Original Research Article

Comparative Analysis of Gross Margin for Three Varieties of Rice Grown Under Two Planting Methods and Different Weed Control Measures.

ABSTRACT

Field trials were conducted during the 2005, 2006 and 2007 rainy season at Irrigation Research Station, Kadawa situated in Sudan savannah agro – ecological zone, Kano state, Nigeria to compare the gross margin values obtained from rice production using three different varieties of rice and different weed control measures under two planting methods. The trials were laid out in split – plot design and replicated three times with factorial combination of two planting methods and three varieties in the main plots and weed control treatments in the subplots. The result revealed that transplanting of rice gave better gross margin value with a mean value of 127,053 Naira for the three varieties of rice cultivated under different weed control methods compare to ~~the~~ x 113,303 Naira obtained in direct seeding for the same three varieties of rice cultivated under different weed control methods. The result of the BCR also showed that transplanting of rice yielded more profit with BCR value of 2.42 for three varieties of rice cultivated under different weed control methods compared to BCR value of 2.33 obtained. FARO 52 performed better among the three varieties of rice with higher gross margin values of 143,170 Naira and 120,720 Naira and BCR value of 2.60 and 2.42 for transplanting and direct seeding, respectively for the three years cropping season. Application of pre – emergence oxadiazon at 1.0 Kg ~~per hectare~~ha-1 followed by post – emergence piperophos plus propanil at 1.5 Kg per hectare applied at 5 WAS / T gave the highest gross margin of 166,770 Naira and BCR value of2.78 under transplanting for the three years which was closely followed by hand-pulling weed control measures with gross margin value of 165,720 Naira and BCR of 2.94 under direct seeding compared to the weedy check that gave the least gross margin and BCR in both methods of planting. The study therefore concludes that transplanting of FARO 52 rice variety and combined application of pre-emergence application of oxadiazon at 1.0 kg a.i.ha^{-1} followed by post-emergence piperophos plus propanil at 1.5 kg a.i.ha^{-1} is the best interaction to obtained good profit. Therefore combination is ~~therefore~~ x recommended as ~~the~~ x economically viable integrated package for lowland rice production in the sudan savanna agro-ecological zones.

Keywords: Gross margin analysis Weed control measures, Benefit cost ratio,Rice varieties, Planting methods

1.0 INTRODUCTION

Rice is the world's second most consumed cereal grain [1]. It provides more than one fifth of the calories consumed worldwide by humans. The current national demand for rice in Nigeria is estimated at 5.0 million metric tonnes of milled rice while the current production status is estimated at 3.0 million metric tonnes leaving a deficit of 2.0 million metric tonnes [2]. On analysis, the nutritional value per 100g of milled rice is: carbohydrate-79.95 g, sugars-0.12 g, dietary fibre-1.3 g, fat-0.66 g and protein-7.13 g. It compares favourably with other cereals in amino acids content. Rice contains a low percentage of calcium and its B group vitamins compares favourably to wheat. It also contains 0.07 mg thiamin, 0.04 mg riboflavin, 1.6 mg niacin, 1.01 mg pantothemic acid, 0.16 mg vitamin B_6, 8 mg Folate, 28 mg calcium, 0.8 mg Iron, 25 mg magnesium, 6 mg phosphorous, 1.0 mg potassium, 1.09 mg zinc, and 1.0 mg manganese [3].

Raw rice may be ground into flour for many uses including, beverages, pudding and bread. The rice bran is high in protein and ideal for use in livestock feed for roughages, protein sources and also used

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as source of fatty oil. Rice is used in industries ~~for~~ x mainly rice wines, alcoholic beverages, beers, and confectionaries. In Nigeria '*Kunnu*' drink is made from raw rice and the popular '*Tuwo*' and '*Massa*' are also delicacies prepared in Nigeria. The parboiled rice is eaten after boiling with stew or prepared into jollof in homes and during social functions. In fact it is the most popular food at all social functions and meetings irrespective of tribe, religion, or social status. The hulls and husks of grains are used as fuel bedding, incubation materials for making blocks, tiles, fibre board, ceramics, cement and fillers. It is used as a medium for growing mushroom [4], and as fuel in cooking.

Gross Margin is the difference between the Gross farm Income (GI) and the Total Variable Cost (TVC). It is a useful planning tool in situation where fixed capital is negligible portion of the farming enterprises as in the case of small scale subsistence agriculture [5].

