BADEGGI JOURNAL OF AGRICULTURAL RESEARCH AND ENVIRONMENT, 2024, 06(02), 115-123

NCRI Press

Available online: www.ncribjare.org
ISSN: 2695-2122, e-ISSN: 2695-2114
DOI: https://doi.org/10.35849/BJARE202402/191/011
Journal homepage: www.ncribjare.org

Research Article

Effects of Methods of Planting and Timing of Herbicide Application on the Economics of Lowland Rice in Badeggi, Nigeria

Audu S. D.[1], Haruna, I. M[2], Ibrahim, A. J.[3], and Ibrahim S. O.[4] Bakare, S. O[1], Gbadeyan S.T[1]., Bassey M.S[1], Oduaro A.O[1]

[1]National Cereal Research Institute Headquarters P.M.B 08 Bida, Niger State, Nigeria.
[2]Department of Agronomy, Faculty of Agriculture P.M.B 135 Shabu-Lafia Campus, Nasarawa State University, Keffi, Nigeria.
[3]Department of Agronomy, Faculty of Agriculture, Federal University of Lafia P.M.B 146, Nasarawa State, Nigeria.
[4]Department of Crop Production Technology, School of Agronomy and Environmental Management, College of Agriculture, Science and Technology P.M.B 33 Lafia, Nasarawa State, Nigeria.

Correspondence e-mail: audusaledogo@yahoo.com

Abstract

The experiment was conducted in 2021 and 2022 wet season at National Cereals Research Institute headquarters, Badeggi, Niger state (latitude 9o041 02.05''N, longitude 0.6o011 3.31''E) in the Southern Guinea Savannah Agro-Ecological Zone of Nigeria. To evaluate the cost-effectiveness of different planting methods and herbicide application timings on lowland rice production for farmers in the region. It was a factorial experiment, laid out in randomized complete block design. The treatment consisted of five sowing methods (broadcasting dry, broadcasting wet, dibbling wet, dibbling dry and transplanting) with two different timing of herbicide application. The 10 treatment combinations arranged in a factorial design. Data were collected on Plant height, number of tillers, day to 50% flowering, day to maturity, number of seeds per panicle, seed yield per panicle, 1000-grain weight and grain yield per hectare. The result indicated that overall, the transplanting method of planting resulted in significantly higher plant height, number of tillers, seed yield per panicle and grain yield, followed by the dibbling wet and dibbling dry methods whereas the broadcast method resulted in the poorest outcomes. Applying herbicide at 2 WAS resulted in better outcomes compared to 3 WAS. The transplanting method with herbicide application at 2 WAS resulted in the significantly highest grain yield, gross returns, and gross margin, making it the most profitable option. Transplanting method therefore gives a better yield than other methods of planting and the best weed control was achieved at application of herbicide at 2 weeks after sowing thereby maximizing profit.

Keywords: *planting, transplanting, dibbling, tillers, panicle, herbicide, gross, margin*

Introduction

Rice (*Oryza sativa* L.), a member of the Poaceae family, is a staple food for over 60% of the global population (ICAR, 2006). In Nigeria, it plays a vital role in agriculture and is a daily staple for millions, providing approximately 20% of the world's dietary energy. Rice is an excellent source of calories, protein, fat, and carbohydrates,

Received on 15th July, 2024; Revised on 7th August, 2024; Accepted on 21st August, 2024 and Published on 30th August, 2024

accounting for two-thirds of the total caloric intake and half of the total protein intake of the average Nigerian.

Rice production faces numerous challenges, with weed growth being the most significant obstacle. Research shows that weed presence can reduce potential rice yields by 75% to 100% (Akobundu, 2011; Imeokparia, 2011; Lavabre, 2011). In no-tillage rice, weed competition has a more severe impact on yield compared to transplanted rice. The use of dwarf varieties, early-maturing varieties, and heavy reliance on fertilizers has led to weed problems in no-till farming. Poor weed control can result in up to 40% production losses Africarice (2022).

In Nigeria, rice planting techniques vary, including broadcasting, dibbling on ridges, random transplanting, and row transplanting (Fukagawa and Ziska, 2019). While row transplanting is promoted for boosting yields in lowland areas, it requires significant water and labor resources. To address the challenges of labour losses and extensive use of water, it is important to explore direct seeding method of rice planting as reported by Kamai *et al.,* 2020.

