

Profitability Analysis of Smallholder Rice Production Under 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 urea deep placement innovation and conventional fertilizer application practice in north central Nigeria. The study was carried out in six (6) LGA's of Wushishi, Shiroro and Katcha in Niger State and Gwer East, Okpokwu and Kwande in Benue State respectively of North Central Nigeria. The study was guided by two objectives which were analyzed using descriptive statistics and standard farm management accounting models. Systematic, multistage and purposive sampling techniques were adopted to select 398 rice farmers from the study area consisting of 197 farmers using the urea deep placement innovation (UDP farmers) and 201 farmers practicing the conventional broadcast of urea fertilizers (Non-UDP farmers) for rice production. The structured questionnaire used to source the primary data for the study was administered by trained field extension agents to the respondent farmers using personal interview. However, assistance was given to farmers who were unable to read or understand the contents of the questionnaire. Findings from the study revealed that majority (78%) of the farmers were male; with mean age of 42years for UDP farmers and 41years 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, while in Niger State it was 3.6ha (UDP farmers) and 2.3ha (Non-UDP farmers) respectively. UDP farmers harvested an average output (paddy) of 4.23Mt/ha (3.2Mt/ha milled equivalent) as against 2.76Mt/ha (2.1Mt/ha milled equivalent) obtained by Non-UDP farmers. The Net Farm Income (NFI) and profitability ratio analysis revealed that UDP farmers earned a mean net farm income of ₦276, 986.68 as against the ₦117, 354.27 earned by Non-UDP farmers in Niger State; while in Benue State the mean NFI was estimated as ₦312, 451.84 for UDP farmers as against the ₦137, 326.64 earned by Non-UDP farmer respectively. The profitability ratio analysis revealed a return on investment (ROI) of 0.92 (92%) for UDP farmers in both states; while it was 0.46 (46%) and 0.48 (48%) for Non-UDP farmers in Niger and Benue State respectively. These results implies that UDP farmers had a higher return of (0.44) 44% for each invested naira (₦) over their Non-UDP counterpart from both states. The key policy statement and recommendation from the study is that UDP technology should be spread widely among Nigerian rice farmers to enhance the countrys' capacity to increase output 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 among rice producers in the area and country at large.

Keywords: Rice, Smallholder, UDP Farmers, Non-UDP Farmers, Profitability, Niger State, Benue States, Nigeria

1. Introduction

The International Fertilizer Development Centre (IFDC) reports that about 50% to 70% of applied nutrients 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 [14]. This may probably explain why rice yield in Nigeria has remained abysmally

low at an average of 1.9Mt/ha to 2.2Mt/ha when compared with the global 5.5Mt/ha and 2.75Mt/ha to 3.25Mt/ha obtained from neighboring rice producing countries in West and Sub-Saharan Africa [12, 28, 35, 46]; despite the 63% rise in fertilizers use among rice farmers across the country [3]. Rathnayaka, Mahendran, Iqbal and Rifnas (2018) noted that inefficient broadcast application of fertilizers reduces yield by 15% to 18% and increases the cost of production by 33% [38]. Consequently, the cost of fertilizers and labor activities associated with its use alone constitute about 40% to 70% of total rice production cost [36]. This has implications 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 performance and low farm productivity, which most often requires re-fertilization of the affected fields by farmers [40, 43]. Re-fertilization increases the quantity and cost of inputs used as well as labor cost and relatively the overall farm production cost which often affects the profit margins earned by the farm enterprise [44, 31]. This has implications on the growth of smallholder farm enterprises who most often are under no insurance cover and must earn their income and investment capital from the profits of their farms. The high cost of production may suggest why profitability of smallholder farm holdings remains relatively low and a cause for concern. The multiplier effect of inefficient use of farm inputs is manifested in low yield, scarcity of stocks and its resultant hike in food prices which limits food availability and access thus undermining both household and national food security. Of most particular concerns are the over 80% Nigerian rural producers' household and the urban poor who rely hugely on the market to meet their daily food needs. Ahmed *et al.*, [2017] and Liverpool-Tasie *et al.*, [2015] noted that excess application of fertilizers on cropped fields leads to high accumulation of nitrates in groundwater which is detrimental to sustainable fishery and livestock production as well as human life [6, 22]. Evidences [Adelana, 2006; Khatun *et al.*, 2015; Liu *et al.*, 2014; M. S Swaminathan, 2016; Singh *et al.*, 2017 and Vermeulen *et al.*, [48] have shown 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 [1, 20, 21, 27, 43, 48]. Already, recurrent changing climatic conditions caused by depleting ozone layer from build-up of atmospheric greenhouse gases which is 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.

