



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

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Author's contribution

This work was carried out in collaboration author MMO. Author MMO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript, managed the analyses of the study, proof read the article and type the manuscript as well as managed the literature searches. The author has read and approved the final manuscript.

Article Information

DOI: 10.9734/ARJA/2020/v13i230100

Editor(s):

(1) Dr. M. Yuvaraj, Adhiparasakthi Agricultural College, India.

Reviewers:

(1) S. P. Singh, ICAR - Central Potato Research Institute, India.

(2) Shabistana Nisar, ICAR- National Research Centre for Integrated Pest Management, India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/61639>

Original Research Article

Received 25 July 2020
Accepted 29 September 2020
Published 30 September 2020

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 results revealed that transplanting 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 mean value of 113,303 Naira obtained in direct seeded of the same varieties 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 the three varieties of rice cultivated under different weed control methods compared to BCR value of 2.33 for direct seeded rice. FARO 52 performed better among the three varieties of rice with higher mean gross margin values of 143,170 and 120,720 Naira, BCR of 2.60 and 2.42 for transplanting and direct seeded, respectively for the three years cropping season. Application of pre – emergence oxadiazon @ 1.0 Kg/ha-1 followed by post – emergence piperophos plus propanil @

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1.5 Kg/ha-1 applied at 5 WAS / T gave the highest gross margin of 166,770 Naira and BCR of 2.78 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 pre-emergence application of oxadiazon @ 1.0 kg a.i.ha⁻¹ followed by post-emergence piperophos plus propanil @1.5 kg a.i.ha⁻¹ were the best and second suitable treatment interaction to obtain good profit. Therefore combination is recommended as the economically viable option 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. INTRODUCTION

Rice is the world's second most consumed cereal grain [1]. It provides more than one fifth of the calories consumed worldwide by human being. 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 acid 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 pantothenic acid, 0.16 mg vitamin B₆, 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 as source of fatty acid. Rice is used in industries mainly for 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 ha⁻¹ 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 126,702.00), 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 N212,993.60 Kobo with revenue of N401,310.00 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 244,000 - 292,800

Naira and benefit 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. 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 (11° 39'N; 80° 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 1.0 m² 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 direct seeding and transplanting, while the seven weed control treatments were 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.

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 tillering 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, having 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) with 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 form unripe to matured seeds bearing green to 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 i.e. physiological maturity. The crop was harvested on 16th November, 19th December and 14th 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 sun 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 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:

$$\text{Operating Cost Ratio} = \frac{\text{Total Variable Costs}}{\text{Total Returns}}$$

2.7 Benefit Cost Ratio (BCR)

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

$$\text{Benefit Cost Ratio} = \frac{\text{Total Returns}}{\text{Total Variable Costs}}$$

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Gross margin analysis estimates

Average cost and returns per hectare for lowland rice varieties under transplanting

and weed control method studied in the combined mean of 2005-2007 is contained in Table 1 and that of direct seeding method in Table 3.

The data in 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 is ₦ 216,683 and mean gross margin ₦ 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 @ 1.0 kg a.i.ha⁻¹ followed by post emergence application of piperophos plus propanil @ 1.5 kg a.i.ha⁻¹ produced the highest total returns of ₦260,400.00ha⁻¹ compared to least ₦ 116,131.00 ha⁻¹ obtained from the weedy check 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 ₦ 38,501.00 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 FARO 44 with N 113,570.00 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 ₦ 165,720.00 ha⁻¹ was also obtained from the hand - pulling method compared with ₦ 48,370.00 ha⁻¹ obtained with the weedy check (Table 3).

Comparison of the two methods of planting showed that FARO 52 was best variety that gave both highest return and gross margin values under both transplanting and direct seeding. However the transplanting method recorded a higher return and gross margin values than the

Table 1. Average cost and returns ha-1 of lowland rice variables under transplanting combined with weed control study

Treatments	Rate (kg a.i. ha ⁻¹)	Seed cost (N)	Transplanting (N)	Weed control (N)	Labour cost (N)	Total variable (N)	Total Returns (N)	Gross ¹ margin (N)
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
Oxadiazonfb 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 plu propanil fb handpulling 6WAS/T	1.5	1,000	9,400	18,000	67,230	95,630	233,850	138,220
Oxadiazon f 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

