversification and its implications on farm productivity and income among small holder farmers in Abia State, Nigeria. A multistage sampling procedure was used to obtain a sample size of 250. Data were collected by the distribution of a structured questionnaire. Simpson Index of diversification, gross margin and land equivalent ratio were used as the analytical tools. The result revealed that crop diversification was high (Simpson Index = 0.76). Categorically, the generated net farm income of farmers was specialized diversification (₦51,472), low diversification (₦187,330), moderate diversification (₦402,300), high diversification (₦304,398) and complete diversification (₦169,130). Also, the Land Equivalent Ratio of farmers was specialized diversification (0.39), low diversification (1.16), moderate diversification (1.80), high diversification (1.40) and complete diversification (1.06). The study discovered that differences occurred in farmers' productivity and income levels as a result of crop diversification.

Agricultural Economy

Research Article

Article History
Received : 29.07.2021
Accepted : 17.02.2022

Keywords
Crop
Diversification
Farm
Farmers
Income

To Cite : Okezie, C., Ovharhe, O., & Chukwuji, CO., (2023). Crop Farm Diversification and Income Generation among Small holder: The Nigerian Experience. *KSU J. Agric Nat 26* (1), 126-131. https://doi.org/10.18016/ksutarimdoga.vi.975785.

INTRODUCTION
Agriculture in developing nations including Nigeria engages approximately one-half of the available labour force. A greater portion of rural communities and particularly the rural poor are directly or indirectly dependent on agriculture through farming activities, agri-business, food processing endeavour, fishing technology, forestry and wildlife, vocational skills and trade (Muhammed 2007). An enormous segment of the agricultural output is in the hands of smallholder farmers usually with possession of average holdings of roughly 1-3 hectares. Also, there is poor access to modern enhanced technical know-hows and their overall condition does not always portray excellence in noticeable investments in human capital development, raw material inputs and outputs (Ogunlela & Mukhtar 2009). This is the motive why a greater part of the smallholder farmers in the country grip a cropping pattern that is characterized by cultivating a large variety of crop mix under multiple cropping systems in space modified to various agro-ecological regions known as crop diversification (Ajibefun 2006). In Asia, it is supposed as one of the greatest ecologically achievable, cost-saving and justifiable traditions of decreasing uncertainties and risks in agriculture principally among smallholder farmers (Joshi 2004).

Crop diversification offers a wider option in varieties of crop productivity in a specified area and also lessens the threat of crop failure Tsubo Walker and Mukhala (2001). It can also offer reasonably higher net returns from crops, per unit of labour, optimization of higher land utilization efficiency (Ashaq *et al.* 2008). Agriculture is a risky professional venture due to its organic nature in practice, prone to vagaries of weather and climate including the devastating effects of pests and diseases. This risk in agriculture has led to low returns from produce and has greatly affected the income and productivity levels of farmers. This has compelled most farmers to adopt the technology for crop diversification. Crop diversification is considered as one of the tactics, methods and strategies for reducing the reported farming problems. Walelign (2004). When making choices about agricultural production, the farmer is considered to decide on a cropping plan that increases resilience and provides economic benefits, considering many forms of crop combinations at different scales (Lin 2011). The question the study sought to address was, to what extent farmers diversify their crop production enterprises and their implications on farm output? The focus is on micro farmers in Abia State Nigeria. The specific objectives were to determine the extent of diversification in crop production business and ascertain its effects on-farm productivity and farmers' income in the study area.

MATERIALS and METHODS

The study was carried out in Abia State of Nigeria. The state lies between longitudes 7°00E and 8°00E and latitude 4°45¹N and 6°17¹N of the equator. The capital is Umuahia. The state approximately occupies 6,320 square kilometers. It is characterized by low-lying tropical rainforest vegetation, agrarian with an average rainfall of about 2,400 millimeters per year and is especially intense between April through October (Federal Republic of Nigeria Official Gazette, 2007).

Sampling: The study population comprised of arable crop growers. A multistage sampling procedure was employed in the sample selection process. The *first stage* involved the selection of three LGAs each from the three agricultural zones using a simple random sampling technique. The *second stage* involved a simple random selection of four communities from each of the nine selected LGAs. *Lastly*, a technique of proportionate random sampling was used to select 250 respondents from whom primary data were collected. Ten percent of respondents were carefully chosen from each of the 36 communities. A total number of 2500 arable crop farmers formed the population size from the 36 communities.

