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COMPLIANCE INDEX ANALYSIS AND TOTAL FACTOR PRODUCTIVITY OF SEED YAM PRODUCTION TECHNOLOGIES IN NORTH-CENTRAL NIGERIA

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Abstract Technology adoption for increased productivity can only be relevant when technologies introduced are adequately complied with. This study assessed the level of compliance by CAY -Seed and NRCRI-Seed yam farmers to the usage of the seed yam production technologies and examined the productivity of the CAY- Seed and NRCRI - Seed yam farmers' farms. The study adopted a multi-stage sampling technique and a total of 283 respondents were used for the study. In addition, the study made use of cross-sectional data which were analysed using descriptive statistics, compliance index and total factor productivity. The findings of the study revealed that CAY-Seed yam farmers optimally complied (0.8932) with the usage of the seed yam technologies than their NRCRI counterparts (0.5982). Similarly, NRCRI-Seed yam farmers' farms had a higher TFP (1.9133) compared to CAY-Seed yam farmers' farms (1.8009). Seed yam farmers should take up and super-optimally utilize all improved agricultural (bio-farming activities) technologies made available to them. Similarly, trainings and intervention projects meant to improve productivity of seed yam farms should be established in areas where productivity of agricultural produce is low.

Keywords: *Compliance Index, Seed Yams, Technologies, Total Factor Productivity*

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INTRODUCTION

In Nigeria, the application of agricultural technology has been responsible for the improvement in agricultural production and processing activities. Agriculture provides food, raw materials and employment opportunities for a growing number of people particularly, the youths (FAO, 2013). Fasoyiro and Taiwo (2012) stated that agriculture is critical in achieving increased income generation, food security and poverty alleviation as it helps to improve the welfare of farming households through increased agro-economic activities. Some crops which have helped to improve the welfare and food security status of households are root and tuber crops. Consequently, Babatunde (2012); and Gweyi-Onyango *et al*. (2021) noted that roots and tubers majorly account for two-thirds of crops cultivated in Nigeria and are resilient due to their ability to adapt to marginal areas.

Yam (*Dioscorea Spp)* as a staple food crop has improved the welfare of households by improving income generation. The second most important tuber crop after cassava worldwide is yam (11TA, 2013; Bassey, 2017). As of 2019, world production of yam was about 74.2 million tonnes while yam production

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for Nigeria was 50.1 million tonnes which implies that Nigeria produced about 67.42% of total global yam production. Other African countries which produce yams include Togo, Benin, Ghana and Côte d'Ivoire. Similarly, average profit per yam and seed yam tuber was estimated at US$19,664,908 per hectare in year 2019 (FAO, 2019). Nutritionally, 118 dietary calories per capita per day is contributed through yam consumption to about 150 million people particularly in West Africa (Babaleye, 2003; and FAO, 2019). However, the production of yam has not ultimately met the demand for it. Similarly, the agricultural production system has been affected negatively due to low yam production, unfavorable effect of climate change and increasing population.

This concern birthed the emergence of concept of sustainability. Thus, sustainably producing yam without over-exploiting the natural ecosystem has been of interest to various agricultural research institutes in Nigeria. In an attempt to address the issues facing yam production, the Community Action in improving Farmers Saved Seed Yam (CAY-Seed) and National Root Crops Research Institute projects were established. They were put in place to help multiply quality seed yams (planting materials used to produce ware yams) (Oguntade *et al*., 2010) using positive selection, biofertilizer, biopesticides, mini-setting techniques and improved ridging methods. With the introduction of seed yam technologies, there was a need to carry out an assessment of the seed yam technologies so as to access the level of compliance to the usage of CAY-Seed and NRCRI-Seed yam production technologies and also compare the productivity of the CAY- Seed and NRCRI - Seed yam farms. This study intends to encourage proper compliance to technologies introduced to farmers if increased productivity is to be achieved in the long-run. The rest of the paper is sectioned as follows: Section 2 presents the methodology of the study while section 3 discusses the findings of the study. Section 4 provides the conclusion and recommendations of the study.

