

Comparative Study on Factors Influencing Rice Yield in Niger State of Nigeria and Hainan of China

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Abstract. The trajectory of rice output in Nigeria has been increasing, but it has little to do with an increase in yield compared to other rice producing nations like Egypt, China, and the USA. This study provides empirical factors influencing rice yield in Niger state, a major rice producing state in Nigeria, and Hainan of China, a province sharing relatively similar crops and climate conditions, all with the intent of finding yield influential and determining to what extent any management system could be inserted into the Nigerian rice system. Based on a survey carried out in 2013/2014 consisting of 164 and 236 farmers from Niger state and Hainan, respectively, the study employed Cobb-Douglas production function analysis. The results indicate that yield can be further improved in both regions, especially in Niger state, when the appropriate investment on essential inputs are provided to the farmers. A lot can be learned from China's rice subsector. Policy makers should take advantage of the existing bilateral relationship with China for transfer of information and technologies.

Keywords. comparative study; rice yield; Cobb-Douglas; Niger state; Hainan province

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1. Introduction

The Nigerian economy has gone through many years of vicissitude, especially in the agricultural sector. The rice subsector is still growing but is faced with many challenges, including biotic, abiotic, and socioeconomic constraints, with greater pressure from the socioeconomic constraints (Abdul-Gafar et al., 2016). The majority of the rice producing countries in Africa attained yield below the world average (4.3MT) from 2008 to 2014. Some of the pivotal factors for the low yield are inadequate extension services, poor management practices, and structural obstacles. China's development in the agricultural sector has been a huge wake-up call to other developing countries. The Chinese agricultural system is characterized by a long history of development in technologies associated with seed development, fertilizer and water control, and land preparation. China's agricultural production can be

said to operate on a high-yield and relatively high use of labor, fertilizer, and other agrochemicals (Low 2003).

According to a FAOSTAT (2012) estimate, although rice yield has been increasing recently, it is still below the yield experienced during the 1970s and 1980s. According to some researchers (Akande 2002; Longtau 2003; Ogundele and Okoruwa 2006; Ojehomon et al., 2009), this stagnation is attributed to depreciating land fertility as a result of production constraints, poor crop management practices, and policy inconsistency.

Over time, the trend of rice yield in Nigeria exhibits little or no contribution to total output. Increasing the cultivated area has been the most effective means to increase rice output in the country (Kebbeh et al., 2003; Ogundele and Okoruwa 2006).

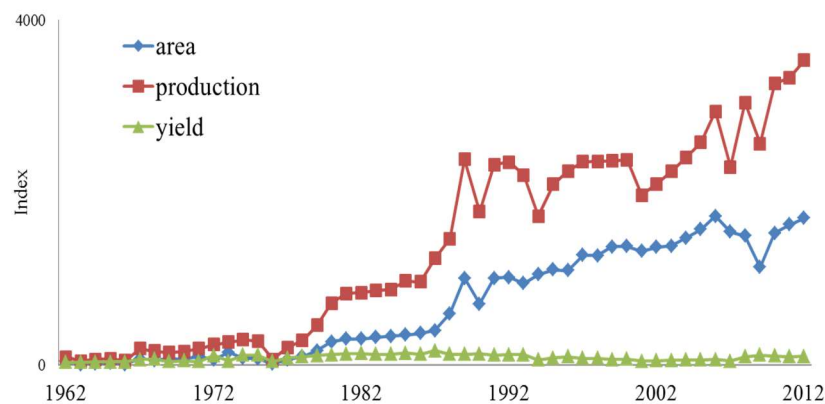


Figure 1a: Rice area, Production, and Yield (Nigeria)