A structured questionnaire was used to obtain primary data from the respondents. The questionnaire was designed to elicit needed information from the farmers on their socioeconomic characteristics, farm input and output.

Data generated were analysed using descriptive statistics, Simpson Index of diversification, gross margin, land equivalent ratio and analysis of variance. The Simpson Index of diversification (D) was applied to determine the extent of crop diversification [following from Joshi *et al.* (2003); Ibrahim *et al.* (2009)] and is expressed as:

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Where:

D is the Simpson Index of Diversification for farmer *i*

n = number of species of a crop cultivated by farmer *i*

N = the total sum of available species

The index (D) is between 0 (zero) and 1 (one) where 0 means no diversification and 1 represents infinite diversification. The greater the rate of D, the greater is the sample diversification. The categories of diversification are, 0.1–0.3 (low diversification), 0.4–0.6 (moderate diversification), 0.7–0.9 (high diversification) and one (complete diversification).

The gross margin (GM) was used to determine the effect of crop diversification on farmers' income. It is the differential value between the gross farm incomes (GFI) obtained and total variable cost (TVC). Olukosi and Erhabor (2008) recognized the GM analysis which permits the approximation of the entire expenses (costs) as well as several receipts (revenue or returns) within the production period.

It is expressed as:

GM = GFI – TVC

NFI = GM – TFC

(Where NFI = Net Farm Income and TFC = Total Farm Cost)

The land equivalent ratio (LER) was incorporated to determine the real effect of crop diversification on-farm productivity. LER as cited by Chukwuji (2008), is defined as total land area of sole crops required to produce equivalent yields as would be obtained when they are intercropped. LER as applicable here is the utmost communal index adopted and acceptable in intercropping practices to measure land productivity which is a determinant of the efficiency of intercropping models (Brintha & Seran, 2009). The LER would be calculated using the formula:

$$LER = \sum_{i-1}^{n} \left(\frac{Q_m}{Q_s} \right)$$

Where Q_m is crop yield in the intercrop farm and Q_s is specific crop yield in the sole crop farms. In a particular crop, a ratio is computed to define its partial LER, and the partial LERs are added up to equate the grand value of LER for the intercrop. A value of LER, 1.0 indicates no difference obtained in the intercrop yield and the assemblage of monocultures. Yield values greater than 1.0 indicate advantage for intercrop (Mazaheri, et al, 2006). The farmers' productivity coupled with income levels were tested across the various degrees of diversification using land equivalent ratio.

RESULTS and DISCUSSIONS

The respondents' socio-economic characteristics (Table 1) considered were gender, age, education, experience of farmers and farm size. As could be seen from the result the majority (59.2%) of farmer were males. This implies more males owned farms than females. This finding concurs with Miller (2004) and Jabil (2009) who reported that most farmlands are owned by a male. This finding is in tandem with Ayanwuyi Adeola and Oyetoro (2013) who reported that 74.1% of arable crop farmers are males. Respondents' mean age, 45 years, indicated that the crop farmers were still in their active age. This contributed to spreading of innovation practices since young people tend to accept innovations than older people and as such, they serve well as agents of innovation transfer. Ayanwuyi *et al.* (2013) also noted that more arable crop farmers were between 31-50 years old.

Farmers (60.8%) attained tertiary education. This means that a high proportion of them are literate and are more opened to absorb technologies and new farm practices, all things being equal. Nkhori (2004) pointed out that education increases the capability of households to employ their resources effectively, access, interpret and analyze information.

The mean years of farming experience was about 18 years. This suggests that the growers have the necessary experience in arable crop production. The higher the farming age, the more the farmer would have gained more knowledge and technical ideas on how to tackle farm production problems, and the higher would be his output and income (Nwaru Okoye & Ndukwu 2011).

The respondents' mean farm size was 1.42 hectares. This infers that the crop farmers were small scale farmers with high degree of land fragmentation associated with arable crop production. This finding agrees with Ajieh (2014) and Ovharhe (2020) that the small scale farm holders had between 0.5 to 3.5 hectares. Population growth forces farmers to shorten fallow periods, increase investment in land and manage soil fertility through the addition of manure (Obasi 2005).