METHODOLOGY

The study was carried out in the North-Central Nigeria. This zone was selected because it was a pilot zone for the CAY-Seed and NRCRI-Seed yam projects in Nigeria. Nigeria is located on the Gulf of Guinea and lies between latitudes 4° and 14°N; and longitudes 2° and 15°E. In addition, Nigeria has a land area of about 923,768 km^2. Nigeria has a population of over 200 million people (National Population Commission and National Bureau of Statistics Estimates, 2016). The land scape of Nigeria varies from mangrove on the coastal lines to the derived and Sahel savannah (WFB, 2011). The annual rainfall is between 1,500 to 2,000 mm per year. Similarly, Nigeria has six geopolitical zones: North-east, North-west, North-central, South-east, South-west, South-south. Nigeria has 36 State and the Federal Capital Territory. Nigeria is largely an agrarian community with over 70 per cent of the population employed in the agricultural sector. The populations of this study were seed yam farmers who participated in the seed yam projects.

Method of Data Collection

Primary data (Cross sectional data) were collected using structured questionnaire.

Sampling Procedure

A multistage sampling procedure was adopted for the study: the first stage was the purposive selection of the zone; the second stage was the purposive selection of the states and villages due to their participation in the seed yam projects. Third stage was the random selection from the list of seed yam farmers who participated in the seed yam projects. Similarly, using the Yamane (1967) formula, a total of 283 seed yam farmers (133 CAY-Seed and 150 NRCRI-Seed) were used for this study.

Analytical Techniques

The compliance index was used to assess the level of compliance to the usage of the seed yam production technologies by seed yam farmers. Similarly, total factor productivity (TFP) was used to access the productivity of CAY- Seed and NRCRI – Seed yam farms. Also, t-test was used to test the research hypotheses.

Compliance Index

The compliance index was computed using the number of seed yam technologies which were used by CAY-Seed and NRCRI – Seed yam farmers. This first technique was the positive selection method which comprised of three stages namely: identification of healthy plants, tagging of healthy plants and removal of infected plants. The second technique involved the use of various sizes of setts. The third technique involved the use of biopesticides to prevent infestation of setts. Other techniques include use of improved varieties; use of biofertilizers and application of biocontrol techniques such as improved ridging techniques, planting techniques, spacing techniques, weeding techniques, and staking techniques. Each of these techniques was given weighted scores ranging from 1 to 5 and the level of compliance was calculated

using the compliance index formula, presented in equations (1) and (2) as adapted from Virenda, *et al.* (2008).

Compliance index for CAY-Seed yam farmers

$$=\sum \frac{No\ of\ technology\ used\ by \frac{each\ famer}{Optimal\ no\ of\ technology\ usage}}{Total\ no\ of\ technology\ available} \quad (1)$$

Compliance index for NRCRI seed yam farmers

$$=\sum \frac{No\ of\ technology\ used\ by \frac{each\ famer}{Optimal\ no\ of\ technology\ usage}}{Total\ no\ of\ technology\ available} \quad (2)$$

Total Factor Productivity

The Total factor productivity is defined as the aggregate output ratio produced with aggregate input used. Lipsey and Carlaw (2002) pointed out that three different views exist regarding the concept of TFP. The first set of opinions considers TFP as the quantity of the rate of technical change (Law, 2000; Krugman, 1996). The second view sees TFP measures of technical change while the third view is uncertain in terms of TFP measuring anything useful (Griliches, 1995; Frija, Dhehibi, Aw-Hassan, Akroush and Ibrahim, 2015). In measuring the TFP, two approaches have been named; frontier and non-frontier approaches. In this research work, the total factor productivity was applied to assess the excess of the increase resulting from increasing input use in the production process. TFP was assessed as the ratio of output to total variable cost of farm production by CAY- and NRCRI- seed yam farmers.

Total factor productivity (TPF) was employed to analyse the productivity of seed yam farms. The formula according to Sadiq *et al.* (2018) and Folorunso, *et al.* (2020) was presented in equations (3) and (4) as follows:

TFP = Y/TVC (3)

Where Y = output (₦)

TVC = Total Variable Cost (₦)

Put alternatively,

$$TFP = \frac{Y}{\sum P_i X_i} \quad (4)$$

Where:

P_i = ith variable input unit price

X_i = ith variable input quantity.

Total Fixed Cost (TFC) was ignored in this methodology because TFC does not affect the resource use efficiency and profit maximization conditions.