Planting methods significantly influences the yield performance of lowland rice varieties. Historically, transplanted rice was considered to outyield direct-seeded rice. However, inconsistent grain yields reported in the literature may also be attributed to intervening factors such as nitrogen fertilizer and weed management, which can impact crop performance under different rice establishment methods (Kamai *et al.,* 2020).

In Nigeria, manual weeding is commonly practiced, but the increasing cost and scarcity of labor necessitate alternative methods. Manual weeding is also challenging due to the similar morphology of early rice seedlings and certain weeds, particularly grasses (Rahman et al., 2012). Herbicides are the most effective method for managing weeds, but selecting the appropriate herbicide is crucial for cost-effective weed suppression from the existing seed bank.
Environmental factors, such as soil water content during application, can impact herbicide efficacy and crop phytotoxicity by modifying herbicide absorption, translocation, or metabolism (Sanjoy *et al.,* 2019). Optimizing the timing of herbicide application and soil moisture levels is critical to minimize crop phytotoxicity while maximizing herbicide effectiveness in weed control.

There is a lack of knowledge on the optimal planting method and timing of herbicide application that can lead to higher rice yields in this agro-ecological zone. This study aims to investigate how different planting methods and herbicide application timings impact rice productivity, in order to identify the best practices for improving rice yields in this region.

Materials and Methods

The experiment was conducted at the research field of National Cereals Research Institute headquarters, Badeggi, Niger state and Bacita out station in Kwara state. National Cereals Research Institutes Badeggi experimental field is located at (latitude $9^{o}04^{1}$ 02.05''N and longitude $0.6^{o}01^{1}$ 3.31''E), Bacita is located at (latitude 9^{o1} 16'N and longitude 5^{o}59'E) both in the southern Guinea Savannah Agro Ecological Zone of Nigeria. The experiment was carried out during the wet season of 2021 and 2022 in the two locations.

The experiment consisted of factorial combinations of five planting methods (dry-seeding broadcasting, wet-seeding broadcasting, dry-seeding dibbling, wet-seeding dibbling and row transplanting methods) and two levels of timing of herbicides application (2 and 3 weeks after sowing). The 10 treatments combinations with three replications were arranged in a factorial manner and laid out in a randomized complete block design. The gross plot size was $9m^2$ (3m x 3m) and net plot size was $4m^2$ (2m x 2m).
The experimental field was prepared using standard procedures, involving ploughing, harrowing, leveling, and manual bounding. In both locations, nursery beds were created for sowing seeds and raising seedlings, which were later transplanted to the field.

Direct seeding and broadcasting were done using both dry and pre-germinated seeds. A nursery was established for the seedlings, which were later transplanted at 14 days after establishment at a rate of 2 seedlings per hole. Both transplanting

and direct seeding were done with a spacing of 20 x 20 cm. The FARO 44 rice seed variety was used, with the following seeding rates: 25 kg/ha for transplanting, 50 kg/ha for direct seeding, and 60 kg/ha for broadcasting.

A basal application of NPK 15:15:15 fertilizer was applied on the day of sowing or transplanting, prior to sowing or transplanting. The first topdressing with Urea was applied 3-4 weeks after sowing or transplanting, followed by a second topdressing with Urea 6-8 weeks after sowing or transplanting, according to the specified fertilizer rates for each treatment.

Throughout the experimental period, there were no occurrences of pest or disease outbreaks. As a result, no pesticides were applied during the experiment. The rice field was harvested when 80-85% of the panicles had turned yellow or brown, which occurred around 14-16 weeks after sowing (WAS). Harvesting was done using a rice sickle.

Threshing was done manually using a drum on a tarpaulin. The seeds were then separated from the chaff through winnowing, a process that uses air to blow away the lighter chaff, leaving the heavier seeds behind. In each plot, five plants were randomly selected and tagged for periodic observations during the growth period. These observations were made at 10 weeks after sowing (WAS) to determine various growth characteristics. Additionally, at harvest time, ten plant samples were randomly selected from each plot to determine yield characteristics. In each plot, five hills were randomly selected and tagged for data collection, and the following parameters were recorded:

This was collected at 10WAS and at harvest by measuring the height of the tagged plants using a meter rule from the ground level to the apical bud of the plant and mean recorded. The data was collected from the 10 tagged plants at 10WAS and the mean recorded. This was determined by counting the number days from sowing to when half of the plant in a plot have flowered This was counted from the sowing date to the date of harvesting for each treatment. The number of seeds per panicle from the selected tagged plants was threshed, counted and the mean recorded.
The seed from the selected panicles after threshing were weighed and the mean recorded.
Total grain at harvest was determined by weighing the grains from each net plot with a Mettler scale Model 1210 and the value obtained was converted to per hectare basis.

