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Comparative Analysis on the Cropping System of Rice Intensification and Traditional Method of Rice Production in Mubi North, Adamawa State, Nigeria

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ABSTRACT
A field experimentation to determine the rate of tillering, productivity and economic return of rice under different methods of crop establishment was carried out at the Teaching and Research Farm of the Faculty of Agriculture during 2017 cropping season. Two different methods of crop establishments were used; system of rice intensification (SRI) and traditional method. The experimental design, randomized complete block design (RCBD) which was replicated three (3) times was tested. Among the different methods of crop establishment, traditional method was found to be superior (significant at $P \leq 0.05$) in all the vegetative growth except in the panicle initiation period which were at par with SRI, and the cost of cultivation was not higher, but the benefit cost ratio (B:C) ratio was considered safe (2.23) compared to SRI method in terms of economic income to the farmer. In the case of dry mater and yield, there was no significant difference among the methods of cultivation at $P \leq 0.05$. On the basis of net return and cost of production, traditional method is therefore, considerably safe and is recommended in the area of the research.
Key words: Rice, Intensification, Traditional, system.

INTRODUCTION
Today, about 800 million people are suffering from malnourishment and hunger worldwide, thus creating the need for a sustainable increase in rice production to improve global food security and contribute to poverty alleviation (Badawi (2004). The role of agricultural production remains cardinal to feed the growing population of over 6 billion people, gradually increasing on a yearly basis (Traore, 2005). To meet the nutritional needs of such a large population, it would require increasing agricultural productivity through expansion of cultivated land areas, development of crops with high yield potential, vigorous protection of yields losses due to insect-pest and improving soil fertility (Traore, 2005).
It is estimated that Africa produces an average of 14.6 million tons of rough rice per year on 7.3 million hectares between 1989 and 1996 (Traore, 2005). Out of the vast available areas, West Africa has the largest planted rice area of about 4.1 million hectares. Yet, production remains at low levels. This is probably due to poor crop management techniques, lack of research and extension system, and limited utilization of productive varieties (Badawi, 2004; Anonymous, 2008a). One of the major concerns in rice production has to do with seed and grain quality (Traore, 2005). While many components contribute to rice quality, the most important are cooking and eating qualities. These parameters primarily involve the physical and chemical characteristics of starch. The constituents that play important roles in cooking and

eating quality are amylose content, gelatinization temperature, and gel consistency (Traore, 2005). According to Horna *et al*. (2005) grain quality is one of the key selection criteria highly prioritized by farmers and consumers of rice and therefore farmer select rice with traits that are desirable for consumption as well as for production and sale. In the future, grain quality will be more important as very poor consumers, who depend largely on rice for their daily food, demand higher quality rice (Traore, 2005). Therefore, there is a need to improve the system of cultivating rice in order to meet with the demand of food required by the large daily growing population. The System of Rice Intensification (SRI) is a way of harmonizing the elements of soil, water, light and plant to allow the plant to achieve its fullest potential, which is often hidden when inappropriate techniques are used (Zotoglo, 2011). SRI, as opposed to traditional rice production, involves alternate wetting and drying (AWD) of rice fields (Kepha, Bancy and Patrick, 2014). Research and demonstration plots in several tropical countries have shown SRI techniques as productive resource-saving and environmentally benign when compared to conventional or traditional rice production (Namara, *et al*., 2004: Sato and Uphoff, 2007; Sinha and Talati, 2007). Under the traditional method of rice production water is the most important component of sustainable rice production. In the traditional method of growing rice, the rice fields are continuously flooded during vegetative growth of the crop with draining of water during grain ripening stage (Uphoff, 2006, Satyanarayana, Thiyagarajan and Uphoff, 2007; Chapagain and Yamaji, 2010; Kunimitsu, 2006). SRI differs from traditional system of rice production (TSRP) practices by giving the plant all opportunities to achieve its full production potential. The methodology develops a better root system, a longer amount of vegetation, and maximum paddy production. It saves time more than 80% in seeds and fertilizer, uses about 35% water, saves more than 70% in hand wedding and hoeing cost, and has a much shorter production cycle-two to three weeks. The results are a 35 to 100% increase in product yield. This improved productivity translates into a more marketable production with more income for the producer and increased sustainable land use (Zotoglo, 2011; Chapagain, Riseman and Yamaji, 2011; Amod, *et al*., 2014). However, SRI and traditional method of rice production are similar in the area of land preparation which requires good tilling and mudding.