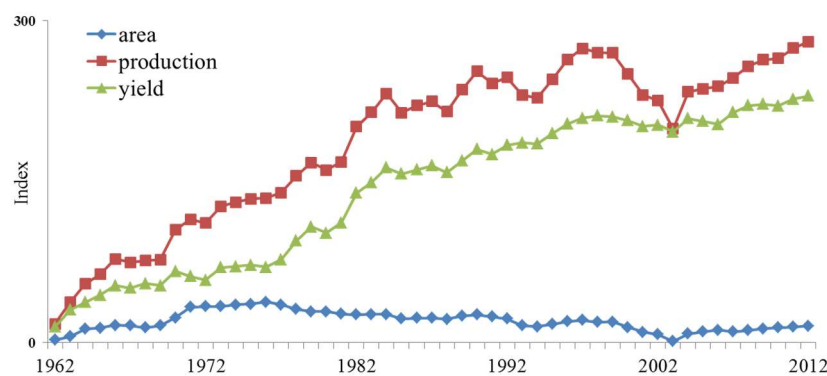


Figure 1b Rice area, Production and Yield (China)

Figure 1a above reveals that the changes in rice production in Nigeria are due more to an increase in cultivated area. Unlike Nigeria, the cultivated area in China has been declining, which explains the importance of yield to the total output as shown in Figure 1b. Among other factors, the limited expansion area for rice production gears the country to putting more effort on improving yield to meet the demand of the growing population (Low 2003). The development and wide adoption of hybrid rice and increased chemical fertilizer use, among other factors, explains the improvement in yield in China over the years (He et al., 1984; Huang and Rozelle 1996; Duwayri et al 2000).

This study aims to find yield influential factors from the viewpoint of the two regions using the Cobb-Douglas production function and to determine the extent to which any management sys-

tem could be inserted into the Nigerian rice system from the Chinese farming system. Although regional farming systems can be diverse, the existing technological system has made it easier to adopt farming techniques from both agro-ecologically and sociologically diverse regions. Thus, partnership and linking agricultural technology and information is conceivable (Eponou 1993).

2. Methodology

2.1 Study Area

Niger state was purposely selected as a case study due to the ecological advantage available for rice farming. Niger state is one of the leading rice producers in Nigeria. On the other hand, Hainan province of China shares relatively similar crops and climate conditions with Niger state.

Thus, plausible comparative evidence can be deduced from both regions.

Ecosystem of the Study Areas

	Niger State	Hainan Province
Seasons	Rainy and dry	Rainy and dry
Annual rainfall	1100 - 1600mm	1,500 - 2,500mm
temperature	23°C ~ to 37°C	22.5°C ~ 25.6°C
Major crop produced	RICE, Sugar cane, Maize, Millet, Fruits	RICE, Sugar cane, coconuts, Fruits, Tea

Source: National Bureau of Statistics NBS (2013 a & b)

2.2 Data Collection, Processing

About 400 rural household farmers were interviewed using a structured questionnaire: 164 from 5 local governments of Niger state and 236 from 3 counties of Hainan province. The questionnaire (English and Chinese versions) were constructed at the Agricultural Information Institute (AII) of Chinese Academy of Agricultural Science (CAAS). It is divided into five parts: the socioeconomic status of the farmer, production inputs, output information, land utilization, and production constraints. Data collected was first transferred into EpiData software in Agricultural Research Council of Nigeria (ARCN) and later exported to STATA software. The pilot test and construction of models were all carried out in AII of CAAS Beijing. The Cobb-Douglas production function was chosen to determine the influential factors.

2.3 Econometric Application

Both descriptive and inferential statistical analysis was employed to analyze the result of the cross-sectional data. As for the inferential statistics, this study applied the Cobb-Douglas and Translog (transcendental logarithmic) production function to test the relationship and significance (allocative efficiency) of factor input in the Niger State and Hainan Province. Labor input has been divided into seven stages corresponding to

the growth stages of rice production in the model. This was done to determine the efficient use of labor resources of the rural household in both locations.