Studies on analysis of cost and return of rice production in Ankpa, Nigeria, where results obtained gave the gross margin for rice production as ~~₦~~ 43,117.08 per hectare and benefit cost ratio was 1.70. It was concluded that rice production was profitable in the area, therefore farmers should be encouraged to go into rice production business [6]. Similarly, survey conducted at Kadawa, and Watara indicated that rice production was more profitable amongst small scale farmers compared to medium and large scale farmers. The net return obtained was ~~₦~~ 92,697.00 ha^{-1} by small scale farmers in Kadawa and ~~₦~~ 122,547.00 ha^{-1} by farmers in Watara in the Sudan savanna ecological zone [7]. Madu and Aniobi [8] in their study revealed that the variable cost per hectare for rice production was found to be $360.29 (N 162,130.5) per production cycle, while total revenue of $650 (N292,500.00|) was realized by the respondents. Meanwhile, the gross margin and gross profit were estimated to be $289.71 (N130, 369.50) and $281.56 (N 126702.00) respectively. The gross profit margin was calculated to be 0.45 which is equivalent to 45%. A study carried out by Oyewole, Akinbola and Ayanrinde[9] in Nassarawa state, Nigeria revealed that rice farmers obtained a mean yield of 4459 Kg of rice per hectare from total variable costs of N212993.60 Kobo with revenue of N401310.00 given a gross margin value of N 188,316.40. Toungos [10], reported a gross margin of that ranged between 238, 620 - 299,750 Naira, gross return of between 531,240 - 543,750 Naira, cost of production of between 244000 – 292,800 Naira and benfit cost ratio that ranged between 1.81 – 2.23 when comparing two methods of rice establishment in Mubi North, Adamawa state,Nigeria.

The objective of this study is to compare the gross margin value of three varieties of rice grown under two methods of planting and different weed control measures.

2.0 MATERIALS AND METHODS

2.1 Experimental Site

Field trials were conducted during the 2005, 2006 and 2007 wet seasons at the Irrigation Research Station, Kadawa (11º 39`N; 80º 02`E, 500 m altitude above sea level) of the Institute for Agricultural Research, Zaria, Nigeria. Kadawa is located in the Sudan savanna agro-ecological zone. Geomorphologically, the Kano region where Kadawa is located is in the Western African plains, with a flat to slightly undulating surface, bordering the Jos Plateau in the Southeast. The prominent weed species of the experimental sites were collected from 1.0m² areas at random within the plots and the weeds were identified at all sampling stages. The intensities of occurrence were also recorded at the sites of the trials,

2.2 Experimental Treatments

The three rice varieties used during the trial were Sipi 692033 (FARO 44), Wita 4 (FARO 52) and ITA 230 (FARO 50). The two planting methods were the direct seeding and transplanting, while the seven weed control treatments were as follows: Oxadiazon (Ronstar) 25 EC at 1.0 kg *a.i.*ha^{-1} pre-emergence (PE), oxadiazon (Ronstar) 25 EC at 1.0 kg a.i.ha^{-1} (PE) followed by (fb) hand pulling of weed at 6 weeks after sowing/transplanting (WAS/T), piperophos plus propanil (Rilof S) at 1.5 kg a.i.ha^{-1} applied post-emergence (POE) at 2 WAS/T, piperophos plus propanil (Rilof S) at 1.5 kg a.i.ha^{-1} applied POE at 2 WAS/T fb hand pulling at 6 WAS/T, oxadiazon (Ronstar) 25 EC at 1.0 kg a.i.ha^{-1} applied (PE) fb piperophos plus propanil (Rilof S) at 1.5 kg a.i.ha^{-1} applied POE at 5 WAS/T, Hand pulling of weeds at 3 and 6 WAS/T (control) and Weedy check.

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2.3 Planting Materials

FARO 44 and FARO 52 seeds of the three rice varieties were obtained from National Cereal Research Institute, Badeggi while FARO 50 was obtained at Kadawa Irrigation Research Station of the Institute for Agricultural Research, Ahmadu Bello University, Zaria.

The notable characteristics of these varieties used in this study are given below:

FARO 44 (Sipi 692033): This variety originated from Asia (Taiwan) and it is cultivated under irrigated swamp condition. It grows to a plant height of 110-120cm (tall variety). It has a tilleg capacity of 15-20, with a green stem base. The leaves are long, semi broad and lax. The leaf sheath is green, with fully exerted panicle, erect flag leaf and medium ligule. It matures within 110-120 days, and it has long grains [11]. The potential yield is 5,000-8,000 kg ha^{-1}.

