Profitability Analysis of Smallholder Rice Production under the Urea Deep Placement Technology and Conventional Fertilizer Application Practice in North Central, Nigeria

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ABSTRACT

The study examined the profitability of smallholder rice farmer's under the urea deep placement innovation and conventional fertilizer application practice in north central Nigeria. Systematic, multistage and purposive sampling techniques were adopted to select 398 rice farmers from Niger and Benue States consisting of 197 farmers using the urea deep placement innovation (UDP farmers) and 201 farmers practicing conventional fertilization practices (Non-UDP farmers).The study used primary data which was obtained through the administration of structured questionnaires to the farmers using personal interview. The study covered the 2020/21 wet season cropping year. Data analysis was attained using descriptive statistics, net farm income (NFI) and profitability ratios analysis. The result showed that majority (78%) of the farmers was male; with a mean age of 42 years for UDP farmers and 41 years for Non-UDP farmers. The mean farm size cultivated by the farmers was 1.2ha (UDP farmers) and 1.3ha (Non UDP farmers) in Benue State and 3.6ha (UDP farmers) and 2.3ha (Non-UDP farmers) in Niger State respectively. Rice output (paddy) was estimated at 4.23Mt/ha (3.2Mt/ha milled equivalent) for UDP farmers as against 2.76 Mt/ha (2.1Mt/ha milled equivalent) obtained by Non-UDP farmers. The results indicated that UDP farmers had a mean net farm income of ₦294, 719.26 as against the ₦127, 340.46 obtained by Non-UDP farmers. The key policy statement and recommendation is that UDP technology should be spread widely among Nigerian farmers so that Nigeria can increase and attain self sufficiency in rice production. To achieve this there is need to create more awareness of the Urea deep placement technology and address the challenges militating against its adaption and rice production in the area.

Keywords: Rice; Net farm income; UDP Users; Non-UDP Users; North Central; Nigeria.

INTRODUCTION

The International Fertilizer Development Center (IFDC) reports that about 50% to 70% of applied nutrient using the broadcast and band placement method is not utilized by the crop but are rather lost to the environment through nutrient volatilization and erosion run-off (IFDC, 2013). This may probably explain why rice yields in Nigeria has remained abysmally low at an average of 1.9Mt/ha to 2.2Mt/ha when compared with the global 5.5 Mt/ha and 2.75Mt/ha to 3.25Mt/ha obtained from neighboring rice producing countries in West and Sub-Saharan Africa (USDA, 2019; FAOSTAT, 2018); despite the 63% rise in fertilizers use among rice farmers across the country (Africafertilizer.org, 2018). Rahman *et al.,* (2018) posits that inefficient broadcast application of fertilizers reduces yield by 15% to 18% and increase the cost of production by 33%. Singh *et al.,* (2017) and Phillip *et al.,* (2018), asserts that the cost of fertilizers and labor activities associated with its use alone constitute about 40% to 70% of total rice production cost. This has implication on crop performance and the overall farm enterprise profitability and productivity especially among resource poor Nigerian farmers who produce to earn their living and investment capital from their small size plot holdings.

Washed-off nutrients from cropped field results to reduced crop yields and low farm productivity, most often requires re-fertilization of the fields by farmers. This increases fertilization and labor cost which relatively increases the overall farm production cost leading to low farm profit margins. This has implications on the growth of smallholder farm holdings who most often are under no

insurance cover and most earn their income and investment capital from their farms. The high cost of production may suggest why profitability of smallholder farm holdings remains relatively low and a course for concern, as its multiplier effect has often been manifested as a hike in the prices of food produces and reduced food security especially among the rural and urban poor who constitute over 75% of the Nigerian population (NBS, 2017). Ahmed *et al*, (2017) and Liverpool-Tasie *et al.,* (2016) noted that excess application of fertilizers on cropped fields leads to high accumulation of nitrates in groundwater which is detrimental to sustainable fishery production and human life. Vermeulen *et al.,* (2012) and FAO (2014) showed that inorganic chemical nitrates from over-fertilized agricultural fields contribute about 19% to 29% to the increased green house gases (GHG) volume in the atmosphere. Already, recurrent changing climatic conditions caused by depleting ozone layer from build-up of atmospheric green house gases manifested as hurricanes, floods and prolonged dry spell is being witnessed globally and in Nigeria on an annual basis leading to total loss of farm output and investment capital among farmers

The Urea Deep Placement (UDP) technology is developed by International Fertilizer Development Center while working with rice farmers in Asia (Bangladesh) in the early 1980's to address the challenge of inefficient fertilizer application practice. The concept of the technology is built on improved nitrogen use efficiency in rice production to boost farm productivity and profitability. The technology adopts a two way approach, which begins with the briquetting of inorganic urea to produce a 1.8gm to 2.7gm tablet sized briquette known as urea super granules (USG) using a briquetting machine (IFDC, 2013). The second step involves the meticulous administration of the USG at a depth of 7cm to 14cm between the root zones of every four rice plants one week (7 days) after transplanting using a mechanical applicator or manually (IFDC, 2016; Rattan *et al.,* 2015). The IFDC (2013) claims that the technology has the potential to reduce fertilizer use by one third (20% to 30%) and increase yield at an average of 20% with an estimated rise in rice output by 3.4tons per hectare for all growing seasons. This is because, the applied USG nutrient retained in the root zone of the plants where is optimally absorbed by the plants' during its vegetative, biomass and sprinkle formation for increase yields. The Bangladesh Rice Research Institute (BRRI) reports that the deep burial of the USG into the root zone reduces nutrient losses through leaching, nutrient volatilization and nitrification thus increasing nitrogen use efficiency by the plants (BRRI, 2008).