The profitability status of rice production in this study was measured using Gross Margin Analysis by computing the revenue based on the pooled means of yield from different sowing methods and rates of NPK fertilizer using farm gate price (₦250.00/kg). Gross Margin Analysis was estimated as Revenue minus the total variable cost. That is: GM=R-TVC, Where GM =Gross margin, R=Revenue and TVC =Total Variable Cost. The pooled total revenue estimates were expressed in naira per hectare: Benefit Cost Ratio (BCR) of the study was also computed - The BCR was calculated by dividing the proposed total cash benefit of a project by the proposed total cash cost of the project.

Data analysis was performed using GENSTAT software (2008 edition). Analysis of Variance (ANOVA) was conducted using the General Linear Model Procedure. Least Significant Difference (LSD) was used to compare means at a 5% level of probability ($P \leq 0.05$).

Results and Discussion

As shown in Table 1**,** the pre-planting physico-chemical properties of the soils at the experimental sites during the 2021 and 2022 cropping seasons revealed that the soil texture was sandy clay, with a slightly acidic pH ranging from 5.16 to 5.4 across both years. The soil organic carbon content was between 2.5 and 2.8%, total nitrogen was moderately low, available phosphorus was moderate, and exchangeable cation contents were low, as described by Peter et al. (2006**)** which is a good range of organic carbon that supports rice growth**.**

Table 2 shows the effect of planting methods and timing of herbicide application on Plant height, Number of tillers, Days to 50% flowering, Days to maturity, Number of seeds per panicle, Seeds yield per panicle, 1000-grain weight and Grain

yield per hectare during the wet seasons of 2021 and 2022 at Badeggi.

Plant height result indicated that transplanting method of planting produced significantly tallest plants (86.59 and 128.01cm) in 2021 and 2022 respectively compared to the other methods of planting Timing of herbicide application on plant height revealed that applying herbicide at 2 WAS resulted in significantly taller plants (85.19 and 104.75 cm) in both years compared to 3WAS time of herbicide application. No significant interactions between planting methods and herbicide application timings, indicating that the effects of planting methods and herbicide application timings were independent of each other.

Number of tillers result indicated that transplanting method of planting produced significantly highest number of tillers (17.55 and 20.33cm) in both years compared to other planting methods. Wider row spacing likely optimized plant population, thereby supporting better growth and development in rice. This finding aligns with previous studies by Shriame et al. (2000), who noted that wider spacing promotes more functional leaves and higher leaf area, enhancing photosynthesis and resulting in taller plants. Similarly, Kawure et al. (2022) and Hassan et al. (2014) reported similar trends with taller plants observed under transplanting and wet dibbling methods.

Timing of herbicide application on the number of tillers showed that applying herbicide at 2WAS resulted in significantly higher number of tillers compared to 3WAS of herbicide application. The performance of these methods on growth attributes can be attributed to factors like plant density, row spacing, and reduced competition for light, water, and nutrients. This can be attributed to the early control of weeds, which were in a tender stage at the time of application. Early weed control allowed more sunlight to penetrate the rice canopy, reducing natural shading and enhancing photosynthesis efficiency. This finding aligns with Kawure et al. (2022), who emphasized that higher plant density can intensify competition for nutrients, space, and sunlight, affecting individual plant performance.

Days to 50% flowering result showed that the transplanting method of planting significantly attained late flowering (69.94 and 70.33 days) in 2021 and 2022 compared to others methods of planting. Broadcasting method of planting was the first to attain 50% compared to other methods. The timing of herbicide application on days of 50% flowering revealed that there was no significant difference at 5% level of probability. Days to 50% flowering were notably longer with transplanted rice, indicating delayed physiological maturity compared to other methods, possibly due to transplant shock and subsequent adjustments in dibbling and broadcasting methods. This finding parallel results by Mani et al. (2017), underscoring transplanting's impact on flowering time compared to other methods.

Days to maturity result indicted that all treatments showed statistically similar days to maturity, ranging from 115.94 to 116.50 days, though transplanting method of planting significantly influenced the day to maturity compared to other method of planting. Transplanting planting method of rice matured late compared to broadcasting and dibbling methods. The timing of herbicide application on days to maturity revealed that 2WAS application significantly matured earlier compared to 3 WAS application.