FARO 52 (Wita 4)**:** This variety was developed by the International Institute of Tropical Agriculture (IITA), Nigeria; It is grown as lowland irrigated and shallow swamp rice. It has a plant height of 95-105 cm (medium stature), and tillering capacity of 12-18. The stem base is green with long leaves and green leaves sheath, with a panicle that is fully exerted, and erect flag leaves. The husk from unripe to mature seed is green to straw colour. The stigma is colourless, awnless and the ligule is of medium size. It matures within 125- 130 days and it has short grains [11]. The potential yield is 5,000-8,000 kg ha^{-1}.

FARO 50 (ITA 230): This variety was developed by IITA, Nigeria, as irrigated low land swamp rice. It grows to a height of 100–110 cm (tall variety). The stem base is green and the leaves are long with green leaf sheath. The panicle is fully exerted with erect flag leaf. The husk colour from unripe to matured seeds bears green straw coloration. The stigma is colourless, it is awnless and ligule is medium. It matures in 120 – 125 days and produces short grains [11]. The potential yield is 5,000-8,000 kg ha^{-1}.

2.4 Harvesting

All rice plants in the net plot area were harvested manually using a sickle by cutting the stem at ground level when the paddy reached dough stage at physiological maturity. The crop was harvested on 16 November, 19 December and 14 December in 2005, 2006 and 2007 respectively. The harvested paddy was later sun dried and threshed and the paddy yield recorded per plot.

Paddy yield (Kg/ha): Harvested paddy from each net plot was threshed after sew drying, winnowed and the weight obtained expressed on per hectare basis and recorded accordingly

2.5 Gross Margin Analysis

Gross margin was done to determine profitability of rice production with the following model:

Where, GM= Gross margin

TR=Total revenue

TVC=Total variable costs.

Fixed cost arising from simple tools such as hoes, cutlasses and sickles are negligible as such can be ignored when calculating profitability of small scale rice production [12].

2.6 Operating Cost Ratio (OCR)

The operating cost ratio was estimated for the three varieties of rice considering the two methods of planting and weed control measures adopted. The OCR is calculated by dividing the total variable costs by the total returns. This established the proportion of the gross income that goes to service the operating expense of the respondents and this is directly related to the farm variable input usage. As

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a rule, an operating ratio of one means that the gross income just defray the expenses incurred on the variable inputs used on the farm. The formula is given below:

Operating Cost Ratio = Total Variable Costs / Total Returns.

2.7 Benefit Cost Ratio (BCR)

This was estimated for for the three varieties of rice considering the two methods of planting and weed control measures adopted. The BCR is calculated by dividing gross return by the total variable cost. This BCR indicates how safe the business. The higher the BCR the safer the business. The formula is given below:

Benefit Cost Ratio = Total Returns / Total Variable Costs

3.0 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Gross margin analysis estimates

Average cost and returns per hectare of lowland rice varieties under transplanting method and weed control study in the combined mean of 2005-2007 is contained in Table 1 and that of direct seeding method in Table 3.

The data on Table 1 revealed that, transplanting FARO 52 gave higher total returns (₦ 232,800.00 ha^{-1}) than FARO 44 and FARO 50. Higher gross margin of ₦ 143,170.00 ha^{-1} was obtained in FARO 52 compared to ₦ 114,720.00 ha^{-1} in FARO 44 and ₦ 123,270.00 ha^{-1} in FARO 50 respectively. The mean total returns of transplanting lowland rice variety is ₦ 216,683 and mean gross margin of ₦ 127,053.00.

The mean value for the three varieties of rice was adopted to estimate the gross margin under different weed control measures for transplanting method. The result showed that pre-emergence application of oxadiazon at 1.0 kg a.i.ha^{-1} followed by post emergence application of piperophos plus propanil at 1.5 kg a.i.ha^{-1} produced the highest total returns of ₦260,400.00ha^{-1} compared to the least ₦ 116,131.00 ha^{-1} obtained from the weedy check plots under transplanting method (Table 1). Similarly highest gross margin value of ₦ 166,770.00 was also obtained from the combined application of oxadiazon followed by piperophos plus propanil compared with ₦ 38,500.00 ha^{-1} obtained with the weedy check.