The system for rice intensification known (SRI) was developed by French Priest Father Henri de Laulani in Madagascar in the 1980's in an effort to find sustainable agricultural practices which lead to higher productivity, optimum use of capital and labour, less input cost and less requirement of water. In the broadcasting, one has to use a minimum of 100kg of rice seeds for one hectare, in planting one require about 30-60kg of seeds or so. But in SRI, only 4-10kg of seeds are required for one hectare (A.R Durga, D. Suresh Kumar 2013). Therefore, this reduces input cost for the farmers and also less drudgery.

There are six principles guiding system of rice intensification (SRI), these are:

- seedlings get transplanted at a much younger age;
- only single seedling, instead of a handful of seedlings get planted in each hole;
- increased use of organic fertilizer to enhance soil fertility;
- intermittent water application to increase wet and dry soil conditions, instead of continuous flood irrigation;
- plants are spaced wider apart Instead of close, dense planting, with seed rates of 50-100 kg/ha, plants were set out carefully and gently in a square pattern, 25x25cm or wider if the soil is very good; the seed rate is reduced by 80-90%, netting farmers as much as 90 - 95 kg of rice per hectare and
- rotary weeding to control weeds and promote soil aeration.

Statement of Problem

Several efforts were made over the years to increase the production of rice in Nigeria. These efforts aimed at actualizing the dreams of Nigeria to achieve self-sufficient in rice production. Currently, the country spends a huge amount of money daily on rice importation. In time past, many government agencies, community development organizations (CBOs), non-governmental and organizations conducted trials and demonstrations. These demonstrations aimed at encouraging rice farmers' adoption of SRI. However, the rural rice farmers are still faced with low rice yield as well as rural incomes which are lower than twenty years ago (Cross River State projects/Programmes Monitoring and Evaluation Unit, 2012).

In Nigeria, for instance some agencies were identified to be involved in rice related activities including training and demonstration of SRI. These agencies are Commercial Agriculture Development Project (CADP), Fadama III Project, IFAD/FGN/ Community-based Natural Resource Management Programme (CBNRMP), Sasakawa, National Food Security Programme (NFSP) and Green Earth Implementation Initiatives (GEIDI). All these interventions from these agencies do not seem to have yielded desirable results as the rice farmers remain poor with low productivity. This study therefore, attempts and conducted comparative analysis of System of Rice Intensification (SRI) and Traditional System of Rice Production (TSRP).

Objectives of the Study

The drive of the study is to conduct a comparative analysis on the cropping system for rice intensification and conventional or traditional method of rice production.

The specific objectives are:

- to assess the rate of tillering of rice under different methods of crop establishment.
- to ascertain the productivity of rice under different methods of crop establishment; and
- to determine the economic return of rice cultivation under different crop establishment methods.

Scope of the Study: The study investigated the comparative analysis on the cropping system for rice intensification and conventional or traditional method of rice production in Mubi north of Adamawa state. The study was restricted to Mubi, northern guinea savannah of Adamawa State, Nigeria.

Significance of the Study

The inextricable connection between technological change and adoption of innovation underlines the growth of agricultural productivity (Payne, Fenamdez and Daberknow, 2003). Agricultural research effort can only be successful when developed technologies by research Institutes are adopted by the end users to increase production. Therefore, an agricultural innovation that is unable to boost production on this ground shows ineffective research effort. Hence it is always important to determine the status of adoption of transferred technologies by target farmer groups. This will elicit information on the usefulness and relevance of the technologies as well as elucidate further modifications that are supposed to be made to increase adoption of the technologies.

This study, therefore, seeks to give information that would help National Cereals Research Institute (NCRI) and other related research institutes, farmers and Universities to promote technological advancement on rice production that would be relevant to the needs and problems of farmers in Adamawa State. It can also provide extension workers, development Institutions and policy makers with valuable information that will assists in improving efficiency of communication. This study will contribute to improving the efficiency of agricultural research, technology transfer, input provision and policy formulation. Findings of this study would also add to the existing body of knowledge. It is expected that this study will serve as a spring board to undertake detailed and comprehensive studies in other states. The study will also be significant to researchers who want to keep abreast with the current trend in the study of the adoption of SRI over traditional method of rice production.