Urea Deep Placement (UDP) technology was developed by the International Fertilizer Development Center while working with rice farmers in Asia (Bangladesh) in the early 1980's to address the challenge of inefficient fertilizer use among farmers. The technology's concept was built on improved nitrogen use efficiency in rice production to boost

farm productivity and profitability. The UDP innovation adopts a two way approach, which begins with the briquetting of inorganic urea fertilizer to produce a 1.8gm to 2.7gm tablet sized briquette known as urea super granules (USG) using a briquetting machine [14]. The second step involves the meticulous administration of the USG at a depth of 7cm to 14cm between the root zone of every four rice plants one week (7days) after transplanting using a mechanical applicator or manually [8],[40]. The International Fertilizer Development Centre claims that the technology has the potential to reduce fertilizer use by one third (25% to 40%) and increase yield at an average of 20%. This is because the applied USG nutrient is retained in the root zone of the plants where it can be optimally absorbed and utilized by the plants during its vegetative stage for healthy biomass and sprinkle formation that enhances increased yields. Furthermore, the deep burial of the USG into the root zone reduces the quantity available on the surface of the soil, which minimizes nutrient losses from erosion run-off, nutrient volatilization and nitrification thus increasing nitrogen use efficiency by the plants [42, 43]. Nayak *et al.*, [2017], describes the UDP technology as an environment friendly technology that enhances yield and nitrogen use efficiency [31].

In 2009, the IFDC flagged-off the pilot phase of the UDP Africa initiative in thirteen (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 [2013] 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 20years [15]. IFDC [2016] 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 [16].

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). 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 (MARKETSII), a USAID funded project began collaborating on expanding the supply and demand of USG in targeted Nigeria rice producing states in 2012. 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 [15, 44].

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, compares the profitability differences of farmers' using the UDP innovation (UDP farmers) against those practicing the conventional broadcast/bandplacement of urea fertilizer (Non-UDP farmers). 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?

Inferences generated from the study will assist a wide range of stakeholders including government and non-governmental organisations, development and research institutions, farmers, extension service providers and the academia to formulate, design and implement initiatives that will influence policy actions on improving agricultural productivity in the rice sub-sector. In addition, information obtained from the study will help enhance rice farm enterprise viability among smallholder farmers in Nigeria.

2. Materials and Methods

2.1. Conceptual Framework

Net farm income (NFI) analysis 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 owned capital invested in the business as well as equity capital used in the farm business [50]. Salako *et al.*, [2013] posits that net farm income is sometimes called net income or net profit [41]. 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 [39]. It is obtained as the difference between the gross margin and the total operating 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 gross margin is obtained from the difference between the total farm revenue and the overall cost of production. 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 long 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 [34] as cited in [47].