Similarly, (Table 3) shows that FARO 52 gave the highest gross margin of ₦ 120,770.00, followed by ₦ 113,570.00 ~~obtained with FARO 44~~x while the least value of ₦ 105,570.00 was obtained from FARO 50 .

Similarly using the mean value for the three varieties of rice to estimate the gross margin under different weed control measures for direct seeding showed that hand - pulling method produced the highest returns of ₦ 250,950.00 ha^{-1} compared to the least of ₦ 121,600.00 obtained from the weedy check (Table 3). The highest gross margin value of N 165,720.00 per hectare was also obtained from the hand - pulling method compared with ₦ 48,370.00 per hectare obtained with the weedy check (Table 3).

Comparison of the two methods of planting showed that FARO 52 was the best variety that gave both highest return and gross margin values in both transplanting and direct seeding. However the transplanting method recorded a higher return and gross margin values than the direct seeding in all the three varieties of rice. In comparing the gross margin for different measures of weed control for both planting methods revealed that pre-emergence application of oxadiazon at 1.0 kg a.i.ha^{-1} followed by post emergence application of piperophos plus propanil at 1.5 kg a.i.ha^{-1} also gave the highest return and gross margin values for transplanting method while hand – pulling method gave the highest values for both gross return and gross margin for direct seeding. However the return and gross margin values of ₦260,400.00ha^{-1} and ₦ 166,770.00 ha^{-1} respectively under transplanted method with application of pre-emergence application of oxadiazon at 1.0 kg a.i.ha^{-1} followed by post

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emergence application of piperophos plus propanil at 1.5 kg a.i.ha^{-1} was higher compare to the values of ₦ 250,950.00 ha^{-1} and N 165,720.00 per hectare obtained with hand – pulling method in direct seeding. The mean value for transplanting for the three varieties o rice for return and gross margin were also higher than those obtained in direct seeding.

3.1.2 Operating cost ratio (OCP)

Table 2 captured the operating cost ratio (OCR) for rice production for three years in the study area using transplanting method and from the analysis it was found to have values that ranged between 0.39 for FARO 52 rice variety to 0.44 for FARO 44 and FARO 50 had a value of 0.42 with the mean value for the three rice varieties stood at 0.41.This showed that 41 % of gross return realized from cultivating the three varieties of rice was used to defray the operating cost. Similarly, considering the varieties individually showed that FARO 52 had the lowest operating costs, followed by FARO 50 while FARO 44 had the highest operating cost with 44% of its return goes to operating cost. The operating cost ratio for rice production under different weed control measures shown in Table 3 also revealed that weedy check had the highest value of 0.67 compared to the rest, while lowest value of 0.36 was obtained for piperophos plus propanil alone and oxadiazon followed by piperophos followed by propanil at 5WAS/T, respectively . This was closely followed by hand- pulling method with an OCR value of 0.37. This showed that more of the returns using weed check method goes to defray the operating costs in rice production compare to the other weed control measures.

Table 4 captured the operating cost ratio (OCR) for rice production for three years in the study area using direct seeding method and from the analysis it was found to have values that ranged between 0.41 for FARO 52 rice variety to 0.43 for both FARO 44 and FARO 50, respectively with the mean value for the three rice varieties stood at 0.43.This showed that 43 % of gross return realized from cultivating the three varieties of rice was used to defray the operating cost. Similarly, considering the varieties individually showed that FARO 52 had the lowest operating costs, followed by FARO 50 and FARO 44, they had the highest operating cost with 43% of return realized used to defray operating cosst. The operating cost ratio for rice production under different weed control measures shown in Table 3 also revealed that weedy check had the highest value of 0.60 compared to the rest, while lowest value of 0.34 was obtained for hand- pulling method. This showed that more of the returns using weed check method goes to defray the operating costs in rice production compare to the other weed control measures.

Comparison of the two methods of plating clearly showed that in term of rice varieties the OCR of direct seeding of mean value 0.43 is higher than that of 0.41 obtained for transplanting which showed that more gross margin is obtained using transplanting method for rice production than the direct seeding ~~since~~ Since more of the return from direct seeding goes to defray the operating costs in direct seeding compare to transplanting. Similarly, the result revealed that in term of using different methods of weed control for rice production the transplanting method also performed better with a mean OCR of 0.41 compared to direct seeding of 0.43.