Definition of Terms: According to this study, the following terms can be significant as;

a) **Comparative:** this refers to proportional, qualified, relative or reasonable methodology.
b) **Analysis;** mean study, scrutiny, investigation, examination or breakdown of both SRI and traditional method of rice production.

c) **Cropping** is the act of gathering, harvesting, collecting of crops in the field.
d) **System:** this is the arrangement, classification or organization to some degree.
e) **Rice:** this is a cereal plant, *Oryza sativa* of the grass family (poaceae) whose seeds are used as food.
f) **Intensification:** this refers to an increase, amplification, or rise in production.
g) **Traditional:** this means an old-fashioned or an old-style of production.
h) **Production** is the creation, making or management of crops in the field.
i) **S.R.I:** this is an acronym that is defined as 'system for rice intensification'. The System of Rice Intensification (SRI) is a way of harmonizing the elements of soil, water, light and plant to allow the plant to achieve its fullest potential, which is often hidden when inappropriate techniques are used (Zotoglo, 2011).
j) **T.S.R.P:** this is an acronym that is defined as 'traditional system of rice production'. The traditional system of rice production (TSRP) is an olden system of rice production that is based on the indigenous knowledge of the local farmer living in a particular area.

MATERIALS AND METHODS

The research was conducted at the Teaching and Research Farm of the Faculty of Agriculture. Adamawa State University Mubi, during the 2017 cropping season.
Mubi is at 10^0 10^1 N and 10^0 30' N of the equator and between longitude 13^0, 10^0 E and 13^2 E and 696m above sea level. Rain fall is the critical climatic factor in this area and the pattern is unimodal. The rainfall is high in July and August. Stable crops grown are maize, groundnut, sorghum, cowpea, soybean and Rice. (Shehu *et al.,* 2007).
The climate of Mubi is characterized by an alternate period of hot raining season and cool dry season. The raining season normally begins at April – May and last until October – November; February is normally cool and dry. Rainy season is associated with tropical continental air mass which is cool, dry and dusty, by January. Both of the seasons have their peculiar characteristics of temperature, pressure, wind, humidity and rainfall. The annual rainfall of Mubi ranges from 700 mm – 1,050 mm.
The experiment was laid out in randomized complete block design (RCBD) with three replications having two treatments. The treatments consist of combination of methods (different methods of cropping pattern that were generally recommended for transplanted rice (TPR), system of rice intensification (SRI), and direct seeded rice with other SRI management practices (DSR). The total land area was 17 m x 9 m (153 m^2) and the size of individual plot was 5 m × 4 m (20 m^2). There was a bound of 1 m width between two experimental plots and each replication respectively. The crop geometry for general recommended transplanted rice (TPR) was maintained at 25 cm × 25 cm (hill to hill and row to row spacing in a square shape) with single seeding per hill and 16 rows in each plot. In direct seeding rice (DSR) plots, crop geometry was maintained at randomly spaced (hill to hill and row to row spacing) with at least 5-8 seeds/hole. The layout of the field was done by making 6 plots manually by digging, weeding and pulverizing soils.

Parameters and procedures used

The following data was measured:
Data was collected on the biometrical observations, yield and yield attributes.

Biometrical observations

Biometrical observation was carried out on plant height, number of tillers per square meter, period of panicle initiation and dry mater.

Plant height (cm): The height of plants from four (4) randomly selected plants was measured using meter rule from the base of the plant to the growing tip at 2 WAS up to 8WAS and at harvest.

Number of tillers per square meter: The number of tillers per square meter was taken by counting the number of tillers from four (4) randomly selected plants at 2 WAS up to 8WAS and at harvest.

Panicle initiation: Days to first flowering; the days to first flowering was determined as the number of days from sowing to the first day flowering is observed. Days to fifty percent flowering; this was determined as the number of days from sowing to the time when fifty percent of the plant flowers.

Dry matter analysis: Dry matter analysis; this was done by uprooting the plant at four and eight weeks after planting to determine the biomass of the plant, by drying at 60^0c for 24 hours and was weighed using digital weighing scale or meter.

Yield attributing characters of rice: Yield qualities were tested on seed diameter (thickness of the seed), number of grains per panicle, hundred grain weight (HGW) and harvest index.

Seed diameter: The seed diameter was determined by measuring the thickness of the seed using Vanier calliper**.**

Number of grains per panicle: Numbers of filled and unfilled grains were counted to determine the number of grains per panicle of the sampled 20 panicles. The numbers of unfilled grains per panicle were used to determine the sterility percentage.

Hundred grain weight (HGW): Hundred grains were counted from the randomly separated grain yield of plot and weighed with the help of portable automatic electronic scale.