In 2009, the IFDC flagged off the pilot phase of the UDP Africa initiative in 13 major rice producing West and Sub Saharan countries of Rwanda, Togo, Benin, Ghana, Madagascar, Senegal, Zambia, Tanzania, Burkina Faso, Mozambique, Niger, Mali and Nigeria (IFDC, 2013a) IFDC (2016) posits that the Africa UDP initiative was necessitated by the significant achievement of the technology in improving and sustaining rice productivity gains in Bangladesh, Cambodia, Vietnam and other Asian countries over the last 20 years. The IFDC (2015) asserts that the UDP Africa initiative will help countries address the rising rice deficit, productivity gaps, enhance sustainable and profitable production of rice in the region. The pilot phase of the initiative in Nigeria kicked off in 2010 in nine (9) major rice producing states (Benue, Kebbi, Kano, Jigawa, Kaduna, Niger, Kwara, Ebonyi and Anambra) [(IFDC, 2015)]. To support the initiative, the Federal Government of Nigeria through the Federal Ministry of Agriculture and Rural Development (FMARD), Notore Chemical Industries Limited, IFDC and Maximizing Agricultural Revenue and Key Enterprises in targeted sites II (MARKETS II), a USAID funded project began collaborating on expanding the supply and demand of USG in targeted Nigeria rice producing regions in 2012 (Kiger and Tarfa, 2013). In line with this action, the FMARD approved the introduction of USG fertilizers as one of the agro-inputs distributed the 2014 Growth Enhancement Support Scheme (GES) in Niger, Kano, Kebbi, Jigawa and Sokoto States on a pilot phase base (FEPSAN, 2014).

The broad objective of this paper is to examine the profitability of smallholder rice producers under the urea deep placement and conventional fertilizer application practice in north central, Nigeria. Specifically; this paper attempts to describe the socio-economic characteristics of rice farmers in the study area and secondly, compare the profitability differences of farmers using the UDP innovation(UDP Users) against those practicing the conventional broadcast/band placement of urea fertilizer practice (Non-UDP users). Based on the specific objective of the paper the following research questions were addressed:

(i) What are the socio-economic characteristics of UDP and Non-UDP rice farmers in the study area?

(ii) How profitable is rice production under the urea deep placement technology over the conventional broadcast

of urea fertilizer application practice among farmers in the study area?

As our contribution to the existing literature, we have examined the profitability of UDP technology on rice farm enterprise profitability at the farm-level using standard statistical profitability accounting approach on farmers owned plots. This is because available evidences on the profitability analysis of the UDP were based on field experiments (IFDC, 2009; BRRI, 2008; Tarfa and Kiger, 2013). Findings from this study are expected to support the academia, private researchers, stakeholders as well as policy makers with useful information that will help reform the rice sub-sector and enhance rice farm enterprise viability among smallholder farmers in Nigeria.

LITERATURE REVIEW

Conceptual Framework

Net farm income is a useful farm enterprise planning tool in situations where fixed capital contributes a significant proportion of the farm operations in subsistence agriculture. Yisa *et al.,* (2018) defines net farm income as the profit accrued from the farmer's operations and at such represents the return to the farmer for his personal labor, managerial efforts, interest on his own capital invested in the business and equity capital used in the farm business. Net farm income is sometimes called net income or net profit (Salako *et al*., 2013). Net farm income analysis is conceptualized on the fact that a farm enterprise is an independent and productive unit, which provides common services under a coordinated process (Johnson, 1990 as cited in Raoul *et al.,* 2017). Net farm Income is obtained as the difference between the gross margin and the total fixed cost for a specified farm produce unit within the production cycle, and does not necessarily centre on cash income or revenue obtained from produce sales alone from the farm, but also on that which is consumed by the farm family. The total farm revenue represents the volume of the output from the farm (physical quantity of the crop multiplied by the unit price), while the total cost is the total value of the entire farm input used during the production cycle which comprises of two components (fixed cost and variable cost). Fixed costs are costs incurred on fixed inputs which do not change as production changes and are often in the short run. Variable costs are the short term costs of farm inputs which last within the production cycle and vary with quantity of output produced for a specific farm enterprise unit (Olukosi and Ogungbile, 1982).