3.1.3 Benefit cost ratio (BCR)

The result of benefit cost ratio considering rice varieties, weed control methods under transplanting and direct seeding methods are presented in Table 2 and Table 4, respectively. The result in Table 3 revealed that for the three varieties of rice under transplanting method, a mean BCR value of 2.42 was obtained. FARO 52 had the highest BCR value of 2.60, followed by FARO FARO 50 with BCR of 2.38 and FARO 44 had the lowest value of 2.28. This showed that more profit was made using ~~FARO 52x~~ rice variety FARO 52 for the three years cropping season compared to the other two varieties. The higher the BCR value the safer for the business to succeed. With respect to rice production using the different weed control methods under transplanting method, the weedy check had the lowest BCR value of 1.50 compared to the rest methods. The application of piperophos plus propanil alone gave the highest BCR value of 2.81 which was closely followed by the application of oxadiazon followed by piperophos followed by propanil at 5WAS/T with BCR value of 2.78. The result revealed that if weeds are left on the rice farm without controlling them, the profitability of the rice production will declined. So weed control measures help to increase output of rice.

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The result in Table 4 revealed that for the three varieties of rice under direct seeding method, a ,mean BCR value of 2.33 was obtained. FARO 52 had the highest BCR value of 2.42, followed by FARO 44 with BCR of 2.33 and FARO 50 had the lowest value of 2.24. This showed that more profit was made using FARO 52 rice variety for the three years cropping season compared to the other two varieties. With respect to rice production using the different weed control methods under method, the weedy check had the lowest BCR value of 1.66 compared to the rest methods. Hand – pulling method gave the highest BCR value of 2.94 followed by the application of oxadiazon followed by piperophos followed by propanil at 5WAS/T with BCR value of 2.69.. The result like the transplanting method also revealed that if weeds are left on the rice farm unchecked, the profitability of the rice production will decreased. So weed control measures help to increase output of rice thereby leading to increase gross return.

Comparison of the two methods of plating clearly showed that in term of rice varieties the BCR ~~of~~ xdirect seeding ~~of mean~~x value 2.33 ~~is~~ xwas lower than that of 2.42 obtained for transplanting which showed that more gross margin is obtained using transplanting method for rice production than the direct seeding since ~~the h~~Higher the BCR ~~the always~~ safer for the business. Similarly, the result revealed that in term of using different methods of weed control for rice production the transplanting method ~~also x~~ performed better with a mean BCR of 2.42 compared to that of direct seeding ~~ofof~~ xof ~~with BCR~~x 2.33..

3.2 Discussion

The result revealed that good returns with good gross margins were made from cultivating rice in the study area using different rice varieties and different weed control measures under the two planting methods. When comparing the two methods transplanting gave higher returns and gross margins compared to direct seeding. This may be as a result that direct seeding may witness poor germination rate compare to transplanting which may result into low plant population and low output. The optimum returns and gross margin values obtained in this study was in agreement with different studies. Oyewole, Akinbola and Ayanrinde [9], reported a gross return of N401310.00 and gross margin value of N 188,316.40 in their study. Toungos [10], reported a gross margin of 238, 620 Naira for system of rice intensification 299,750 Naira for traditional method of rice production in Mubi North, Adamawa state, Nigeria.

The BCR values obtained for both method of planting using different varieties of rice and different methods of weed control showed that rice production in the study area for the three cropping years was profitable and it is a business that is safe to invest on. The BCR values obtained in this study were higher than the BCR of 1.81 reported by [6] but similar to the range of 1.93 – 2.44 reported by Ali et.al.[13] in their study titled comparison of different methods of rice establishment and nitrogen management strategies for lowland rice.

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Table 1: Average cost and returns per hectare of lowland rice variables under transplanting and weed control study in the combined mean of 2005-2007.