The number of seeds per panicle panicle was significantly higher in the transplanting method of planting compared to other methods in both years. The herbicide timing of application on number of seeds per panicle revealed that 2WAS herbicide application significantly produced highest number of seeds per panicle compared to herbicide application at 3WAS.

Seeds yields per panicle result indicted that the transplanting method of planting significantly produced highest seed yield per panicle compared to other method of planting. Transplanting generally led to higher seed yield per panicle and per plant, comparable to dibbling methods, reflecting the role of tiller count in yield determination, as noted by Kawure et al. (2022). The timing of herbicide application on seeds yields per panicle indicated that 2WAS significantly influenced the production of higher seed yield per panicle compared with 3WAS of

herbicide application.

1000-Grain weight result indicated that the transplanting method of planting produced significantly highest 1000 grain compared to other methods of planting. These findings corroborate studies by Mani et al. (2017) but contrast with Hussein et al. (2013), who found no significant effect of planting methods on 1000 grain weight.
The timing of herbicide application on 1000-Grain weight indicated that 2WAS significantly influenced the production of 1000- grain compared the application at 3 WAS application.
Grain yield per hectare result revealed that the transplanting method of planting significantly produced highest yield (4882.5 and 6073kgha) in both years respectively compared to other methods of sowing. This can be linked to taller plants, increased tiller count, higher biomass and dry matter accumulation, more panicles, higher seed yield per hill, and greater photosynthetic capacity. These results are consistent with findings by Kawure et al. (2023), emphasizing that transplanting and direct seed dibbling methods generally result in higher yields compared to seed drilling and broadcasting methods.

The timing of herbicide application on grain yield per hectare indicated that 2 WAS significantly influenced the production of rice yield per hectare compared with 3WAS application of herbicide. This improvement in yield can be attributed to the early weed control, which facilitated optimal nutrient, sunlight, and water use by the rice plants, thereby enhancing grain production per hectare.
Table 3: showed the Economic analysis of rice production on different planting methods and timing of herbicide application in Badeggi (pooled data for 2021 and 2022) on the grain yield (t/ha) indicated that highest yield was obtained from P_5H_1 (5387.36 t/ha) and P_5H_2 (5568.33 t/ha), with the transplanting method of sowing with combination of herbicide application at 2 WAS compared to other methods of planting and 3 WAS timing of application respectively. The Gross returns (Naira #/ha) revealed that the highest gross returns were obtained from P_5H_1 (₦1,346,840/ha) and P_5H_2 (₦1,392,083/ha), the transplanting method of planting with herbicide application at 2WAS. The Total Variable Cost (TVC ₦) showed that the TVC ranged from ₦331,800 to ₦386,500 across all treatments. The Gross Margin (Net returns ₦) indicated that the highest gross margin was obtained from P_5H_1 (₦960,340/ha) and P_5H_2 (₦1,005,583/ha), which are the transplanting methods with herbicide application at 2 WAS respectively.

Conclusion

The transplanting method resulted in significantly better plant growth performance, increased yield parameter and grain yield compared to other planting methods. Application of herbicide at 2WAS resulted in higher grain yield per hectare compared to application of herbicide at 3WAS The combination of the transplanting method and herbicide application at 2 WAS (P5H1) produced the highest grain yield, gross returns, and gross margin, indicating that higher yields lead to higher profits.

The transplanting method improved rice productivity in the study area and is recommended. Herbicide application at 2 WAS also enhanced rice production and is recommended. The combination of transplanting and herbicide application at 2 WAS significantly increased rice growth, development, and yield while maximizing profits. Additionally, the wet dibbling method with herbicide application at 2 WAS is recommended as the best alternative to transplanting in the study area. Adopting these findings would enhance rice productivity and improve the standard of living for rice farmers in the study area.

References

Africarice (2022). Stress-Tolerant Rice Varieties. https://www.Africarice.Org/StressTolerant Rice. Accessed on 17–03–2022

Akobundu, I. O. (2011). Weed control in direct-seeded lowland rice under poor water control conditions. *Weed Research* 21:273-278.

Allen, B. L. (2012). Dryland corn yield affected by row configuration and seeding rate in the northern Great Plains. *Journal of Soil Water Conservation* 67:32–41. http://www.

jswconline.org/content/67/1/32.abstract.