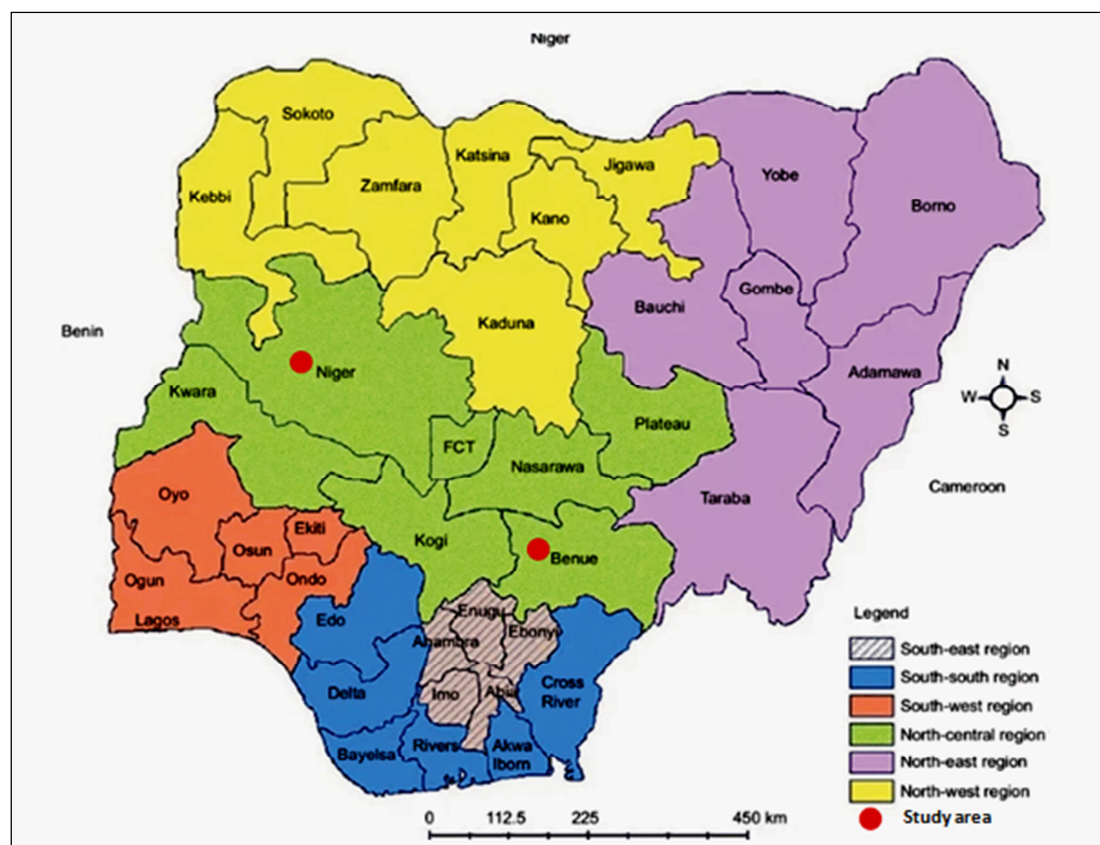


Figure 1. Map of Nigeria showing the Study Area.

2.2. 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 2.9% in South East Ebonyi State of Nigeria [32]. Usman [2020] reported 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 [47]. The study further revealed that mechanized farmers have a gross margin ratio of 0.33 (33%) and a return on investment of 0.67 (67%) as against the 0.34 (34%) and 0.66 (67%) earned by the non-mechanized farmers'. The operating ratio of 0.32 (32%) for both category of farmers was reported, implying that mechanized maize farms were not more efficient and profitable than non mechanized maize farms in the study area. Kadiri, Eze, Orebiyi and Ukoha [2014] obtained a net farm income of ₦307,071.84/ha and a return on investment ratio of 0.80 (80%) in Niger Delta Region Zone of Nigeria [19]. 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 [51]. Islam, Begum, Sharmin and Khan [2017] found that smallholder rice farmers' earned higher net farm income of Tk.10, 292.89/ ha than the Tk 6,894.39/ha and TK 4,798.70/ha earned by medium scale farmers and large scale rice producers respectively in Bangladesh [18]. Noonari *et al.*, [2016] found a net farm income of Rs.35,890.00 in Takula Pano Akil District Sukkur Aindh of Pakistan [30].

2.3. Study Area

The study area is North Central Nigeria which consists of six states namely Nasarawa, Benue, Plateau, Niger, Kogi, Kwara and the Federal Capital Territory. The area 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 7,000' - 11,030' North of the equator and longitude 4 000' - 11000' East of the Greenwich Meridian [10]. The region has a land area of 296,898km² representing about 32% of the country's total land area. Mean annual rainfall ranges between 1,200mm and 1500mm with a temperature of 32°C to 37°C almost throughout the year except during the cold and hazy hamattan period (November and lasts until February) with a temperature range of 20°C to 21°C respectively [28]. The vegetation of the area cuts 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 [5].

2.4. Population and Sampling Techniques

The population for this study consisted of rice farmers using the UDP innovation (UDP farmers') and those using the conventional urea broadcast application practice (Non-UDP farmers') in their rice farm enterprise from selected Local Government Areas (LGAs) of Benue and Niger States of Nigeria. The sample for the study was done in multi-stages and purposive selection procedures. In the first stage, two states (Benue and Niger) were purposively selected out of the six (6) states in the North Central Region and the FCT of Nigeria. This is because these two states are among the states where the UDP innovation was promoted and still being used among rice farmers. 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 of the states. In total six (6) LGAs' were sampled. The population of the respondents consist of 197 UDP farmers' and 201 Non-UDP farmers' from the six (6) LGAs which was determined using Taro Yaman (1973) [49] sampling formula and represented mathematically as:

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

Where n is the sample size, N is the population while 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 and 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.