Empirical Review

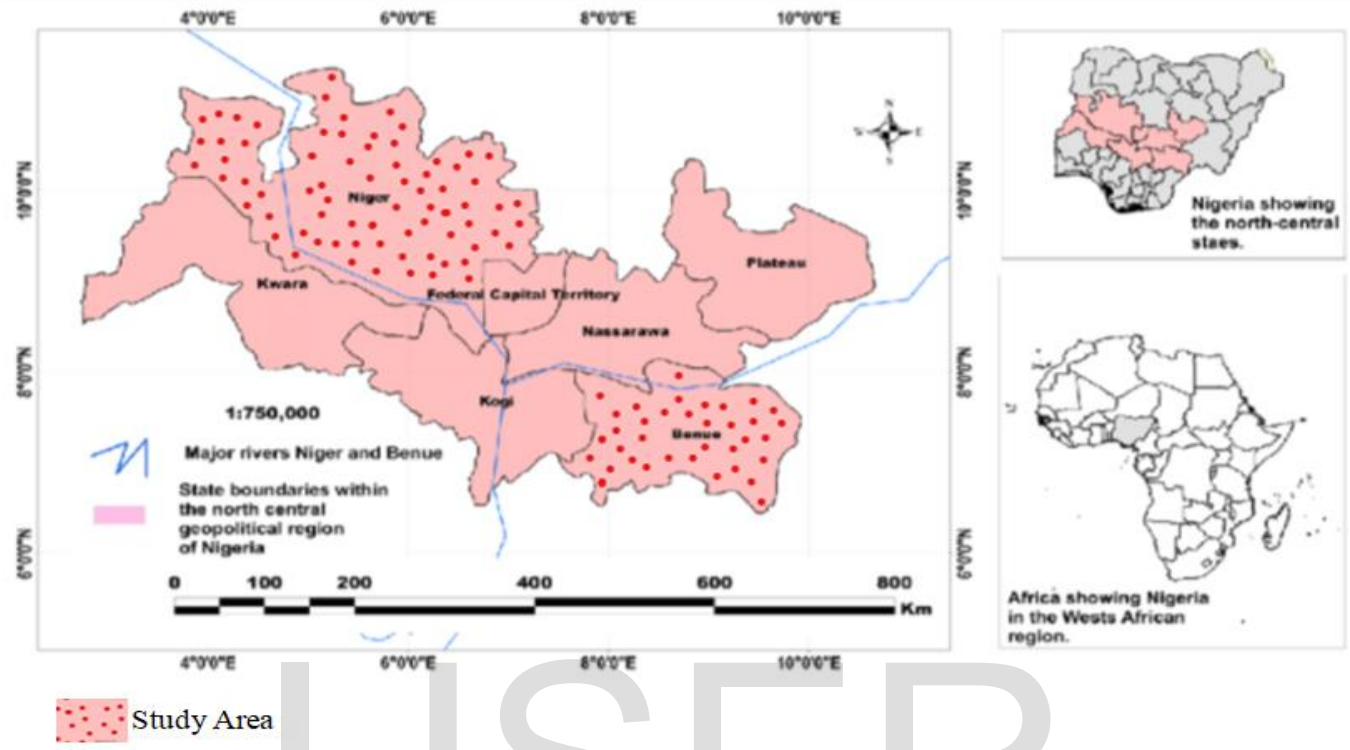
Profitability analysis by Nwahia (2020) found that rice farmers earned an average net farm income of $900.10/ha (₦323, 135.90/ha) with a return on investment of $2.90/ha in South East Ebonyi State of Nigeria. Usman, Aaasa, Balogun and Yahaya (2020) found that the net farm income for mechanized and non-mechanized maize farmers' was ₦310, 100.00/ha and ₦127, 950.00/ha respectively in Kaduna State, Nigeria. The study further revealed that mechanized farmers has a gross ratio of 0.33(33%) and a return on investment on investment of 0.67 (67%) against the 0.34(34%) and 0.66 (67%) earned by the non-mechanized farmers. However, the operating ratio was 0.32 (32%) for both categories of farmers, thus implying that mechanized maize farmers were not more efficient and profitable than non-mechanized maize farmers in the study area. Kadiri,Eze, Orebiyi and Ukoha (2014) obtained a net farm income of ₦307, 071.84/ha and a rate of return on investment of 0.80 (80%) in Niger Delta Region Zone of Nigeria. Yusuf and Adeife (2019) found that the average net farm income of contract and non-contract rice farmers in the derived guinea savannah zone of Nigeria was ₦ 26,400.82/ha and ₦ 2,277.49/ha respectively. Islam *et al* (2017) found that smallholder rice farmers earned higher net farm income of Tk.10292.89/ha than the medium of Tk. 6894.39/ha earned by medium scale farmers while Tk. 4798.70/ha was obtained by large scale rice producers in Bangladesh. Noonari *et al.,* (2016) found a net farm income of Rs. 35,890.00 in Takula Pano Akil District Sukkur Aindh of Pakistan.