Arouna, A., Lokossou, J. C., Wopereis, M. C. S., Bruce-Oliver, S. and Roy-Macauley, H. (2017). Contribution of improved rice varieties to poverty reduction and food security in Sub-Saharan Africa. *Global Food Security*, 14, 54 60. https://Doi.Org/10.1016/J.Gfs.2017.03.001

CGIAR (2023). What do we know about the future of rice to food system transformation? *Initiative on Foresight.* https://www.cgiar.org/news.Events/News/What-Do-We-Know-About-The-Future-*Of*-Rice-In-Relation-To-Food System-Trans*for*mation/

Chauhan, B. S., Johnson, D. E. (2011). Row spacing and weed control timing affect the yield of aerobic rice. *Field Crop. Research* 121, 226–231.

Fukagawa, N. K., and Ziska, L. H. (2019). Rice: Importance for global nutrition. *Journal Nutrition Science Vitaminol* (Tokyo); 65 (Supplement): S2-S3. Doi: 10.3177/Jnsv.65. S2. Pmid: 31619630.

ICAR (2006). Hand Book of Agriculture. http://www.icar.org.

Imeokparia, P. O. (2011). Control of Cut grass (*Leersia hexandra*) in direct seeded lowland rice at Badeggi. Agronomy Seminar, Ahmadu Bello University, Zaria.

Kamai, N., Omoigui, L. O., Kamara, A. Y and Ekeleme, F. (2020). Guide to rice production in Northern Nigeria. Published by the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. Pp.2-10

Kawure, S., Garba, A. A, Fagam, A. S, Shuaibu, Y. M. Sabo, M. U. Bala, R. A. (2022). Performance of lowland rice (*Oryza sativa* L.) as influenced by the combined effect of season and sowing pattern in Zigau. *Journal of Rice Research and Developments* 5 (2). doi:10.36959/973/440. S2CID 256799161.

Kawure, S., Garba, A. A., Fagam, A. S. Shuaibu, Y. M., Sabo, M. U. Nayaya, J. (2018). Effect of sowing method on growth and yield of irrigated lowland rice (*Oryza sativa* L.) in alternate wetting and drying (AWD). *FUDMA Journal of Science (FJS)*, Vol. 2, No 3; pp 170-174. ISSN: 2616-1370

Kumar, S., Ashok, K. S., Singh, G., Nareshmani, P., Ajit, Kumar., and Dinesh, K. (2018). Effect of establishment methods and weed management practices on the growth and yield of direct seeded rice (*Oryza sativa* L.). *Journal Pharmacogn Phytochemistry*.7(1):164-168.

Lavabre, E. M. (2011). The Tropical Agriculturist: Weed Control, pp.86.

Mahajan, G., and Chauhan, B. S. (2022). Screening of herbicides for rice seedling safety and *Echinochloa colona* management under Australian Conditions. *Agronomy*, *12*(6), 1273. https://Doi.Org/10.3390/Agronomy12061273 2024 Nigerian Seed Portal Initiative

Peng, S. et al. (1996). Increased N-use efficiency using a chlorophyll meter on high-yielding irrigated rice. *Field Crops Research.* **47**, 243–252.

Sanjoy, S., Nayak, A. K., Tripathi, R., Mohammad, S., Sangita, M., Panda, B. B., Vijayakumar, S, Mohapatra, S. D., Priyadarsini, S., Sarangi, D. R., Udaya, S., Nagothu and Pathak W. H. (2019). Weed management in dry direct-sown rice. ICAR – National Rice Research Institute, Cuttack. Technology Brief No. 7. http://Resilienceindia.Org/Sites/Default/Files/7%20weed%20managment%20in%20sr.Pdf

Street, J. E. and Lanham, D. J. (2016). Pendimethalin as a Delayed Preemergence Herbicide in Rice. Bulletin No. 1064. Missssippi. Agricultural and Forestry Experiment Station. Mississippi State University, Mississippi State

Table 1: Physical and Chemical Properties of Soil in the Experimental Site for the both wet seasons

Properties	Badeggi (2021)	Badeggi (2022)
PH	7.3	6.9
O.C.%	1.82	1.80
O.M.%	3.12	3.09
N%	0.35	0.28
Avail P (ppm)	12.35	8.43
K	0.34	0.30
Na	0.21	0.19
Ca	3.56	3.21
Mg	2.86	2.15
EA	0.50	0.67
TEB	6.97	5.85
CEC	7.47	6.52
B.S.%	93%	89%
Particle size analysis		
Sand %	76.4	74.6
Silt %	5.4	5.4
Clay %	18.2	20
Texture	Sandy loam	Sandy loam

Table 2: Physical and Chemical Properties of Soil in the Experimental Site for the both wet seasons