¹Gross margin measures profitability and estimated revenue less total variable cost

direct seeding in all the three varieties of rice. For comparing gross margin for different measures of weed control of both planting methods revealed that pre-emergence application of oxadiazon @1.0 kg a.i.ha⁻¹ followed by post emergence application of piperophos plus propanil @ 1.5 kg a.i.ha⁻¹ also gave the highest return and gross margin values for transplanting method. 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 N260,400.00ha⁻¹ and ₦ 166,770.00 ha⁻¹ , respectively were recorded under transplanted method along with pre-emergence application of oxadiazon @ 1.0 kg a.i.ha⁻¹. It was followed by post emergence application of piperophos plus propanil @ 1.5 kg a.i.ha⁻¹ which was higher compared to the values of ₦ 250,950.00 ha⁻¹ and ₦ 165,720.00 ha⁻¹ obtained with hand – pulling method in direct seeding. The mean value for transplanting for the three varieties of 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) of rice production for three years in the study using transplanting method. From the analysis, OCR values ranged between 0.39 for FARO 52 rice variety to 0.44 for FARO 44. 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, individual variety showed that FARO 52 had the lowest operating costs, followed by FARO 50, FARO 44 had the highest operating cost of which 44 % return goes to operating cost. Operating cost ratio for rice production under different weed control measures is shown in Table 2, it revealed that weedy check had the highest value of 0.67 compared to the rest treatments. However, 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.

Table 2. Operating and benefit cost ratios of lowland rice variables under transplanting combined with weed control study

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

Table 3. Average cost and returns per hectare of lowland rice variables under direct seeding combined with weed control study

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

¹Gross margin measures profitably and estimated revenue, less total variable cost

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

using direct seeding method From the analysis, OCR values ranged between 0.41 for FARO 52 rice variety to 0.43 both for FARO 44 and FARO 50, respectively. The mean value for the three rice varieties stood at 0.43. This showed that 43% of gross return realized from cultivating three

varieties of rice was used to defray the operating cost. Similarly, considering individual variety showed that FARO 52 had the lowest operating costs, followed by FARO 50 and FARO 44, wherein they had the highest operating cost with 43% of return realized used to defray operating costs. Operating cost ratio for rice production under different weed control measures shown in Table 4 also revealed that weedy check had the highest value of 0.60 compared to the rest treatments. However, 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 mean value 0.43 is higher than that of 0.41 obtained for transplanting. This showed that more gross margin is obtained using transplanting method than the direct seeding. More return from direct seeding goes to defray the operating costs compare to transplanting. Similarly, the result revealed that transplanting method performed better with a mean OCR (0.41) compared to 0.43 OCR for direct seeded under different methods of weed control.

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 2 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 (2.60), followed by, FARO 50 with BCR (2.38) and FARO 44 having the lowest BCR (2.28). This showed that more profit was made using FARO 52 rice variety for the three years cropping season compared to the other two varieties. Higher BCR indicates safety for the business. Considering different weed measures under transplanting showed that the weedy check had the lowest BCR (1.50) compared to other methods. The application of piperophos plus propanil alone gave the highest BCR (2.81). This was closely followed by the application of oxadiazon followed by, piperophos followed by, propanil at 5WAS /T with BCR (2.78). The result revealed that if weeds are left on the rice farm without control, the profitability of the rice production will declined. So weed control measures help to increase output of rice.

The result in Table 4 revealed that for the three varieties of rice under direct seeding method had a mean BCR of 2.33. FARO 52 had the highest BCR (2.42), followed by FARO 44 with BCR {2.33}. FARO 50 had the lowest BCR (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. Considering different weed control measures under direct seeded revealed that the weedy check had the lowest BCR (1.66) compared to other methods. Hand – pulling method gave the highest BCR (2.94) followed by, the application of oxadiazon followed by, piperophos followed by, propanil at 5WAS /T with BCR (2.69). The result is similar, to that of transplanting method which also revealed that if weeds are left on the rice farm unchecked, the profitability of the rice

Table 4. Operating and benefit cost ratios of lowland rice variables under direct seeding and weed control study

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

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 planting/sowing clearly showed that in term of rice varieties the BCR of direct seeding with mean value 2.33 is lower than that of 2.42 for transplanting., It showed that more gross margin is obtained using transplanting method for rice production than the direct seeded. Similarly, the result revealed that in term of using different methods of weed control for rice production transplanting method also performed better with mean BCR of 2.42 compared to that of direct seeded BCR of 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 establishment of transplanted rice 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 N188,316.40 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.

4. CONCLUSION

Based on the result of this study, transplanting of FARO 52 combined with pre-emergence

application of oxadiazon @ 1.0 kg a.i.ha⁻¹ followed by post-emergence piperophos + propanil @ 1.5 kg a.i.ha⁻¹ gave highest gross margin of N166,770.00 from the recommended combined herbicide compared to N38,501.00 ha⁻¹ in the unwedded control, N127,053.00 with transplanting FARO 52 compared to N113,303.00 in direct seeding. Therefore, it can be concluded that transplanting of FARO 52 rice variety and combined application of pre-emergence application of oxadiazon @ 1.0 kg a.i.ha⁻¹ followed by post-emergence piperophos plus propanil @ 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.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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