STUDY METHODOLOGY

Study Area

The study area is North Central Nigeria consists of six states namely Nasarawa, Benue, Plateau, Niger, Kogi and the Federal Capital Territory and is situated geographically in the middle belt region of the country and spans from the west, around the confluence of the River Niger and the River Benue. It covers latitude 70 00'-110 30' North of the equator and longitude 40 00'-110 00' East of the Greenwich meridian (Olajimedi, 2015). The zone has a land area of 296, 898 km2 representing about 32% of the country's total land area (NBS, 2008) as in Biam *et al.* (2017). Mean annual rainfall ranges between 1,200mm and 1500mm with a temperature of 32^0c to 37^0c almost throughout the year except during the cold and hazy hamattan period (November and lasts until February) which has a range of 20^0c to 21^0c respectively. The vegetation of the area cut across the three savannah belts (Guinea, Sudan and Sahel) and thus permits the favorable cultivation of roots and cereals crops such as yam, cassava,

sweet potatoes, sorghum, maize, rice, cowpea, soybean, groundnut, onion and sugar-cane.



Population and Sampling Techniques

The population for this study consisted of rice farmers using the UDP innovation (UDP farmer) and those using the conventional urea broadcast application practice (Non-UDP farmer) in their rice farm enterprise in selected Local Government Areas (LGAs) of Benue and Niger States of Nigeria. The sample selection for the study was done in multi-stages and purposive selection. In the first stage, two states (Benue and Niger) were purposively selected out of the six (6) states in the North Central. This is because these two states are among the states were the UDP innovation is being promoted and secondly, they are amongst the major producers of rice in the country. In the second stage, one (1) LGA was purposively selected from each of the three (3) agricultural zones in the state. In total six (6) LGAs were sampled. The population of the respondents' (197 UDP farmer and 201 Non-UDP farmers) from the six LGAs was determined using Taro Yamane (1973) formula represented mathematically as:

$$N = \frac{N}{1 + N(e)^2} \quad (1)$$

Where **n** is the sample size, N is the population and e is the level of precision or sampling error of 7% with 95% confidence interval. Given N for the total number of UDP rice farmers = **5,640**, e =7%

$$n = \frac{5{,}640}{1 + 5{,}640\ (0.07)^2} \quad (2)$$

This gives a sample size (n) of **197** for the UDP rice farmers.

$$n = \frac{12{,}497}{1 + 12497\ (0.07)^2} \quad (3)$$

Also given **12,497** as the total population (N) of non UDP rice farmers, with sample error of 7% at 95% confidence interval, the sample size for the non UDP rice farmers was obtained as **201.**

Proportionate Stratified Random Sampling was used to determine the sample size for each category of farmers from the sampled LGA and is applied as follows;

Using the above formula, the total sample size (n) for both categories of farmers was calculated as **398** as represented in **table 1**:

$$n_h = \frac{N_h}{N} * n \quad (4)$$

Where

n_h= Sample size for h^{th} stratum (per each LGA);

N_h= Population size for h^{th} stratum (number of UDP and Non- farmers) in each LGA;

n = Size of entire sample= as determined by Yamane (1967) ;

N =Total population of UDP farmers/ No-UDP farmers.

Table 1: Sample Selection

State	Zone	LGA	Sampling frame	Sample size / LGA
Benue	Nort	Gwer Eas	UDP farmers : 1,500	52
			Non-UDP farmers: 2,882	46
Benue	East	Kwande	UDP farmers : 940	33
			Non-UDP farmers: 1394	23
Benue	Centr	Okpokwu	UDP farmers : 800	28
			Non-UDP farmers: 1961	32
Niger	Nort	Wushishi	UDP farmers : 1,000	35
			Non-UDP farmers: 1577	25
Niger	Sout	Katcha	UDP farmers : 700	24
			Non-UDP farmers: 1,805	29
Niger	East	Shiroro	UDP farmers : 700	24
			Non-UDP farmers: 2,878	46
			Total	**398**

Source: Author's Computation adopted from the sample frame of Niger and Benue States' Agricultural Development Programme (ADP) & IFAD-Rice Value Chain Development Project, 2020

Variable and Model Specification

(i) Sex of farmers (Male =1 and female =2) (ii) Age of farmers (years) (iii) farming experience (in years); (iv) Farmers household size (Numbers); (v)farm plot measured in hectares (vi) farm output measured in Tons/ha, (vii) USG measured in Kg/ha, (viii) fertilizers (prilled urea) measured in kg/ha; (ix) agrochemicals measured in kg/Ltr/ha

Following Yisa *et al,* (2018) net farm income is obtained as specified;

$$NFI = GM - TVC \quad (5)$$

$$GM = GFR - TVC \quad (6)$$

But:

$$GFR = P \times TQ \quad (7)$$

$$\pi = GFR - TFE \quad (8)$$

$$TFE = TFC + TVC \quad (9)$$

Where;

GM = Gross margin; GFR = Gross farm revenue (₦/ha); π = Profit from farm output sells; TVC = Total variable cost; TFC = Total fixed cost; TFE = Total farm expenditure; P = Price of farm produce; TQ = Total quantity of farm produce

(i). Gross Ratio (GR) = TFE ÷ GI (10)

(ii).Operating Ratio (OR) = TOC ÷ GI (11)

(iii). Return on Investment (ROI) = NFI ÷ GFR (12)

RESULTS AND DISCUSSION

Socio-economic Characteristics of Farmers

The distribution of the respondents according to their socioeconomic characteristics is summarized in tables 2 to 7. The result on respondents' sex as represented in table 2 revealed that majority (77.6% of UDP and 78.1% of Non-UDP) was male; while 22.5% (UDP farmers) and 21.4% (Non-UDP farmers) were female. This result implies that rice farming in the area is dominated by male farmers. The labor intensiveness and long hours spent on several activities involved with rice production may be the constraining factor to low women involvement in rice production. Similar results were reported by Ogunmefun and Achike (2015) and Afolami *et al.,* (2012) who noted that male farmers dominate the Nigeria rice sub-sector.