Harvest index: Harvest index (HI) was computed by dividing grain yield with the total straw yield as per the following formula:

$$Harvest\ index\ \% = \frac{weight\ of\ grain}{grain\ yield + straw\ yield}\ x\ 100$$

Economic analysis: The economic analysis was done to determine which cultivation method can generate high net return to the farmer and to determine which method will be considering safe on the basis of benefit cost ratio B: C.

Cost of cultivation: Cost of cultivation was calculated on the basis of local charges for different agro-inputs, i.e. labour, fertilizer, compost, and other necessary materials. Cost of cultivation for the two different methods was calculated separately.

Gross return: Economic yield (grain + straw) of rice was converted into gross return (₦ ha^{-1}) on the basis of local market price.

Net return: It was calculated by subtracting the cost of cultivation from the gross return.

B:C ratio: It was calculated by the formula, B: C ratio = Gross return / Cost of cultivation.

Data analysis: Data collected was subjected to analysis of variance (ANOVA) and the mean values were separated using least significant difference (LSD) where significant difference occur at 5% level of significance.

RESULTS AND DISCUSSION

Biometrical observation of rice: The influence of cultivation methods on plant height, number of tillers, panicle initiation and dry mater are presented with the aid of figures and tables. All the figures used in this chapter show the visible difference between the two methods of crop establishment (where there is a significant difference) on all the parameters taken.

Table 1: Plant height of rice as influenced by method of crop establishment

Treatments	plant height				
	2WAS	4WAS	6WAS	8WAS	at harvest
S R I	32.39^{b}	51.25^{b}	65.75^{b}	83.40^{b}	70.59^{b}
Traditional	51.11^{a}	78.41^{a}	70.12^{a}	103.21^{a} 87.67^{a}	
P value (0.05)	0.037	0.003	0.042	0.001	0.016
S.E ±	3.10	2.10	0.74	0.99	2.11
Grand mean	41.70	64.83	67.94	93.31	79.13

WAS, Weeks after sowing; **Treatments** means followed by common letter (s) within column are not significantly different among each other at P≤0.05 level of significance.

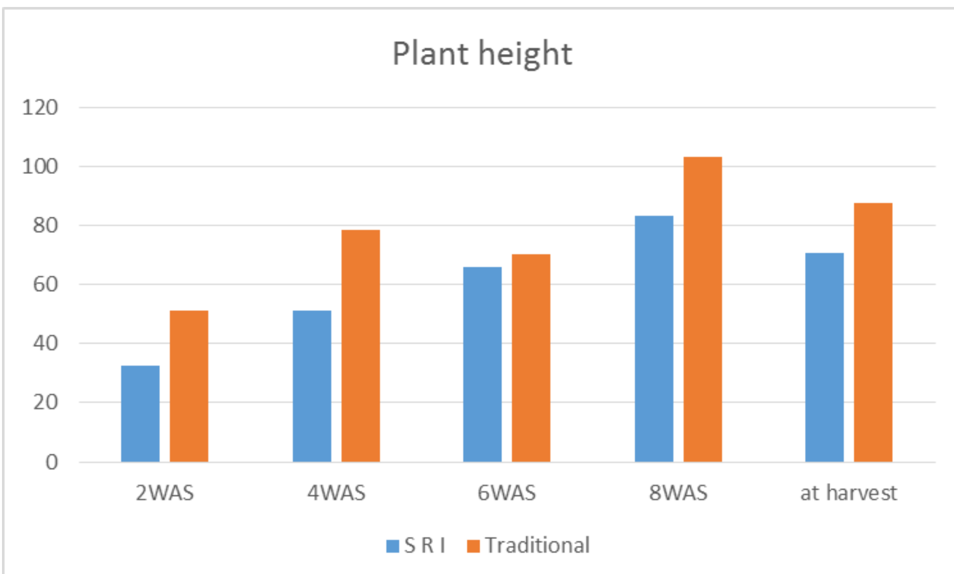

Figure 2. Plant height (cm) of rice as influenced by method of crop establishment

Plant height: The plant height was significantly influenced by the method of cultivation, table 1 and figure 2. The increment in plant height was prominent between 4 WAS and 8 WAS, which represents the rapid vegetative growth stage of plant coinciding with the stage of maximum tillering. Plant heights were significantly influenced by method of crop establishment at all observations. Maximum plant height was observed at 8 WAS of traditional method (104.6 cm) which was significantly higher than SRI (88.7 cm). At 2 WAS, significantly tall plant height (47.9 cm) was observed in traditional method and significantly short plant height (23 cm) was observed in SRI which could be due to late transplantation in SRI and higher rate of competition for space, light, water and nutrients in nursery bed. In case of 4 WAS significantly tall plant height (89.5 cm) was observed in traditional method and significantly short plant height (42.5 cm) was observed in SRI. Significantly tall plant height (97.3 cm) was observed in traditional method in case of 6 WAS and at the same observation short plant height (58.6 cm) was observed in SRI, but there was a slowdown in plant height as observed in traditional and it may be due to water stress as shown in figure 2. At harvest maximum plant height was observed in traditional method (90 cm) followed by SRI method (65.8 cm). It was obvious that the reduction in plant height was attributed to the senescence of leaves and bending down of panicle.