2.3.1 Cobb-Douglas Production Function

$$Y = A \cdot X_i^{\beta_1} \cdot X_i^{\beta_2} \quad [1]$$

Equivalently as:

$$\ln Y = \ln A + \beta_1 \ln X_1 + \beta_2 \ln X_2 \quad [2]$$

The translog¹ of Cobb-Douglas production function in equation (2) with independent variables X_1 to t becomes:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \dots + \beta_t t \quad [3]$$

and decoding equation (3) according to this study we have:

$$\ln Y_{Niger} = \beta_0 + \beta_1 sdsos + \beta_2 \ln fert + \beta_3 \ln pst + \beta_4 \ln hv + \beta_5 \ln trained + \beta_6 \ln off_farm + \dots + \beta_t t \quad [4]$$

$$\ln Y_{Hainan} = \beta_0 + \beta_1 sdsos + \beta_2 \ln fert + \beta_3 \ln hr b + \beta_4 \ln pst + \beta_5 \ln edu + \beta_6 \ln mch + \dots + \beta_t t \quad [5]$$

Where β_0 is the constant, the coefficient $\beta_1, \beta_2, \beta_3, \dots, \beta_t$ the elasticity yield with respect to input $X_1, X_2, X_3, \dots$ and X_t . Summation of the coefficients gives the degree of homogeneity/returns to scale. To relax the rigidity rate of Rate of Technical Substitution (RTS) value, the transcendental logarithmic form was introduced. Likewise, a stepwise regression [$p \geq \text{pr}(\#)$] was introduced to specify the level of significance of the independent variables eligible for removal. This method allows optional commands in regression plus removes highly correlated variables. The study followed the concept used by Felipe et al., (2008), avoiding an endogeneity biasness of inputs measured values where an interaction command was used to slot in regional dummies (from both study areas). This method selects a base region, identifying effects that differ significantly from other regions.

¹Translog is the generalization of the Cobb-Douglas production function

3. Data Description

3.1 Household Demography

Household size/labor is an important medium to reduce cost of production. *Ceteris paribus* (with other conditions remaining constant) the greater the household size, the less labor hired. It should also be noted that the larger size of household does not always translate to abundant labor because in some cases, the siblings are too young or they go to school. In another case, some members of the family may have other duties. The household usually comprises the head, the spouse, children, and other relatives as a form of extended family.

Table 1

Socioeconomic Characteristics of Farmers in Niger state and Hainan province

	Category	Niger state	Hainan province
Household size	mean	10.7	5.4
	≥5	91.50%	67.80%
	<5	8.50%	32.20%
Gender	male	96%	94%
	female	4%	6%
Age in year	mean	43.6	49.6
	≥50	33.50%	50.80%
	<50	66.50%	49.20%
Years of Education	mean	5.8	9
	0	42%	3%

Source: Authors' calculation from survey data 2013/2014

In the rural household, men usually assume the leading role. Some cases where a woman leads are situations where she is a widow or the man has other jobs. The survey shows that there are more young rice farmers in Niger state than in Hainan. Despite the young age of the farmers in Niger state, almost half of the farmers do not have any formal education. Education is an important variable for efficiency and development. According to Ogundele and Okoruwa (2006), the level of education determines the adoption of new technology and ability to plan efficiently and take feasible risks.

Regarding rice cultivation, farmers cropped rice in different seasons. In this survey, none of the farmers operated a triple-season (early – mid – late) or early-mid season. The majority of the farmers in Niger state cultivated rice twice a year. The farmers practice either single (rain-fed) or double season (rain-fed and irrigation) rice farming. Hainan farmers on the other hand operate on early-, mid-, and late-season production with a larger percentage of the farmers cultivating during early- and late-season production.

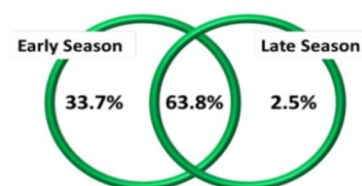


Figure 2a: Niger state

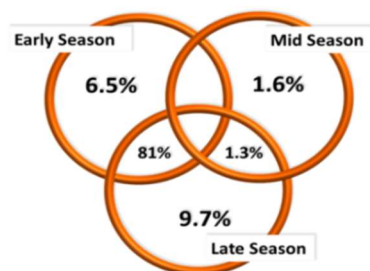


Figure 2b: Hainan province

According to the survey, other than rice, the farmers also grow; maize, guinea corn, groundnut, yam, millet, beans, melon, cassava, vegetables, sugar cane, potato, and soybean. They also rear livestock such as cattle, sheep, goats, chicken, ducks, and turkey. More of the farmers in Niger state diversified their farmland compared to the Hainan farmers who mostly concentrated on rice farming. In Nigeria, most of the farm sizes are of small and medium scale. Rice cultivated areas ranged between 0.2 and 5 ha with an average area of 1.32 ha. However, China's land acquisition is on a short-term contract basis. Thus, they are limiting the number of farmers who can own larger areas due to the large population of farmers. The rice cultivated area in Hainan ranged from 0.1 to 3.3 ha with an average area of 0.43ha.