Treatments	Rate (kg a.i.ha^{-1})	Seed cost (₦)	Transplanting (₦)	Weed control (₦)	Labour cost (₦)	Total variable (₦)	Total Returns (₦)	Gross margin[1] (₦)
Variety								
FARO 44		1,000	9,400	12,000	67,230	89,630	204,350	114,720
FARO 52		1,000	9,400	12,000	67,230	89,630	232,800	143,170
FARO 50		1,000	9,400	12,000	67,230	89,630	212,900	123,270
Mean		1,000	9,400	12,000	67,230	89,630	216,683	127,053
Weed control								
Oxadiazon alone	1.0	1,000	9,400	10,000	67,230	87,630	207,200	119,570
Oxadiazon fb handpulling 6 WAS/T	1.0	1,000	9,400	22,000	67,230	99,630	224,750	125,120
Piperophos plus propanil alone	1.5	1,000	9,400	6,000	67,230	83,630	235,350	151,720
Piperophos plus propanil fb handpulling 6WAS/T	1.5	1,000	9,400	18,000	67,230	95,630	233,850	138,220
Oxadiazon fb piperophos fb propanil at 5 WAS/T	1.0fb1.5	1,000	9,400	16,000	67,230	93,630	260,400	166,770
Handpulling at 3 and 6 WAS/T		1,000	9,400	12,000	67,230	89,630	239,100	149,470
Weedy check		1,000	9,400	0	67,230	77,630	116,131	38,501
Mean		1,000	9,400	12,000	67,230	89,630	216,683	127,053

[1]*Gross margin measures profitability and estimated revenue less total variable cost.*

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Table 2: Operating and benefit cost ratios of lowland rice variables under transplanting and weed control ~~study~~ x in the combined mean of 2005-2007.

Parameter	OCR Value	BCR value
Variety		
FARO 44	0.44	2.28
FARO 52	0.39	2.60
FARO 50	0.42	2.38
Mean	0.41	2.42
Weed control		
Oxadiazon alone	0.42	2.36
Oxadiazon fb hand-pulling 6 WAS/T	0.44	2.26
Piperophos plus propanil alone	0.36	2.81
Piperophos plus propanil fb hand-pulling 6WAS/T	0.41	2.45
Oxadiazon fb piperophos fb propanil at 5 WAS/T	0.36	2.78
Hand-pulling at 3 and 6 WAS/T	0.37	2.67
Weedy check	0.67	1.50
Mean	0.41	2.42

Comment [s226]: combined with

Comment [s227]: (pooled mean 2005-2007)

Table 3: Average cost and returns per hectare of lowland rice variable under direct seeding and weed control study in the combined mean of 2005-2007.

Treatments	Rate (kg a.i.ha^{-1})	Seed cost (₦)	Direct seeding (₦)	Weed control (₦)	Labour cost (₦)	Total variable (₦)	Total Returns (₦)	Gross[1] margin (₦)
Variety								
FARO 44		5,000	1,000	12,000	67,230	85,230	198,800	113,570
FARO 52		5,000	1,000	12,000	67,230	85,230	206,000	120,770
FARO 50		5,000	1,000	12,000	67,230	85,230	190,800	105,570
Mean		5,000	1,000	12,000	67,230	85,230	198,533	113,303
Weed control								
Oxadiazon alone	1.0	5,000	1,000	12,000	67,230	85,230	175,000	89,770
Oxadiazon fb handpulling 6 WAS/T	1.0	5,000	1,000	20,000	67,230	93,230	203,750	110,520
Piperophos plus propanil alone	1.5	5,000	1,000	6,000	67,230	79,230	197,750	118,520
Piperophos plus propanil fb handpulling 6 WAS/T	1.5	5,000	1,000	18,000	67,230	91,230	201,031	109,801
Oxadiazon fb piperophos fb propanil at 5 WAS/T	1.0fb1.5	5,000	1,000	16,000	67,230	89,230	239,650	150,420
Handpulling at 3 and 6 WAS/T		5,000	1,000	12,000	67,230	85,230	250,950	165,720
Weedy check		5,000	1,000	0	67,230	73,230	121,600	48,370
Mean		5,000	1,000	12,000	67,230	85,230	198,533	113,303

[1]*Gross margin measures profitably and estimated revenue, less total variable cost.*

Comment [s228]: S166

Comment [s229]: As table 2

Comment [s230]: H

Comment [s231]: P

Comment [s232]: P

Comment [s233]: P

Comment [s234]: Three

Table 4: Operating and benefit cost ratios of lowland rice variables under direct seeding and weed control study in the combined mean of 2005-2007.