Table 2: Distribution of Respondents by their Sex

Sex	Benue State		Niger State	
	UDP Farmers	Non-UDP Farmers	UDP Farmers	Non-UDP Farmers
	Freq / (%)		Freq / (%)	
Male	95 (84.1)	84 (83.2)	57 (68.7)	74 (73.5)
Female	18 (15.9)	17 (16.8)	26 (31.3)	26 (26.5)

Source: Field Survey, 2021

The distribution of the respondents according to their ages is represented in table 3. The result reports a mean age of 37 years for both categories of farmers in Niger State with a standard deviation of ±9.03 for UDP farmers and ±13.2 for Non-UDP farmers. However, in Benue State the mean age is 44 years with a standard deviation of ±9.82 for UDP and ±9.03 for Non-UDP farmers. Specifically, majority (63%) of UDP farmers and (56%) of Non-UDP farmers in Niger State are within the age range of 21 to 40 years as against 35.4% (UDP farmers) and 34% (Non-UDP farmers) observed in Benue State. The result suggests that rice producers in Niger State are younger than their counterpart in Benue State. Based on these findings, it can be inferred that rice producers in both state are middle aged and agile with the capacity to handle any tedious laborious operations associated with the UDP technology. Olowosegun (2004); Egbe & Eze (2014) and Abubakar *et al* (2017) also reported that rice production is dominated by young farmers in the age bracket of 31-50 years who are more likely to accept and serve as better agents of innovation acceptance and transfer.

Table 3: Distribution of Farmers according to their Age

Age in years	Benue State		Niger State	
	UDP Farmers	Non-UDP Farmers	UDP Farmers	Non-UDP Farmers
	Freq / (%)		Freq / (%)	
Less 20 yrs	1 (0.88)	0 (0.0)	2 (2.4)	7 (7.00)
21 – 40 yrs	4 (35.4)	34 (33.7)	52 (62.7)	56 (56.0)
41 – 60 yrs	70 (62.0)	66 (65.4)	28 (33.7)	33(33.0)
Above 60 yrs	2 (1.8)	1 (0.99)	1 (1.2)	4 (4.0)
Mean	43.6	44.2	38.6	37.3
SD	±9.82	±9.03	±9.03	±13.2

Source: Field Survey, 2021
SD: Standard Deviation

The examination of the respondents' educational background is summarized in table 4. The result indicates that majority (28.5% to 45.8%) of both categories of farmers had at most 7-12 years (Secondary school level) as their highest educational attainment. Specifically, 17% of both

Categories of producers in Benue State, 30.1% (UDP farmers) and 38% (Non –UDP farmers) in Niger State did not have any form of formal or informal education. However, 27.4% (UDP farmers and 35.6% (Non UDP farmers) in Benue State had post secondary education; while in Niger State the proportion of farmers with post secondary education was 19.3% (UDP farmers) and 13% (Non-UDP farmers) respectively. These findings suggest that a significant proportion of the farmers are literally informed and at such they would be more open to adapt new farming innovations and make meaningful management decisions that would improve their farms' enterprise profitability. This finding is contrary to Manza and Atala (2014) and Igboji, Anozie and Nneji (2015) who reported the highest educational years of for farmers in north east Borno and south east Ebonyi States of Nigeria as 1 to 6 years.

Table 4 : Educational years of Respondents

No of years	Benue State		Niger State	
	UDP Farmers	Non-UDP Farmers	UDP Farmers	Non-UDP Farmers
	Freq / (%)		Freq / (%)	
0 yrs	17 (15.0)	17 (16.8)	25 (30.1)	38 (38.0)
1-6 yrs	26 (23.0)	19 (18.8)	4 (3.61)	11 (11.0)
7 -12 yrs	39 (34.5)	29 (28.7)	38 (45.8)	37 (37.0)
Above 13 yrs	31 (27.4)	36 (35.6)	16 (19.3)	13 (13.0)

Source: Field Survey, 2021

The analysis of the respondents' farm size holding is indicated in table 5. The result revealed a mean farm plot is 1.2ha for UDP farmers and 1.3ha for Non-UDP farmers in Benue State. However, for UDP farmers and Non UDP farmers it is estimated at 3.6ha and 2.3ha respectively. The result suggests that majority of the respondents are subsistent and smallholder farmers. This findings buttresses Evans and Meade (2006) assertion that Nigerian agricultural sector has been left largely in the hands of poor and subsistence farmers, whose average holding range from 1ha to 3 ha with limited potential to benefit from economies of scale. Umar *et al.,* (2014) reported a mean farm size of 2.4ha in Niger State. Similarly, Ehrabor *et al* (2013) also estimated the mean farm size for crop producers in Nigeria as 2.9ha.