Figure 2. Plant height (cm) of rice as influenced by method of crop establishment

Numbers of tillers per square meter

Table 2: Number of tillers per square meter of rice as influenced by method of crop establishment

Treatments	Number tillers				
	2WAS	4WAS	6WAS	8WAS	at harvest
S R I	3.67[b]	14.00[b]	25.67[b]	62.00[b]	71.00[b]
Traditional	29.00[a]	57.00[a]	71.00[a]	88.00[a]	94.67[a]
LSD (P=0.05)	0.002	0.001	0.001	0.007	0.017
S.E ±	3.62	2.38	2.78	5.24	6.01
Grand mean	16.33	35.80	48.33	75.17	82.83

WAS, Weeks after sowing; **Treatments** means followed by common letter (s) within column are not significantly different among each other at P≤0.05 level of significance.

The number of tillers per square meter was significantly influenced by the different methods of crop establishment, table 2. Different methods of crop establishment influenced tillers per square meter in all the observations taken. The highest number of tillers per square meter (37) was observed in traditional method at 2 WAS. It was significantly higher than SRI (4). At 4 WAS, the highest number of tillers per square meter was in traditional method (83) and was significantly higher than SRI (21). Similarly, higher number of tillers at 6 WAS was observed in traditional method (93) which was significantly higher than SRI (36). Higher number of tillers at 8 WAS was observed in traditional method (97), which was significantly higher than SRI (67). At harvest significantly higher number of tillers per square meter (105) was observed in traditional method, followed by SRI (89). Significantly higher tillers per square meter were observed with traditional method in all the observations. The number of tillers was significantly influenced by the method of crop establishment in all the intervals as shown in figure 3.

This may be due to the research being conducted under rain fed condition. According to Gupta *et al.* (1976) and Hossain *et al*. (2002), intermittently irrigated rice produced more adventitious tillers. Tillering ability in rice has a close relationship with the number of phyllochrons completed before entering the reproductive stage (Nemoto *et al*., 1995; Stoop *et al*., 2002). The duration of phyllochrons is influenced by a number of environmental factors and biophysical growing conditions for the plant: soil and ambient temperature, exposure to sunlight, spacing, nutrient availability, soil friability versus compaction, soil moisture vs. desiccation, and soil aeration vs. hypoxia (Nemoto *et al*., 1995). Thus higher number of tillers produced in traditional method was due to favorable condition to exploit maximum phyllochrons, SRI method is more favoured under irrigation system because it involves alternating between dry and wet periods. Irrigated rice production is the largest consumer of water in agricultural sector, and its sustainability is threatened by increasing water shortages. Such water scarcity necessitates the development of alternative system of irrigation in (irrigated) rice cultivation (systems) that require less water than traditional flooded rice (Bouman *et al.*, 2005).