Parameter	OCR Value	BCR value
Variety		
FARO 44	0.43	2.33
FARO 52	0.41	2.42
FARO 50	0.43	2.24
Mean	0.43	2.33
Weed control		
Oxadiazon alone	0.49	2.05
Oxadiazon fb hand-pulling 6 WAS/T	0.46	2.19
Piperophos plus propanil alone	0.40	2.50
Piperophos plus propanil fb hand-pulling 6WAS/T	0.45	2.20
Oxadiazon fb piperophos fb propanil at 5 WAS/T	0.37	2.69
Hand-pulling at 3 and 6 WAS/T	0.34	2.94
Weedy check	0.60	1.66
Mean	0.43	2.33

Comment [s235]: Pooled data of

4.0 CONCLUSSION

Based on the result of this study, transplanting of FARO 52 and pre-emergence application of oxadiazon at 1.0 kg a.i.ha^{-1} followed by post-emergence piperophos + propanil at 1.5 kg a.i.ha^{-1} gave highest gross margin of ₦ 166,770.00 from the recommended combined herbicide compared to ₦ 38,501.00 ha^{-1} in the unweeded control, ₦ 127,053.00 with transplanting FARO 52 compared to ₦ 113,303.00 in direct seeding.Therefore, it can be concluded that transplanting of FARO 52 rice variety and combined application of pre-emergence application of oxadiazon at 1.0 kg a.i.ha^{-1} followed by post-emergence piperophos plus propanil at 1.5 kg a.i.ha^{-1} could hereby be recommended as economically viable integrated package for lowland rice production in the sudan savanna agro-ecological zones.

Comment [s236]: Combined with
Comment [s237]: @
Comment [s238]: As above
Comment [s239]: @
Comment [s240]: S186
Comment [s241]: S169
Comment [s242]: S169

REFRENCES

1) Ziegler. Bringing hope, improving lives, mini review. In International Rice Research Notes. International Rice Research Institute 31.2/2006 pp 3-25.
2) Daramola, B. Government policies and competitiveness of Nigerian rice economy. Paper presented at the workshop on Rice Policy and Food Security in Sub Saharan Africa, organised by WARDA, Cotonou Republic of Benin, November 07-09-2005.

3) USDA. Rice Area, Yield and production figure. USAID Foreign Agricultural Service, Washington D.C;2008.
4) Imolehin, ED, Wada AL. Meeting the rice production and consumption demands of Nigeria with improved technologies. International Rice Commission Newsletter.2004;.49, 13p.
5) Eraboh, O. Comprehensive agricultural science, for senior secondary school.Johnson, A. H publishers. Nigeria, 2005;170-171.
6) Audu, SI, Saliu OJ, Ukwuteno SO. Analysis of costs and return production in Ankpa local government area of Kogi state, Nigeria. In Proceeding of . 42nd Annual Conference, Agricultural Society of Nigeria (ASN). Held at Ebonyi state university, Abakaliki, Nigeria, 2008.
7) Kebbeh, M., Itaefele, S., Fagade, SO. Challenges and opportunities for improving irrigated rice productivity in Nigeria. In the Nigeria rice economy in a competitive world: Constraints, opportunities and strategic choices.2003; 1-23
8) Madu AB, Aniobi UJ. Profitability analysis of paddy production: A case of agricultural zone 1,Niger State Nigeria. Journal of Bangladesh Agricultural University. 2018; 16(1): 88–92, doi: 10.3329/jbau.v16i1.36486
9) Oyewole SO, Akintola AL, AyanrindeFA Assessment of Farm Inputs Utilization and Profitabilityof Rice Farms in Nasarawa State of Nigeria Academic Research Journal of Agricultural Science and Research. 2014; 2(4): 63-66, DOI: 10.14662/ARJASR2014.021.
10) Toungos M D. Comparative analysis on the cropping system of rice intensification and traditional method of rice production in Mubi North, Adamawa state, Nigeria International Journal of Innovative Agriculture & Biology Research. 2018; 6(2):7-26, **www.seahipaj.org**
11) National Cereal Research Institute (NCRI). Morphological characteristics of released rice varieties in Nigeria; 1954-2003, *In* National Cereal Research Institute Pamphlet Badeggi, Nigeria; 2003; 4pp.
12) Olukosi JO, Erhabor PO. Introduction to farm managenent economics principles and applications, 3rd Edition. Agitab Publishers, Ltd, Zaria,Nigeria,2008.
13) Ali MA, Ladha JK, Rickman J, Lales JS. Comparison of different methodsof rice establishment and nitrogen management strategies for lowland rice Journal of Crop Improvement, 2006; 16(1/2): 173 – 189, DOI: 10.1300/J411v16n01_12. Available online at http://www.haworthpress.com/web/JCRIP