Table 5: Respondents Farm Plot Holdings

Farm Size in Hectares	Benue State		Niger State	
	UDP Farmers	Non-UDP Farmers	UDP Farmers	Non-UDP Farmers
	Freq / (%)		Freq / (%)	
Less than 1ha	0	3 (2.97)	1 (1.20)	0
1.1-3.0 ha	113 (100)	96 (95.1)	49 (59.0)	81 (81.0)
3.1-6.0 ha	0	1 (0.99)	19 (22.9)	15 (15.0)
Above 6ha	0	1 (0.99)	14 (16.9)	4 (4.00)

Source: Field Survey, 2021

The outcome of the distribution of farmers according to the size of their household is presented in table 6. The result revealed a mean household size of 8 members for UDP farmers in Benue and Non-UDP farmers in Niger State respectively. However, UDP farmers in Niger State had a mean household size of 7 members while Non-UDP farmers in Benue State had a mean hold house size of 9 members respectively. This finding suggests that rice production in the area is dominated by large household sized farm families. This has implications on labor availability and total land area cultivated by the household especially for the USG application which is labor intensive and requires more man-day when carried out manually. With more hectare put into cultivation, the possibility of increased marketable surplus and reduced cost of labor can be achieved. The result conforms to the findings by Ajah and Ajah (2014) which reveals a mean household size of 8 members amongst rice farmers in Abuja the Federal Capital Territory in north central, Nigeria.

Table 6: Status of Respondents Household Size

Household Size (No)	Benue State		Niger State	
	UDP Farmers	Non-UDP Farmers	UDP Farmers	Non-UDP Farmers
	Freq / (%)		Freq / (%)	
Less than 5	21 (18.6)	10 (9.9)	14 (16.9)	31 (31.0)
5 – 10	66 (58.4)	59 (58.4)	45 (54.2)	38 (38.0)
11 – 15	24 (21.2)	30 (29.7)	14 (16.9)	25 (25.0)
Above15	2 (1.8)	2 (2.0)	10 (12.1)	6 (6.0)
Mean	7.67	8.76	6.64	8.21
SD	± 3.53	± 3.46	± 3.88	± 5.16

Source: Field Survey, 2021
SD: Standard Deviation

The distribution of the respondents according to their years of farming experience is summarized in table 7. Findings revealed that the mean years of experience by both categories of farmers was 13 years (SD = ±7.19 and ±10.4) for Non -UDP farmers in both states; 15 years (SD = ±9.57)

for UDP farmers in Niger State and 12 years (SD = ±6.13) for UDP farmers in Benue State respectively. However, majority (50.4% and 38.6%) of UDP and Non-UDP farmers in Benue State; 47% (UDP farmers) and 60% (Non-UDP farmers) in Niger State fall into the farming experience bracket of less than 11 years. This result implies that rice producers in the area are new entrant farmers and may not be highly experienced with farm management capacity, specialization and expertise skills developed over long years of continued farming.

Table 7: Farming Experience of Respondents

Farming Experience (Years)	Benue State		Niger State	
	UDP Farmers	Non-UDP Farmers	UDP Farmers	Non-UDP Farmers
	Freq / (%)		Freq / (%)	
Less than 11	57 (50.4)	39 (38.6)	39 (47.0)	60 (60.0)
11-20	46 (40.7)	47 (46.5)	27 (32.5)	18 (18.0)
21-30	10 (8.9)	14 (13.9)	11 (13.3)	15 (15.0)
Above30	0	1 (0.99)	6 (7.23)	7 (7.00)
Mean	11.7	13.1	14.7	13.2
SD	± 6.13	± 7.19	± 9.57	± 10.4

Source: Field Survey, 2021
SD: Standard Deviation

Net Farm Income Analysis

The net farm income analysis of UDP and Non-UDP farmers in Benue and Niger States is summarized in tables 8 and 9. The result showed that the mean total variable cost (TVC) incurred by Non UDP farmers' in Niger State was ₦231,376.82/ha (89.8%) of the overall total cost of production; while in Benue state it was ₦260,893.79/ha (90.7%) respectively. For UDP farmers, the mean total variable production cost in Niger was ₦271, 964.47/ha and ₦307, 149.02/ha in Benue State representing 91.1% and 90.6% respectively of the overall production cost. Specifically, the mean variable spending by Non UDP farmers in Niger state for farm input (seed and agrochemicals) was ₦62, 617.32/ha (27.1%) of the total variable cost, while in Benue State it was ₦56, 806.98/ha (21.8%). For UDP farmers in Niger State, the mean cost spending on farm input (seeds, USG and agrochemicals) was of farm input was ₦48, 183.00/ha (17.7%) and in Benue State it was ₦50, 718.40/ha (16.5%). The result concurs with several literatures (IFDC, 2013, Liverpool-Tasie *et al.,* 2017; Rattan, 2014; Sandizur *et al.,* 2015 on the reduced cost of fertilization among farmers who adopted the UDP technology in rice production