Table 2

Statistics of Rice Production

	Category	Niger state	Hainan province
Share of cultivated area	Other crops	48%	28%
	Rice only	52%	72%
Changes in rice cultivated area (2013-2014)	Increased	19%	3%
	The same	69%	92%
	Decreased	12%	5%
Seed system	Traditional seed	21%	3%
	Improved/hybrid seed	79%	97%
	Source: previous harvest	68.3%	5%
	Source: other farmers	11.6%	Less than 0.5%
	Source: Market/Extension agent	20.1	95%
Fertilizer system	Source: Market	15%	6%
	Source: others	85%	94%
	Total Average	175.3 kg/ha	618 kg/ha
	Early only	123.4 kg/ha	596.4 kg/ha
	Late only	75 kg/ha	472.5 kg/ha
	Mid only	--	523.2 kg/ha
	Early-Late	234.8 kg/ha	712 kg/ha
Utilization of output (Subsistence/Commercial)	Mid-Late	--	586.2 kg/ha
	Food & equivalent	9.7%	85%
	Sold	86.6%	15%
	Seed	3.2%	--
	Lent out to other farmers	0.5%	--

Source: Authors' calculation from survey data 2013/2014

In Niger state, none of the farmers sowed hybrids but improved (conventional) rice. Remarkably, a large percentage of Hainan farmers sowed hybrid rice, which reveals the success of adopting new varieties. Since there is no hybrid rice sown in Niger state, improved (conventional) varieties are used instead. Most of the farmers used the conventional seed, most of which are more than 20 to 30 years old. For instance, a study discovered that some farmers still use "Yar china2" (local name). The seed is believed to have originated in China about 32 years ago. Commercialization is considered one of the significant factors related to production efficiency (Piya S. et al., 2012). The volume of output, household size and demand, and access to the free market are the major determinants of the level of farm commercialization. From the table above, it is clear that

the majority of Niger state farmers practice a commercial system while Hainan farmers practiced a subsistence system.

3.2 Yield Comparison by Season

In Niger state, yield varies across different groups of farmers and different villages in the state. The average yield recorded was 2.7 MT/ha, which is significantly higher than the FAO estimated national average of 1.8 MT/ha. Seasonally, double-season early-late rice exhibits the highest yield (about 2.9 MT/ha), with an average cultivated area of 1.7 ha. In Hainan, according to the survey, the average yield of farmers in the selected counties is about 4.1 MT/ha, which is slightly lower compared to the 2012 Statistical Bureau estimate (4.8 MT/ha). Seasonally, mid-season rice recorded the highest yield

²"Yar China" was a variety brought into Nigeria in 1983 by then the Governor of Sokoto state who came across the rice variety on an official visit to the China. Till date, the seed is still used by rural farmers. The

variety is seen sown virtually any rice-growing ecology in the country (Longtau 2003)

(5.3 MT/ha) compared to the early and the late season with 4.5 MT/ha and 3.5 MT/ha, respectively.

Table 3

Seasonal Yield of Niger state and Hainan province

Seasons	Category	Average Yield (MT/ha)	
		Niger	Hainan
Total average		2.7	4.1
Total Early	Total early	2.7	4.5
Total Late	Total late	2.8	3.5
Single-season	Early only	2.6	5.31
	Late only	2.3	4.9
	Mid only	--	5
Double-season	Early-Late	2.85	3.8
	Mid-Late	--	3.6

Source: Authors' calculation from survey data 2013/2014

4. Econometric Estimation

Using production function analysis, the explanatory variable "labor" was divided into seven groups related to production stages: land preparation–planting, germination – transplanting, seedling, tiller, booting–flowering, grain filling–ripening, and harvesting. Each of these is the summation of both household and hired labor per hectare. The natural logarithm of each labor per hectare is taken and used in the model.