Cost theory in the implicit form stipulates the following as presented in equations (5) and (6):

$$AVC = \frac{TVC}{Y} \quad (5)$$

Where AVC = Average variable (₦).

$$TFP = \frac{Y}{TVC} = \frac{1}{AVC} \quad (6)$$

Therefore, TFP is the inverse of the AVC.

T-test

The t-test (two paired t-test with unequal variance) was used to test the research hypothesis which states that;

H_0: There is no significant difference between the compliance index of CAY-Seed and NRCRI-Seed yam farms.

H_0: There is no significant difference between the total factor productivity of CAY- and NRCRI - seed yam farms.

The model is presented in equation (7) as follows:

$$t = \frac{(x-y)-(\mu x-\mu y)}{s\sqrt{\frac{i}{nx}+\frac{i}{ny}}} \quad (7)$$

Where:

t= t-test value

x=mean of Compliance index of CAY-Seed yam farms

y=mean of Compliance index of NRCRI-Seed yam farms

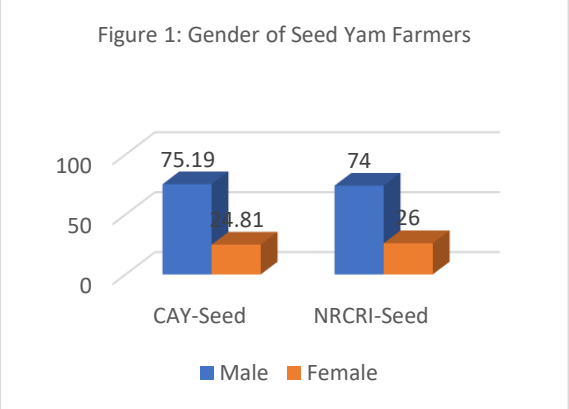
μ= mean weight

n=sample size

s=standard deviation

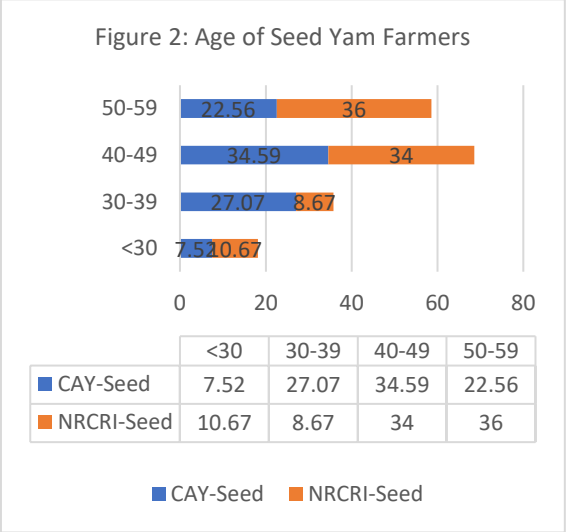
RESULTS AND DISCUSSION

Figure 1 shows the percentage of seed yam farmers by gender. 75.19%were males and 24.81% were females for CAY-Seed yam farmers while 74% were males and 26% were females. This means that for both sets of farmers, the men participated more in producing seed yam farmers than their female counterparts.



Source: Field Survey (2020)

Figure two reveals the age range of seed yam farmers.



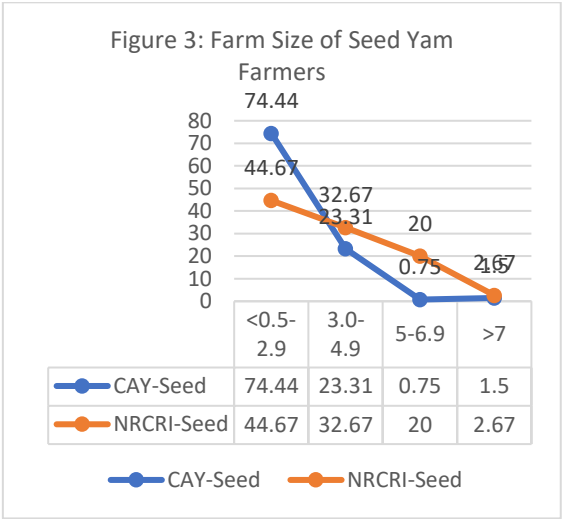
Source: Field Survey (2020)

For CAY-Seed yam farmers 7.52 per cent and 10.67 per cent of NRCRI seed yam farmers were 30 years and below. Only a few CAY-Seed (11 per cent) and NRCRI (30.67 per cent) seed yam farmers were seventy (70) years of age and above. This implies that the NRCRI seed yam farmers were much older than their CAY-Seed counterpart. The results also reveal that a greater part of the seed yam farmers that participated in CAY-Seed yam production fell between less than 30-59 years of age implying that, younger seed yam farmers are likely to take up innovations to increase the level of efficiency as compared to the older farmers in production (Mabe *et al.*, 2018).