The mean gross revenue (GR) obtained by UDP farmers in Niger State was ₦576,571.20/ha as against ₦375, 001.80/ha by Non-UDP farmers; while in Benue State, the estimated mean gross revenue was ₦651,485.46/ha for UDP farmers as against ₦425, 096.50/ha for Non-UDP farmers respectively. The gross margin (GM) analysis is estimated at ₦143, 624.98 for Non-UDP farmers and ₦304, 606.73 for UDP farmers in Niger State; while Benue State UDP farmers had a mean gross margin of ₦344, 336.44 for UDP farmers as against ₦164, 202.71 respectively for Non-UDP farmers. Similarly, the mean net farm income (NFI) of ₦ 276, 986.68/ha was obtained by UDP farmers as against ₦117, 354. 27/ha obtained by Non-UDP farmers in Niger State, and in Benue State the mean estimated NFI for UDP farmers was ₦ 312,451.84 /ha as against ₦137, 326.64/ha by Non-UDP farmers. The difference in NFI margin for UDP farmers as against Non-UDP farmers was ₦175, 125.20 in Benue State and ₦159,632.41/ha in Niger State respectively. These findings are much higher than the average NFI of ₦147,900/ha (UDP farmers) and ₦43,966/ha (Non-UDP farmers) obtained by Kiger and Tarfa (2013) for both categories of farmers for the 2012/2013 dry (irrigation) planting season in Gombe, Niger, Kebbi States.

Profitability Ratio Analysis

The profitability index analysis as indicated in tables 8 and 9 revealed a gross margin ratio (GR) of 0.48 (48%) for UDP farmers in both states as against 0.31(31%) for Non-UDP farmers in Niger State and 0.32(32%) for Non-UDP producers in Benue State respectively. The result suggests that UDP farmers retain a higher percentage (48%) of each one naira invested in the rice farm enterprise as against their Non-UDP users (31% and 32%) in Niger and Benue State. The return on investment (ROI) revealed a ratio of 0.46 (46%) and 0.48 (48%) for Non-UDP farmers in Niger and Benue States; while the UDP farmers in both states had a ROI ratio of 0.92 (92%) each respectively. These results implies that UDP users have 43% and 44% higher return on each ₦1.00 naira invested on the farm than Non-UDP farmers in both states respectively. From the findings, it can be inferred that rice production under the urea deep placement innovation is more profitable over production using the conventional fertilization application practice. In the same vein, the operating ratio (OR) is estimated at 0.25 (25%) for Non-UDP farmers as against 0.20(20%) for UDP farmers in Niger State; while in Benue State the operating ratio for Non -UDP farmers was 0.29(29%)

and 0.21(21%) for UDP farmers respectively, thus implying that UDP farmers incurred low cost of managing and operation on the average their rice farm enterprise than their Non-UDP counterparts rice producers.

Kadiri *et al.* (2014) reported a net farm return of 0.12% and gross ratio margin of 0.80 (80%) among smallholder rice farmers in the Niger Delta region of Nigeria.

Table 9: Profitability Analysis of UDP and Non UDP Users Rice Producers In Benue State

		Non-UDP Users			UDP Users		
Variable cost	**Unit of Me**	**Qty/ha**	**Unit cost**	**Cost/ha**	**Qty/ha**	**Unit cost**	**Cost/ha**
Seed	kg	70.6	216.71	15,299.73	57.4	385.2	22,110.48
Fertilizer(Prilled Urea)	kg	96.5	295.43	28,509.00	38.8	252.15	9,783.42
Urea as USG	kg	-	-		25.3	505	12,776.50
Herbicides	Kg/Ltr	5.6	1,996	11,176.76	3.5	1,728	6,048.00
Pesticides	Kg/Ltr	1	1,822	1,821.50			
Land preparation	Man-day	4.5	1,733	7,798.50	4.5	1,729	7,780.50
Nursery Cost	Man-day	1	2,148	2,148.00	1	2,215	2,215.00
Planting / transplanting	Man-day	5	1,722	8,610.00	6	1,729	10,374.00
Agrochemical application	Man-day	8	1,516	12,124.16	5	1,521.2	7,606.00
USG application	Man-day	-	-	-	10	2,000	20,000.00
Cost of bird scaring	No	10	312.12	3,121.20	10	313	3,130.00
Harvesting cost	Man-day	5	1,705	8,522.70	7	1,716	12,009.76
Threshing & winnowing	Man-day	5	2012.5	10,062.25	8	2014.42	16,115.36
Transport Cost (within locality & market)	Km/bag	27.5	700	19,250.00	42.2	700	29,540.00
Cost of bagging/labor	No	27.5	300	8,250.00	42.2	300	12,660.00
Operating/ Managerial cost	Man-day	90	1380	124,200.00	90	1500	135,000.00
Total Variable Cost				**260,893.79**			**307,149.02**
Revenue	**₦/ha**	2,755	154.3	**425,096.50**	4,222.20	154.3	**651,485.46**
GM	**₦/ha**			**164,202.71**			**344,336.44**
Fixed Cost							
Cost of land rent	**₦/ha**	1	11,000	11,000.00	1	11,000	11,000.00
Dep on cutlass	**₦/ha**	3	512	1,537.35	3	513	1,539.66
Dep on tilling hoes	**₦/ha**	3	2,233	6,699.72	3	2,235	6,706.44
Dep on other equipment	**₦/ha**	1	5,127	5,127.00	1	9,518	9,518.00
Interest on capital	**₦/ha**	1	2,512	2,512.00	1	3,121	3,120.50
Total Fixed Cost				**26,876**			**31,885**
Total Farm Expenditure	**₦/ha**			**287,769.86**			**339,033.62**
NFI	**₦/ha**			**137,326.64**			**312,451.84**
Return on Investment (ROI				0.48			0.92
Gross Margin Ratio (GR)				0.32			0.48
Operating Ratio (OR)				0.29			0.21