The variable "major crop" is included in the Niger state model because not all the farmers considered rice as their major crop. The variable "commercialization" was added in the Hainan model, as not all farmers practice a commercial system. Furthermore, the variables pesticide and herbicide are in cost value for Hainan but volume in liters for Niger state. These differences might change the expected assumption of the value of the constant of the two regressions.

The possible influencing factors are diverse under different farm management styles, policy, and environmental conditions. The results of the estimated factors were obtained using backward stepwise regression. As mentioned earlier, the logarithm form of the Cobb–Douglas production function allows us to examine the percentage change in output (yield) if a factor is increased by one percent.

Table 4

Variables Used and Their Definitions

Variables	Definition
Output	
lny	Natural logarithm of yield in kg
Inputs	
sdsos	Dummy: equals "1" if seed is source from a formal market; and "0" if otherwise
Infert	Natural logarithm of quantity of fertilizer in kg
Inhrb	Natural logarithm of herbicide in liters (Niger state) and cost (Hainan province)
Inpst	Natural logarithm of pesticide in liters (Niger state) and cost (Hainan province)
Inmch	Natural logarithm of the cost of machine used
Irrig	Dummy: equals "1" if used irrigation system
lnlpp	Natural log labor per hectare: during land preparation & planting
Intra	Natural log of labor per hectare: during transplanting
lnsdl	Natural log of labor per hectare: during seedling stage
Intibr	Natural log of labor per hectare: during Tiller & branching stage
lnflo	Natural log of labor per hectare: during flowering stage
lngrfi	Natural log of labor per hectare: during grouting & filling stage
Inhv	Natural log of labor per hectare: harvesting
Household characteristics	
lnhh_s	Natural logarithm of household size
gender	Dummy: equals "1" if male
lnage	Natural log of age of the farmer
lnedu	Natural log of the years of education
trained	Dummy: equals "1" if trained; and "0" if otherwise
off_farm	Dummy: equals "1" if have other job(s) not farming; and "0" if otherwise
Agronomics	
lnsd_yr	Natural logarithm of the seed years
dumcom	Dummy: equals "1" if sold produce; and "0" if consumed only (Hainan province)
majo_crp	Dummy: equals "1" if rice is farmer's major crop
Weather	
flood	Dummy: equals "1" if experienced flood; and "0" if otherwise

Hypothetically, we should expect the relationship between the dependent variable “yield” and independent variables “farm input” such as fertilizer, irrigation, machine, and commercialization are expected to be positive based on economic theory. The efficient management of resources is reflected by the literacy of the household head and thus should be expected to have a positive relationship with yield as well. Training on the other hand reflects the quality of extension services provided to the farmers, and the best agronomic method to grow crops is also expected to have a positive coefficient with yield. Moreover, flood as a constraint factor is expected to have a negative coefficient. The discussion of the result of the rice production function of the two study areas and factors they share in common is presented in this section.

4.1 Estimates

The estimated results of the rice production function of the surveyed areas are presented in Table 5, and their definitions are presented in the above Table 4. These variables passed the $p \geq \text{pr}(0.15)$ of the stepwise regression. The interpretation of the coefficients of dummy variables in the models should be different from other interpretations as suggested by Van Garderen and Shah (2002). For instance, if β is the estimated coefficient on a dummy variable, and $V(\beta)$ is the estimated variance of β , then: $\hat{p} = 100 \left[\exp \left(\beta - \sqrt{V(\beta)} \right) - 1 \right]$ gives an estimate of the percentage impact of the dummy on the variable being explained.