Figure 3 gives that farm size of the seed yam farmers. Table 9 also reveals that 74.44 per cent of the CAY-Seed yam farmers cultivated between 0.5 and 2.9 hectares of farm land. Also, 44.67 per cent of NRCRI seed yam farmers cultivated between 0.5 and 2.9 hectares of farm land. The mean farm size for CAY-Seed yam farmers was 2.36 while that of NRCRI seed yam farmers was 3.49. There was also a significant difference between the mean farm sizes (5.5935) for CAY-Seed and NRCRI - seed yam farmers. This shows that NRCRI seed yam farmers cultivated on slightly larger farmlands than CAY-Seed yam farmers.

Level of Compliance of CAY - Seed and NRCRI - Seed Yam Farmers

A compliance index was used to assess the level of compliance to the usage of the seed yam production technologies (bio-farming technologies). Similarly, each step was categorized, and an index was generated which was used to assess the level of compliance to the usage of the seed yam



Source: Field survey (2020)

production technologies. Tables 1, 2 and 3 present the results for the compliance index of CAY-Seed and NRCRI - seed yam farmers.

Table 1: Compliance Index of CAY –Seed and NRCRI - Seed Yam Farmers

	CAY-Seed		NRCRI-Seed	
Index	Frequency	Percentage	Frequency	Percentage
Sub-optima (<0.5)	32	24.06	32	21.33
Optima (0.5 – 0.8)	60	45.11	98	65.33
Super-optima (>0.8)	41	30.83	20	13.33
Mean	0.89		0.60	
Total	133	100	150	100

Source: Field Survey (2020)

Table 1 reveals that 45.11 per cent of the CAY-Seed yam farmers and 65.33 per cent of NRCRI seed yam farmers optimally complied with the usage of the seed yam technologies introduced to them. Consequently, 30.83 per cent of CAY-Seed yam farmers and 13.33 per cent of NRCRI seed yam farmers fully complied with the level of usage of the seed yam technologies. The mean level of

compliance for CAY- Seed and NRCRI - Seed yam farmers were 0.89 and 0.60 respectively. This implies that the CAY-Seed yam farmers mostly complied with the usage of the seed technologies as compared to the NRCRI-Seed yam farmers. This may be due to the fact that the CAY-Seed yam technologies were more recently introduced to the farmers as compared to their NRCRI counterparts.

Table 2. Compliance Index of CAY–Seed and NRCRI - Seed Yam Farmers Disaggregated by Gender

	CAY-Seed			NRCRI-Seed		
Index	Male	Female	Total	Male	Female	Total
Sub-optima (<0.5)	0	0	0	22	10	32
Optima (0.5 – 0.8)	28	14	42	73	25	98
Super-optima (>0.8)	72	19	91	16	4	20
Total	100	33	133	111	39	150

Source: Field Survey (2020)

Table 3. Compliance Index of CAY –Seed and NRCRI - Seed Yam Farmers Disaggregated by Age

	CAY-Seed			NRCRI		
Index	<30	30-50	>50	<30	30-50	>50
Sub-optima (<0.5)	0	1	0	1	16	14
Optima (0.5 – 0.8)	3	29	9	0	52	48
Super-optima (>0.8)	7	63	21	0	3	16
Total	10	93	30	1	71	78

Source: Field Survey (2020)

The result of compliance to the usage of seed yam technologies by CAY-and NRCRI-seed yam farmers on Table 3 reveals that for CAY-Seed yam farmers, those who optimally and super-optimally complied with the usage of the seed yam technologies were between the ages of 30-50 years of age. This may be because they were still within their active ages thus making it easy for compliance to the usage of seed yam technologies. For NRCRI seed yam farmers, those who sub-optimally and optimally complied with the usage of the seed yam technologies were between the ages of 30-50 while those that super-optimally complied with the usage of the technologies were above 50 years of age. This maybe because of their years of farming experience which made them efficient in using new technologies.