It was detected that farmers had moderate interaction with extension activities in line with crop diversification training (54.4%). Ovharhe Emaziye and Okwuokenye (2020) reported that greater exposure of farmers to food security in line with crop diversification tends to increase farm output and income levels.

Table 1: Socio-demographic characteristics of respondents in the study area

Variables	Frequency	Percentage
Sex		
Male	148	59.2
Female	102	40.8
Age (mean: 44.85)		
Below 30 years	28	11.2
30-39 years	59	23.6
40-49 years	80	32.0
50-50 years	43	17.2
60-69 years	35	14.0
Above 70 years	5	2.0
Level of education		
No formal education	12	4.7
First Sch. Leaving Cert.	15	5.9
Snr. Sec. Cert. Exam.	71	27.8
Tertiary	152	60.8
Farming Experience (mean = 18)		
1-5 years	8	3.2
6-10 years	42	16.8
11-15 years	50	20.0
16-20 years	115	46.0
Above 20 years	35	14.0
Farm size (mean = 1.42Ha)		
Less than 1ha	11	4.4
1-1.9ha	136	54.4
2-2.9Ha	73	29.2
Above 2.9Ha	30	12.0
Contact with Extension Workers		
Monthly	11	4.4
Quarterly	136	54.4
Bi-annually	73	29.2
Annually	30	12.0

Source: Field responses

Crop Diversification (CD)

Table 2 shows respondents according to their extent of CD using the Simpson Index of Diversification. As could be seen from the Table, 4.4% of farmers engage in crop specialization, 16.0% engage in very low diversification, 34.8% carry out moderate diversification, 43.2% practice high diversification and 1.6% practice complete CD.

The farmers are engaged in the cultivation of various enterprises. The enterprises include yam, cassava, maize, pepper, melon and garden egg. The mean value of the Simpson index of diversification is 0.76. This is to say that, the arable crop farmers operated mainly diversified enterprises. Hence, the majority enjoy the benefits of CD. The finding agrees with that of Ogundari (2013) who reported that farmers were more diversified in their cropping pattern. Joshi et al. (2003) adopted the Simpson index to compare CD in several South Asian countries. Ibrahim et al. (2009) carried out research on income and CD among farming households in a rural area of north-central Nigeria using the Simpson index and they got a value of 0.82. This indicated that diversification was high in the study area as the respondents adopted multiple income-generating activities to manage risk and meet household consumption needs concerning the findings of Olukosi and Erhabor (2008).

Table 2: Distribution of respondents according to the extent of crop diversification (CD)

Simpson Index of Diversification	No. of Crops	Frequency	Percent
Zero (Specialization)	Sole crop	11	4.4
0.1–0.3 (low diversification)	Two–three crops	40	16.0
0.4-0.6 (Moderate diversification)	Four crops	87	34.8
0.7-0.9 (High diversification)	Five crops	108	43.2
One (Complete diversification)	All available enterprise	4	1.6

Source: Field responses

Crop Farm Diversification on Income

Table 3 shows the result of crop farm diversification in relation to farm income. The net farm income of the farmers was obtained as the difference between gross revenue and the total cost of production per hectare. The result reveals that 11% of the farmers who were specialized generated a net farm income of ₦51,472.73 per hectare. Farmers that had very low and moderate diversification (16.0% and 34.8% respectively) had an income of ₦187,330.35 per hectare and ₦402,300 per hectare, respectively. Also, 43.2% of the highly diversified farmers had a net farm income of ₦304,398.56 per hectare. Farmers that practiced complete diversification (1.6%) generated an average net farm income of ₦169,130.00 per hectare.

Moderate and highly diversified farms produced statistically the same amount of net farm income (NFI) per hectare that was significantly higher than others. Very low diversification and complete diversification produced the same amount of NFI that was significantly lower than others. This result implies that while enterprise diversification is good, very low and very high levels are not advisable because of income generation, a moderate level is the best. Chukwuji (2008) reported that a mixture of four enterprises considerably produced the maximum NFI, with Cassava + Yam + Maize + Vegetable combination giving the highest of about ₦21514 per hectare. He further stated that the combination of four enterprises appears to be the optimum, as all combinations less than and more than four produced lower NFI. Also, Minot Epprecht Anh and Trung (2006) and Biswajit *et al.* (2017) stated in an empirical analysis on agricultural diversification and its impact on farm income, that moderate crop diversification will increase farm income.