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

Also given 12,497 as the total population (N) of Non-UDP 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 LGAs for the study. Following [48] the formula was applied as;

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

Where

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

N=Total population of UDP farmers/Non-UDP farmers.

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

Table 1. Sample Selection.

State	Zone	LGA	Sampling Frame	Sampled Proportion (%)	Sample Size/LGA
Benue	North	Gwer East	UDP Farmers: 1,500	3.5	52
			Non-UDP Farmers: 2,882	1.6	46
Benue	East	Kwande	UDP Farmers: 940	3.5	33
			Non-UDP Farmers: 1,394	1.6	23
Benue	Central	Okpokwu	UDP Farmers: 800	3.5	28
			Non-UDP Farmers: 1,961	1.6	32
Niger	North	Wushishi	UDP Farmers: 1,000	3.5	35
			Non-UDP Farmers: 1,577	1.6	25
Niger	South	Katcha	UDP Farmers: 700	3.5	24
			Non-UDP Farmers: 1,805	1.6	29
Niger	East	Shiroro	UDP Farmers: 700	3.5	24
			Non-UDP Farmers: 2,878	1.6	46
			Total	5.1	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.

2.5. Variables and Model Specification

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

Following [50] net farm income can be expressed as specified;

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

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

But:

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

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

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

Where

GMR=Gross margin; GFR=Gross farm revenue (N/ha); π =Profit from farm output sells; TVC=Total variable cost;

TFC=Total fixed cost; TFE=Total farm expenditure; P=Price of farm produce (kg/Tons/Ha); TQ=Total quantity of rice produced (Tons/Ha).

$$GMR = GM \div GFR \quad (10)$$

$$OR = TOC \div GFR \quad (11)$$

$$ROI = NFI \div TFE \quad (12)$$

GMR=Gross margin ratio; NFI=Net farm income; GM=gross margin; OR=operating ratio; TOC=total operating cost; GFR= gross farm revenue; ROI= return on investment; TFE= total farm expenditure.

3. Results and Discussion

3.1. Socio-economic Characteristics of Farmers

The distribution of the respondents according to their socio-economic 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) farmers were 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 observed by Ogunmefun and Achike (2015) and Ayoola *et al.*, [2011] who stated that male farmers dominate the Nigeria rice sub-sector [33, 7].

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/(%)	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 revealed 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 respectively. Specifically, majority (63%) of UDP farmers and (56%) of Non-UDP farmers in Niger State were within the age range of 21 to 40 years as against 35.4% (UDP farmers) and 34% (Non-UDP farmers) observed in Benue

State. This result suggest that rice producers in Niger State are younger than their counterpart in Benue State. Based on 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. This

result is in consonance with Balarabe and Muhammad (2019) and Maji *et al.*, [2012] who showed that rice production in Nigeria is dominated by young farmers within the age bracket of 31 to 50 years who are more likely to accept and serve as better agents of innovation acceptance and transfer [9, 24].

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/(%)	Freq/(%)	Freq/(%)
Less20yrs	1 (0.88)	0 (0.0)	2 (2.4)	7 (7.00)
21–40yrs	4 (35.4)	34 (33.7)	52 (62.7)	56 (56.0)
41–60yrs	70 (62.0)	66 (65.4)	28 (33.7)	33 (33.0)
Above 60 years	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 analysis 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 atmost 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 implies that a significant proportion of the farmers are literally informed and at such would be more open to adapt new farming innovations and make meaningful farm managerial decisions that would improve their overall enterprise productivity and profitability. This finding is contrary to Manza and Atala [2014] and Igboji, Anozie and Nneji [2015] who reported the highest educational years of rice farmers in northeast Borno and southeast Ebonyi States of Nigeria to be between 1 to 6 years [25, 17].