Table 2 shows that for CAY-Seed yam farmers, more male farmers optimally and super-optimally complied with the usage of the seed yam technologies. Similarly, for NRCRI-Seed yam farmers, more male farmers complied with the usage of the seed yam technologies than their female counterparts. This may be because more male farmers engaged in use of the seed yam technologies than their female counterparts.

Table 4. Estimation of t-test to assess the difference in mean of compliance index for CAY- Seed and NRCRI - Seed Yam Farmers

	CAY seed farmers (1)	NRCRI farmers (2)	Total Sample (3)	T-test of diff btw the mean of 1&2
Compliance Index	0.8932	0.5982	0.7369	18.7019

Source: Field Survey (2020)

From Table 4, CAY- and NRCRI - seed yam farmers had a significant difference in their means (18.7019). This implies that the CAY-Seed yam farmers optimally complied with the level of usage of the seed yam technologies while the NRCRI seed yam farmers sub-optimally complied with the usage of the seed yam technologies. Thus, the null hypothesis was rejected.

Total Factor Productivity of CAY- Seed and NRCRI - Seed Yam Farms

The Total Factor Productivity of the seed yam farms was assessed to determine which group of seed farmers had a higher total factor productivity score. The results for the TFP are presented in Tables 5 and 6 respectively.

Table 5. Total Factor Productivity of CAY-Seed and NRCRI - Seed Yam Farms

	Output	Total Variable Cost	Total Factor Productivity
CAY-Seed	347,689.15	193,064.11	1.8009
NRCRI	157,866.98	82,510.32	1.9133

Source: Field Survey (2020)

The TFP result in Table 5 indicates that the mean values for CAY-Seed and NRCRI - Seed yam farms were 1.80 and 1.91 respectively. Thus, revealing that NRCRI-Seed yam farms slightly had a higher mean for Total Factor Productivity than CAY-Seed yam farms. This may be because of the NRCRI-Seed yam farmers adequately utilizing their resources appropriately as compared to their CAY-Seed yam counterpart who had a high compliance level but low Total Factor Productivity.

Table 6. Estimation of T-test of the Total Factor Productivity of CAY-Seed and NRCRI - Seed Yam Farms

	CAY-Seed farms (1)	NRCRI-Seed Farms (2)	Total Sample (3)	T-test of diff btw the mean of 1&2
Total Factor Productivity	1.8009	1.9133	1.8605	0.5936

Source: Field Survey (2020)

The t-test was used to compare the mean values of the total factor productivity of CAY-Seed and NRCRI - Seed yam farms. The result in Table 6 reveals that there is no significant difference in the total factor productivity between the two groups of seed yam farms. This implies that both set of farmers had almost the same level of productivity; and as such, the null hypothesis which states that there is no significant difference between the means of CAY- Seed and NRCRI-Seed yam farms was accepted.

CONCLUSION

This study assessed the compliance index and productivity of seed yam farmers in North-central Nigeria. The study revealed that men participated more in producing seed yams than women. Also, the NRCRI –Seed yam farmers owned larger farm size than their CAY-Seed yam counterpart. Similarly, a compliance index was generated to assess the level of compliance to the usage of the seed yam production technologies (bio-farming technologies). It was discovered that both CAY-Seed and NRCRI –Seed yam farmers optimally complied with the usage of the seed yam technologies and most of the seed yam farmers were within their active ages. This enhanced their ability to take up and comply with the usage of the seed yam technologies. However, NRCRI-Seed yam farmers who super-optimally complied with the usage of the seed yam technologies were above 50 years of age. Furthermore, it was discovered that NRCRI-Seed yam farms were slightly more productive than their CAY-Seed yam counterparts. The study concludes that although both CAY-Seed and NRCRI-Seed yam farmers optimally complied with the usage of the technologies, the NRCRI-Seed yam farmers had a higher level of productivity. The study recommends that seed yam farmers should take up and super-optimally utilize all improved agricultural (bio-farming activities) technologies made available to them. This would enable seed yam farmers to increase their outputs and food security status. Similarly, trainings and intervention projects meant to improve productivity of seed yam farms should be established in areas where productivity of agricultural produce is low.

Author's Conflict of Interest Statement

The authors report there are no competing interests to declare.

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