Properties	Bacita (2021)	Bacita (2022)
PH	7.1	6.9
O.C.%	1.81	1.80
O.M.%	3.02	3.09
N%	0.33	0.28
Avail P (ppm)	12.31	8.43
K	0.31	0.30
Na	0.22	0.19
Ca	3.44	3.21
Mg	2.76	2.15
EA	0.49	0.67
TEB	6.47	5.85
CEC	7.30	6.52
B.S.%	91%	89%
Particle size analysis		
Sand %	79.6	78.6
Silt %	6.1	6.0
Clay %	14.3	15.4
Texture	Sandy loam	Sandy loam

Table 3: Effect of Sowing Methods and Timing of Herbicide Application on Plant Height, Number of tillers, Days to 50% flowering, Days to maturity, Number of seeds per panicle, Seeds yield per panicle, 1000-grain weight and Grain yield per hectare at Badeggi 2021 and 2022 wet seasons

	Plant Height (cm)		Number of tillers		Days to 50% Flowering		Days to Maturity		Number of seeds per panicle		Seed Yield per Panicle (Kg)		1000-Grain Weight (g)		Grain Yield per Hectare (tons)	
Treatments	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2012**	**2022**
Sowing Methods (S)																
Broadcast dry	82.82d	89.84b	11.54e	15.17d	67.11c	67.17d	116.00c	116.17b	176.24d	118.83e	84.53d	83.66d	22.79bc	23.87d	2977.54c	3833.33d
Broadcast wet	82.21e	85.33d	11.69d	13.83e	67.28c	67.00e	115.94d	116.17b	177.49c	134.50d	8777.56c	82.50e	22.87bc	24.17c	2638.47d	3930.56cd
Dibbling dry	84.49c	88.38c	13.99b	18.17b	68.39b	68.00b	115.56e	115.67c	179.41b	142.50e	89.38c	86.82c	23.56b	24.11b	3152.50c	4333.33c
Dibbling wet	85.67b	89.12b	12.78c	16.50c	68.33b	67.83c	116.06b	116.11b	179.39b	157.50	92.57b	96.16b	23.92b	24.44a	3495.69b	5277.78b
Transplanting	86.59a	128.01a	17.55a	20.33a	69.94a	70.33a	116.44a	116.50a	182.18a	149.50	105.13a	107.83a	24.71a	24.48a	4882.50a	6073.19a
SE±	0.03	18.82	0.04	0.00	0.29	0.00	0.25	0.02	0.06	0.01	0.07	0.00	0.05	0.05	110.10	83.08
Timing of Herbicide Application (H)																
2 WAS	85.19a	104.75a	13.93a	17.26a	68.47	68.06	116.24a	116.38a	179.65a	142.47a	95.54a	92.39a	23.76a	24.22b	3576.91a	4883.33a
3 WAS	83.52b	87.53b	13.09b	16.33b	68.37	68.06	115.76b	115.87b	178.65b	139.66b	90.92b	90.40b	22.73b	24.16b	3201.78b	4495.94b
SE±	0.02	11.90	0.03	0.00	0.19	0.00	0.16	0.02	0.04	0.00	0.04	0.00	0.03	0.03	69.64	52.54
Interactions																
S x H	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) within the same column and treatment group are not significantly different at 5% level of probability. [1]Weeks after sowing; [2]not significant difference at 5% level of probability.

Table 4: Economic analysis of rice production on different planting methods and timing of herbicide application in Badeggi 2021 and 2022 Combined

Treatment combinations	Grain yield t/ha	Gross returns Naira (₦)/ha	Total Variable Cost (TVC)	Gross Margin (₦)
P_1H_1	2975.32	743,830	331,800	412,030
P_2H_1	3433.33	858,333	336,800	521,533
P_3H_1	3777.36	944,340	346,800	597,540
P_4H_1	4608.75	1,152,188	351,800	800,388
P_5H_1	5387.36	1,346,840	386,500	960,340
P_1H_2	3635.56	908,890	331,800	577,090
P_2H_2	3135.69	783,923	336,800	447,123
P_3H_2	3708.47 |	927,118	346,800	580,318
P_4H_2	4164.73	1,041,183	351,800	689,383
P_5H_2	5568.33	1,392,083	386,500	1,005,583

NB: P_1 =Broadcasting dry, P_2=Broadcasting wet, P_3=Dibbling dry, P_4=Dibbling wet, P_5=Transplanting, H_1 = 2WAS Timing of Herbicide application and H_2 =2WAS Timing of Herbicide appl