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/(%)	Freq / (%)	Freq/(%)
0yrs	17 (15.0)	17 (16.8)	25 (30.1)	38 (38.0)
1-6yrs	26 (23.0)	19 (18.8)	4 (3.61)	11 (11.0)
7-12yrs	39 (34.5)	29 (28.7)	38 (45.8)	37 (37.0)
Above 13yrs	31 (27.4)	36 (35.6)	16 (19.3)	13 (13.0)

Source: Field Survey, 2021

The analysis of the respondents' farm holding is summarized in table 5. The result revealed a mean farm plot size of 1.2ha for UDP farmers and 1.3ha for Non-UDP farmers in Benue State. However, for UDP farmers and Non- UDP farmers, total farm holding is estimated as 3.6ha and 2.3ha each respectively. The result suggests that majority of the respondents are subsistent and smallholder farmers. This finding buttresses IFDC [2016], Mgbenka and Mbah [2016] and IFDC [2020] assertions that the Nigerian agricultural

sector has been left largely in the hands of poor and subsistence farmers, whose average holding range from 1ha to 3ha and have limited potential to benefit from economies of scale [15, 26, 16]. This result is in agreement with previous findings by Umar *et al.*, [2014] who reported 2.4ha as the mean farmsize of rice farmers in Niger State [45]. Smilarly, Ayoola *et al.*, [2011] reported the mean farm size for male and female rice farmers in the northern guinea savannah belts of Nigeria to be 2ha and 1.39ha respectively [7].

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/(%)	Freq/(%)	Freq/(%)
Less than 1ha	0	3 (2.97)	1 (1.20)	0
1.1-3.0ha	113 (100)	96 (95.1)	49 (59.0)	81 (81.0)
3.1-6.0ha	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 their household size is presented in table 6. The result showed a mean household size of eight (8) members for both UDP farmers in Benue State and Non-UDP farmers in Niger State respectively. Consequently, UDP farmers in Niger State had a mean household size of seven (7) members while Non-UDP farmers in Benue State had a mean household size of nine (9) members respectively. This finding implies 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 hectares put into cultivation, the possibility of increased marketable surpluses and reduced cost of labor can be achieved. This result conforms to findings by Ajah and Ajah [2014] who revealed a mean household size of eight (8) members for rice farmers in Abuja the Federal Capital Territory located in North Central region of Nigeria [4].

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/(%)	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 13years (SD = ± 7.19 and ± 10.4) for Non-UDP farmers in both states; 15years (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%) of UDP and (38.6%) of Non-UDP farmers in Benue State; as against (47%) of UDP and (60%) of Non-UDP

farmers in Niger State fall into the farming experience bracket of less than 11years. This result suggest that rice producers in the area are new entrant farmers, who may not be highly experienced with a high wealth of farm management capacity, specialization and expertise skills developed over long years of continued farming. This finding is contrary to the mean farming experience of seventeen (17) years reported by Kadiri *et al.*, [2014] among rice farmers in the Niger Delta region of Nigeria [19].

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/(%)	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)
Above 30	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.

3.2. Net Farm Income Analysis of UDP and Non-UDP Farmers

The net farm income analysis of UDP and Non-UDP farmers in Benue and Niger States is summarized in tables 8 and 9. The results 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 in Niger State, the mean total variable production cost was ₦271,964.47/ha

while in Benue State it was ₦307,149.02/ha representing 91.1% and 90.6% respectively of the overall production cost.

Specifically, the mean spending by Non-UDP farmers in Niger State for farm input (seedlings and agrochemicals) was ₦62,617.32/ha (27.1%) of the overall 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 ₦48,183.00/ha (17.7%) and in Benue State, it was ₦50,718.40/ha (16.5%). The result concurs with several literatures [14, 23, 40, 42] 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 obtained 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 obtained by Non-UDP farmers respectively. The gross margin (GM) analysis is estimated at ₦143,624.98/ha for Non-UDP farmers and ₦304,606.73/ha for UDP farmers in Niger State; while Benue State UDP farmers had a mean gross margin of ₦344,336.44/ha as against ₦164,202.71/ha for Non-UDP farmers respectively.

Specifically, in Niger State a 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. Similarly, in Benue State, the mean estimated NFI for UDP farmers was ₦312,451.84/ha as against ₦137,326.64/ha earned by Non-UDP farmers. The difference in NFI margin for UDP farmers as against Non-UDP farmers was ₦175,125. 20/ha 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 in field trial by Tarfa and Kiger [2013] for both categories of farmers for the 2012/2013 dry (irrigation) planting season in Gombe, Niger and Kebbi States [44].