Table 5

Stepwise Regression of Rice Production Functions: Niger and Hainan

	Niger state		Hainan province	
	β	t	β	t
sdsos	0.107	1.75*	0.519	3.13**
Infert	0.028	2.78**	0.060	2.03*
lnhrb	--	--	-0.027	-2.63**
lnpst	0.054	3.81***	0.021	1.48
lnmch	--	--	0.020	2.57*
irrig	0.196	1.92*	--	--
lnlpp	--	--	0.053	2.39*
lnsdl	0.095	3.43**	--	--
Intibr	-0.066	-2.68**	--	--
lnhv	0.067	1.63	--	--
lnhh_size	--	--	0.105	1.46
trained	0.127	2.56*	--	--
off_farm	-0.112	-2.27*	0.156	1.67*
agr_org	0.086	1.51	0.135	1.47
majo_crp	0.142	2.66**	--	--
flood	-0.178	-3.47**	-0.128	-2.33*
constant	7.187	52.9***	6.788	20.87***
Number of obs		=164	Number of obs	=183
F(16, 147)		=8.15	F(15, 167)	=9.1
Prob> F		=0.000	Prob> F	=0.000
R-squared		=0.4701	R-squared	=0.4497
Adj R-squared		=0.4124	Adj R-squared	=0.4003
Root MSE		=0.27008	Root MSE	=0.30134

Note: Absolute value of t-statistics in parentheses-(*) statistically significant at 10%; (**) statistically significant at 5%; (***) statistically significant at 1%; Source: Authors' calculation from 2013/2014 survey data

Furthermore, as can be observed from the table above, the number of observations in the Hainan model has been reduced. This is due to some of the missing data from some of the farmers. For instance, not all farmers were comfortable providing information that they considered private and sensitive.

Given that some independent variables are dropped out by the stepwise regression process does not mean in any way the variables are not important to the rice yield but rather means they didn't meet a certain level required to influence yield. Different factors influence yield at different magnitudes in the two surveyed areas. The common significant variables shared by the two models (4b and 5b) include seed, fertilizer, pesticide, off farm jobs, farmers association, and flood.

Individually, irrigation, trained farmers, labor (seedling stage), and "rice as a major crop" are significant to changes in yield in Niger state while herbicide, machine labor (land preparation), and household size are significant to the Hainan model.

The source from which farmers acquired their seeds matters since it determines the type of seed used. In the regression, the dummy "sdsos" (source of seed) represents the seeds acquired from the formal market, which are the improved seed (Niger state) and hybrids (Hainan). These seeds used by the farmers shows a positive relationship to yield in both surveyed areas. Yield is expected to increase by about 11.3% at the 10% level of significance according to the Niger state model. To expedite rice output in Niger state, development of seed technology is one of the key factors to be stressed.

In the Niger state model, the impact of fertilizer to yield was highly significant at 5% with a coefficient of 0.028. In other words, a 1% increase in fertilizer application increases yield by about 2.8%. Given the importance of fertilizer to yield enhancement, the current Nigerian Fertilizer Voucher Program is a big step to curbing these problems. The program has already been implemented in some states and has proven to be effective in providing needed fertilizer to the

needy. In the Hainan model, fertilizer shows a sizeable positive impact on rice yield in the study areas of Hainan with an elasticity of 0.06 at the 10% significance level. Chemical fertilizer plays an integral role to the yield increment in the country, but its overuse has its drawbacks, i.e., increased pest and diseases, which in turn encourages farmers to use even more pesticides and herbicides, which in turn increases environmental pollution (Lu et al., 2004; Escalada et al., 2012).

The result shows that with a 1% increase of pesticide use by Niger state farmers, yield is expected to increase to about 5.4% at a 1% level of significance. The use of pesticide helps to reduce insect and other related pests, but excessive use also harms the environment, including beneficial insects and humans. In Nigeria, apart from the cost, scarcity, and timeliness constraints of the agrochemical inputs, there are reports of sub-standard pesticide circulating in the market. Distribution and control of pesticide will go a long way to offer an efficient production system. In south Asia, many farmers have learned how to control pests and other related constraints by managing the natural predators in the field. In Bolivia and Paraguay, old hazardous pesticides have been taken off the market (FAO 2013; Escalada et al., 2012).

Flood is one of the major menaces to rice production in both surveyed areas. Ojehomon et al. (2009) highlighted flooding as a major constraint to rice production after low use of fertilizer in Nigeria. Annual flooding, especially in Niger state, is a serious problem not only to rice crops but to other crops as well. Flood has the strongest negative impact on yield in the two surveyed areas with about -16.3 and -12% at 5% and 10% statistical significance in Niger state and Hainan, respectively. This result supports our hypothesis of flood having a negative relationship to yield.