Table 3: Effects of crop diversification on income

Degrees of diversification	No. of crops	No. of farmers	Percent (%)	Gross income/ha(₦)	Total cost/ha (₦)	Net farm income/ha (₦)
Zero (specialization)	Sole crop	11	4.4	99473	82572	51472
0.1–0.3 (low diversification)	Two–three crops	40	16.0	242330	231233	187330
0.4–0.6 (moderate diversification)	Four crops	87	34.8	460300	442200	402300[c]
0.7–0.9 (high diversification)	Five crops	108	43.2	376399	366398	304399[c]
One (complete diversification)	All available enterprise	4	1.6	210000	201000	169130

Source: Field responses

Crop Diversification on Farm Productivity

Table 4 shows the outcome of crop enterprise diversification on-farm productivity measured as Land Equivalent Ratio (LER). The result reveals that 11% of the specialized farmers had a Land Equivalent Ratio of 0.39. Farmers that had very low and moderate diversification (16.0% and 34.8% respectively) had a LER of 1.16 and 1.80 respectively, while 43.2% of the highly diversified farmers had a LER of 1.40.

From the findings, statistically, farmers that practiced low and complete diversification had lower

and significant yield advantage. Farmers that practiced moderate and high diversification had the same and significant yield advantage, statistically. Hence, farmers with higher LER have a greater yield advantage, all things being equal. This suggests that it is most profitable to diversify on the accounts of high returns benefitted. This finding is following that of Chukwuji (2008) who stated that farms with higher economic LER were more diverse, all things being equal to those with lower economic LER. Agegnehu Ghizaw and Sinebo (2008); Dahmardeh *et al.* (2009); Brintha and Seran (2009) also reported that intercropping gives greater stability of increased yield and productivity than a sole crop cultivated in the same area of land.

Table 4: Effects of crop farm diversification on farm productivity

Degrees of diversification	No. of crops	No. of farmers	Percentage (%)	LER (Farm productivity)
Zero (specialization)	Sole crop	11	4.4	0.39
0.1–0.3 (low diversification)	Two–three crops	40	16.0	1.16
0.4–0.6 (moderate diversification)	Four crops	87	34.8	1.80
0.7–0.9 (high diversification)	Five crops	108	43.2	1.40
One (complete diversification)	All available enterprise	4	1.6	1.06

Source: Field responses

CONCLUSION

The study shows that the sampled arable crop farmers were engaged in various levels of diversification (low, moderate, high and complete). A smaller proportion also engaged in crop specialization, but majority engaged in moderate and high diversification. The land equivalent ratio result showed significant differences in the productivity and income of the farmers'. Moderate and highly diversified farms produced statistically the same amount of net farm income (NFI) per hectare that were significantly higher than others. Very low diversification and complete diversification produced the same amount of NFI that were significantly lower than others. Farmers that engaged in low and complete diversification had the same and significant yield advantage while moderate and highly diversified farmers had the same and significant yield advantage.

It is hereby recommended that farmers should be stimulated to boost their productivity by diversification to meet their income and consumption needs. This can be achieved through improving the farmers' access to credit and the extension agents through more awareness creation on the essence of CD and output increase. The monetary authority in collaboration with the government should encourage access to credits through reduced interest rates and perhaps, a little requirement for a small amount of loan. The Agronomist and Agricultural Engineers should create multiple cropping patterns that can support mechanized devices. Agrochemicals that suit multiple cropped enterprises rather than being specific should be formulated. While, as an implication to the study, extension advisers should recommend crop diversification practices mostly at moderate and high levels so as to increase income generation.

Acknowledgements

We recognize the ethical committee and field workers who contributed to the actualization of this work.

Conflict of interest

None.

Contributions from authors

Okezie C, did the field works; Ovharhe OJ did the manuscript arrangement, presentation supervision and Chukwuji CO did the dissertation supervision and data analysis.

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