3.3. Profitability Ratio Analysis of Rice Enterprise Under UDP and Non-UDP Agronomic Practice

The profitability ratio analysis as indicated in tables 8 and 9 revealed a gross margin ratio (GR) of 0.53 (53%) for UDP farmers in both states as against 0.38 (38%) for Non-UDP

farmers in Niger State and 0.39 (39%) for Non-UDP producers in Benue State respectively. These findings suggest that UDP farmers retain a higher percentage (53%) of the overall farm gross income for each one naira invested in their rice farm enterprise as against their Non-UDP counterpart in Niger and Benue State who retain 38% and 39% each respectively.

The return on investment (ROI) analysis revealed a ratio of 0.46 (46%) and 0.48 (48%) for Non-UDP farmers in Niger and Benue States. Consequently, for UDP farmers in both states a ratio of 0.92 (92%) was observed. These results imply that UDP farmers have 43% to 44% higher return on each ₦1.00 naira of the overall farm invested capital than Non-UDP farmers. From these findings, it can be inferred that rice production under the urea deep placement technology is more profitable over production using the conventional fertilization application practice. Findings by Chidiebere-Mark *et al.*, [2019] using the conventional fertilizer application practice revealed a return on investment of 0.13 (13%) for upland rice, 0.20 (20%) for lowland rice and 0.29 (29%) for swamp rice production systems in Ebonyi State, South East Nigeria [11].

In the same vein, the operating ratio (OR) was estimated as 0.25 (25%) for Non-UDP farmers as against 0.20 (20%) for UDP farmers in Niger State. However, in Benue State the operating ratio for Non-UDP farmers was 0.29 (29%) as against 0.21 (21%) obtained by UDP farmers. This implies that UDP farmers incurred lower average operating cost of managing their rice farm enterprise than their Non-UDP counterpart producers.

Table 8. Net Farm Income and Profitability Ratio Analysis of UDP and Non UDP Rice Producers 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
Seedling	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

Variable Cost	Unit of measure	Non-UDP Farmers			UDP Farmers		
		Qty/Ha	Unit cost	Cost/Ha	Qty/Ha	Unit cost	Cost/Ha
Net Farm Income (GM)	₦/Ha			117,354.27			276,986.68
Return on Investment (ROI)				0.46			0.92
Gross Margin Ratio (GR)				0.38			0.53
Operating Ratio (OR)				0.25			0.20

Source: Field Analysis. 2021.

Table 9. Net Farm Income and Profitability Ratio Analysis of UDP and Non UDP Rice Producers in Benue State.

Variable cost	Unit of Measure	Non-UDP Farmers			UDP Farmers		
		Qty/ha	Unit cost	Cost/ha	Qty/ha	Unit cost	Cost/ha
Seedling	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 (Tilling & Ploughing)	₦/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)				0.39			0.53
Operating Ratio (OR)				0.29			0.21

Source: Field Survey, 2021.

4. Conclusion

Generally, outcomes from this study reveals that rice production is highly profitable. However, when compared with production under the conventional fertilization application practice, rice farm enterprise under the UDP innovation is more viable and efficient. The profitability of the UDP innovation is observed in its lower operational cost, higher gross returns and profitability ratio index as against that obtained under the conventional fertilization practice.

5. Recommendation

To further increase profit and enhance efficiency of resource use under the UDP technology, there is need for the Nigeria government, policy makers and partners in the rice sub-sector to;

- support actions that will enable the wide spread of the UDP innovation among farmers,
- continue to initiate and sustain strategies to raise and sustain back-up capital for farmers so as to keep them on the farms, since majority of them are still in their active ages. As they are still agile and the potentials to adapt new innovations to grow and improve their farm output is very high,
- support and initiate policy measures that will enhance the restructuring and rebuilding of worn-out market institutions and facilities (warehouses, stalls and roads and farmers cooperatives) especially in interior farming communities so as to open up more linkages and connectivity among high rice production baskets with distribution channels,
- recruit and train more extension agents to facilitate farmer's access to the right information and training on the UDP technologies' use,

- (v) invest in the establishment of more USG production factories and its complementary implements (briquetting machines and mechanical applicators) to facilitate all year round seasonal availability and access of the USG at reduced price especially among rural farmers.
- (vi) 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, expanding research in seed security, sustaining bans on rice imports to encourage local production and putting up strategies that will open new opportunities for the Nigeria rice export sub-sector.
- (vii) strengthen farmers' groups for information sharing to help them build resilience and skills to source markets and new opportunities to improve their rice enterprise business.

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