Farmers with other jobs than farming (off-farm job) pay less attention to their crop production. This is a common trait of farmers in places like the Bosso local government of Niger state because of their nearness to the city. The regression shows a negative relationship with yield.

Contrary to this, the Hainan model shows a positive relationship to yield. In both regions, farmers' association shows a positive relationship with yield. The irrigation system provides many advantages, such as controlling water supply, use of treatments via the water system, and the possibility of cropping double or triple seasons in a year. The estimate shows that irrigation had the strongest positive impact on yield in Niger state. Farmers that practice irrigation systems are expected to have a 21.7% increase in yield at the 10% level of significance. The coefficient for training was positively significant (at 10%) to yield with an expected impact of 13.5% to yield. The advantages of training farmers cannot be overemphasized.

The relationship between the cost of herbicide invested by the Hainan farmers and the rice yield presented a negative relationship, showing an impact of -0.027 at the 5% significance level. In other words, all things being equal, the reduction in the use of herbicide should have a relative increase to yield. This also reduces the cost of production. In the model, "mch" denotes the total cost on the use of machine, and the estimate reveals that the use of machines has a positive influence on yield at the 10% significance level with a production coefficient of 0.02. All things being equal, the greater the use of machines, the better the yield. Also from the estimate (Hainan), labor (land preparation and planting) shows an impact of 0.053 at the 10% level of significance. It should be noted that the labor used on other stages does not mean they are not essential to rice production, rather than their requirements didn't meet specific levels to influence yield.

5. Conclusion

The rice yield in Nigeria has been relatively stagnant or declining since the 1980s compared to other rice producing countries such as China (one of the world's leading rice producers). Based on the relative similarities in weather conditions, this study estimates the rice yield of two primary rice producing region from Nigeria, Niger state, and from China, Hainan province. The study uses face-to-face interactions with farmers

to provide practical reasons for the differences in yield as well as to identify plausible lessons than can be learned from rice production management. The study used the Cobb-Douglass production function to determine the factors influencing rice yield. The yield between the regions varies greatly: Niger state (2.7 MT/ha) and Hainan (4.1 MT/ha). The yield gap could be deduced from the inadequate essential inputs in Niger state. Despite Hainan having higher yield, the yield is relatively low nationally (in China) because of other factors.

Different factors influenced yield at different magnitudes in the two regions. The study reveals that the seed acquired from the formal market's conventional seeds (the case of Niger state) and hybrid seed (the case of Hainan), fertilizer, pesticide, and participation in farmers' associations are the major important factors the two regions have in common that positively influence yield. Although the outside job of the household head is a common factor between the regions, it has shown to negatively affect yield in Niger state but otherwise in Hainan. Flood affects both regions negatively. Training provides quick knowledge on how to manage farms effectively and a quick adoption of new technologies. In Niger state, training of farmers has proven to increase farmers' yield. More so, farmers that practice irrigation systems and applied adequate pesticides tend to have a better chance of improving their yield. In contrast to Niger state, the application of pesticide by Hainan farmers was not as significant to yield increment. The increment in herbicide application showed a negative impact on yield. Few farmers in Niger state employed the use of machines; but in Hainan, the farmers that applied the use of machines for transplanting and harvesting proved to have a promising effect on yield improvement.

This study shows that seed technology, fertilizer, extension services (training and introducing new technology), irrigation, and mechanization are very important factors to yield improvement. Thus, to achieve a high yield and efficient rice farming, government should invest in essential inputs, providing a solid bedrock for private sec-

tors and international organizations to participate with a proper feedback system to monitor the progress. Most importantly, the introduction of simple and affordable machines, development of an irrigation system to support more seasons, and broadening extension services to remote areas can go a long way and have significant implications on Niger state rice yield and Nigeria as whole. The above findings clearly show that great potential remains to further improve rice yield in both regions given the appropriate investment in essential inputs and management.

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