Source: Field Survey, 2021

Table 8: Profitability Analysis of UDP and Non UDP farmers in Rice Production In Niger State

Variable Cost	Unit of measure	Non-UDP Farmers			UDP Farmers		
		Qty/Ha	Unit cost	Cost/Ha	Qty/Ha	Unit cost	Cost/Ha
Seed	kg	76.62	309.83	23,739.17	51.14	385	19,689
Fertilizer(Prilled Urea)	kg	101.42	251.37	25,493.95	35.5	164.2	5,829
Urea as USG	kg	-	-		32.6	500	16,300
Herbicides	Ltr	5.69	2,000	11,380.00	3.25	1,958.33	6,365
Pesticides	Ltr	1.1	1,822	2,004.20	0	1,898	0
Land preparation	Man-day	4	1,545	6,180.00	4	1,645	6,580
Nursery Cost	Man-day	1	1,722	1,722.00	1	1,748.20	1,748
Planting / transplanting	Man-day	5	1,650	8,250.00	5	1,550.80	7,754
Agrochemical application	Man-day	8	1,505	12,040.00	4	1,560.80	6,243
USG application	Man-day			0.00	10	1,800	18,000
Cost of bird scaring	No	10	300.25	3,002.50	10	300.25	3,003
Harvesting cost	Man-day	5	1,550	7,750.00	7	1,580	11,060
Threshing and winnowing	Man-day	6.00	1500	9,000.00	8	1500	12,000
Transport cost (within locality & market)	Km/bag	27.7	650	18,005.00	42.52	650	27,638
Cost of bagging/labor	No/M-day	27.7	300	8,310.00	42.52	300	12,756
Managerial /operational cost	Man-day	90	1050	94,500.00	90	1,300	117,000
Total Variable Cost				**231,376.82**			**271,964.47**
Revenue	**₦/ha**	2765.5	135.6	375,001.80	4252	135.6	576,571.20
GM	**₦/ha**			143,624.98			304,606.73
Fixed Cost							
Cost of land rent	Ha	1	10,000.0	10,000.0	1.0	9,000.0	9,000.0
Dep on cutlasses	No/Ha	3	504.4	1,513.1	3.0	502.4	1,507.2
Dep on hoes (Tilling & Ploughing)	No/Ha	3	1,885.72	5657.3	3.0	2085	6255
Dep on other equipment	No/Ha	1	5,120.2	5,120.2	1.0	6,873.6	6,873.6
Interest on capital	₦/Ha	1	3,980.2	3,980.2	1.0	3,984.2	3,984.2
Total Fixed Cost	₦/Ha			**26,270.71**			**27,620.05**
Total Farm Expenses	₦/Ha			**257,647.53**			**299,584.52**
Net Farm Income (GM)	₦/Ha			**117,354.27**			**276,986.68**
Return to Investment (RI)				0.46			0.92
Gross Margin Ratio (GR)				0.31			0.48
Operating Ratio (OR)				0.25			0.20

Source: Field Analysis. 2021

CONCLUSION and RECOMMENDATION

The result of this study shows that generally rice production is highly profitable; nonetheless rice farm enterprise under the UDP innovation is more profitable and operationally more efficient than production under the conventional fertilization application practice. To improve profit and resource use under the UDP technology, there is need to; For government to continue to initiate and sustain strategies to improve back-up capital for farmers so as to keep them on the farms, especially as majority of these farmers are still in their economically active ages when the capacity to involve in new innovations that will improve their farm output is often very high.

1. Policy measures should be aimed at restructuring and rebuilding worn out market institutions and facilities (warehouses, stalls, roads and markets) especially in rural communities to open more linkages and connectivity especially in interior rural areas with very high food production capacity

2. Since the UDP technology requires high level of technicality in its application, there is need for government to recruit and train more extension agents to facilitate farmer's access to the right information on the technology use.

3. There is need for private sector government partnership in the establishment of USG production factories and its complementary implements (briquetting machines and mechanical applicators) to facilitate the availability and reduced price of the USG among rural farmers.

4. Government should also initiate and review its policies on incentives to help resource poor farmers overcome the huge investment cost of rice production. These measures should include ensuring access to good quality improved seed varieties at affordable prices, enhancing research in seed security, sustaining bans rice importation to encourage local production and putting up strategies that will open new opportunities for rice export.

5. There is need for group formation among farmers to help them build structures that will strengthen their capacity to find markets and new opportunities where their produce would be sold at more profitable and favourable prices.

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