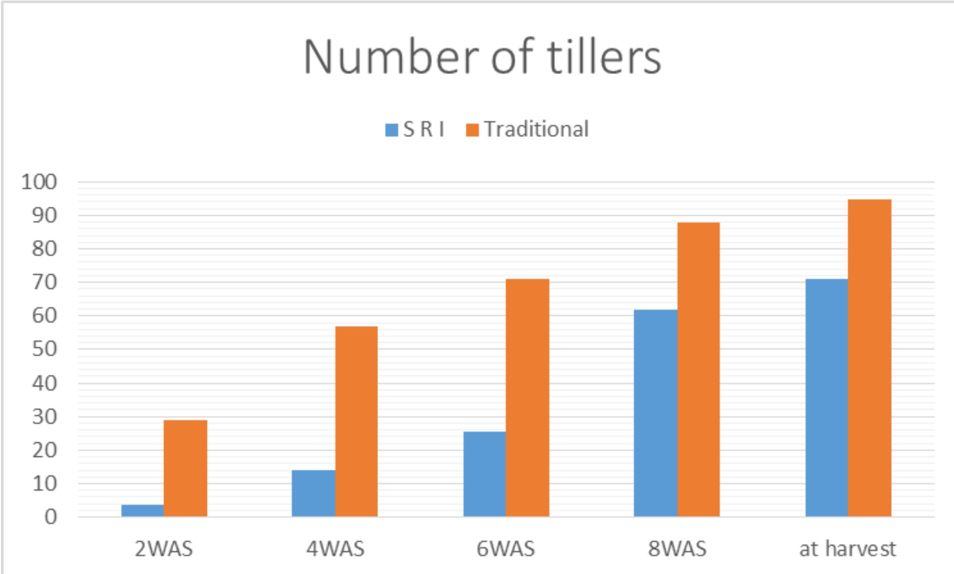

Figure 3. Number tillers of rice as influenced by method of crop establishment

Panicle initiation (PI):

The panicle initiation stage begins when the primordium of the panicle is differentiated and becomes visible.

Table 3: Panicle initiation as influenced by method of crop establishment

Treatments	Days to first flowering	Days to 50% flowering
S R I	62.67[a]	65.67[a]
Traditional	65.67[a]	72.00[a]
LSD (P=0.05)	0.37	0.072
S.E ±	2.98	2.60
Grand mean	64.17	68.83

Treatments means followed by common letter (s) within column are not significantly different among each other at P≤0.05 level of significance.

Days to 50% flowering

In a short duration variety (105 days from seed to maturity), the panicle primordium starts to differentiate at about 40 days after seeding and becomes visible 11 days later (visual panicle initiation) as a white feathery cone 1.0-1.5 mm in length (De Datta, 1981). If water is limiting, panicle initiation may be delayed. This often occurs in rice direct-seeded (traditional) in a non-puddled soil. The period of panicle initiation (PI) was not significantly different among the different methods of cultivation as presented in table 3. The SRI initiated panicles earlier than traditional method as shown in figure 4.

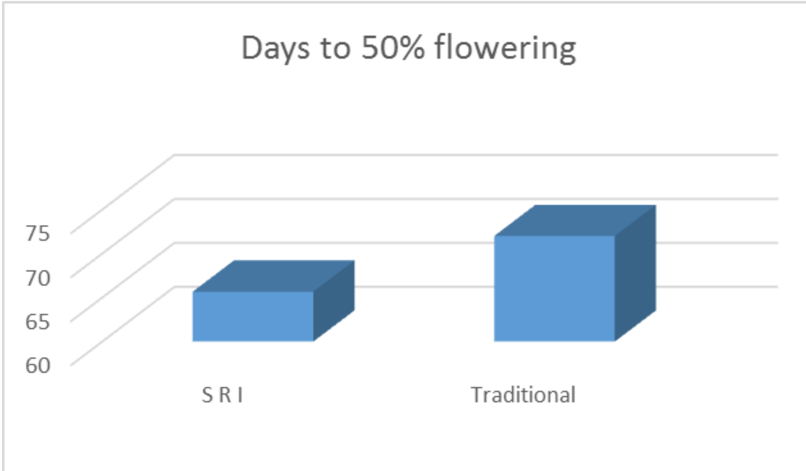

Figure 4. Days to 50% flowering of rice as influenced by method of crop establishment

Dry mater production

Table 4. Dry matter of rice as influenced by method of crop establishment

Treatments	Dry matter		
	4WAS	8WAS	at harvest
S R I	8.01[a]	16.08[a]	34.98[a]
Traditional	8.08[a]	16.32[a]	34.47[a]
LSD (P=0.05)	0.99	0.96	0.97
S.E ±	1.87	4.56	8.42
Grand mean	8.05	16.21	34.73

WAS, Weeks after sowing; **Treatments** means followed by common letter (s) within column are not significantly different among each other at P≤0.05 level of significance.

High production of total dry mater per unit area is the first prerequisite for high yield. The amount of dry matter production depends on effectiveness of photosynthesis of crop and furthermore, on plants whose vital activities are functioning effectively. The total yield of dry matter is the total amount of dry matter produced, less the photosynthates used for respiration. Finally, the manner in which the net dry matter produced is distributed among different parts of the plant, which determine magnitude of the economic yield (Arnon, 1972). There was no significant difference between the methods of crop establishment. Crop establishment methods at 4WAS, 8WAS and at harvest were statistically at par to each other respectively as presented in table 4. The cultivation methods have no influence on the dry mater produced as in figure 5.

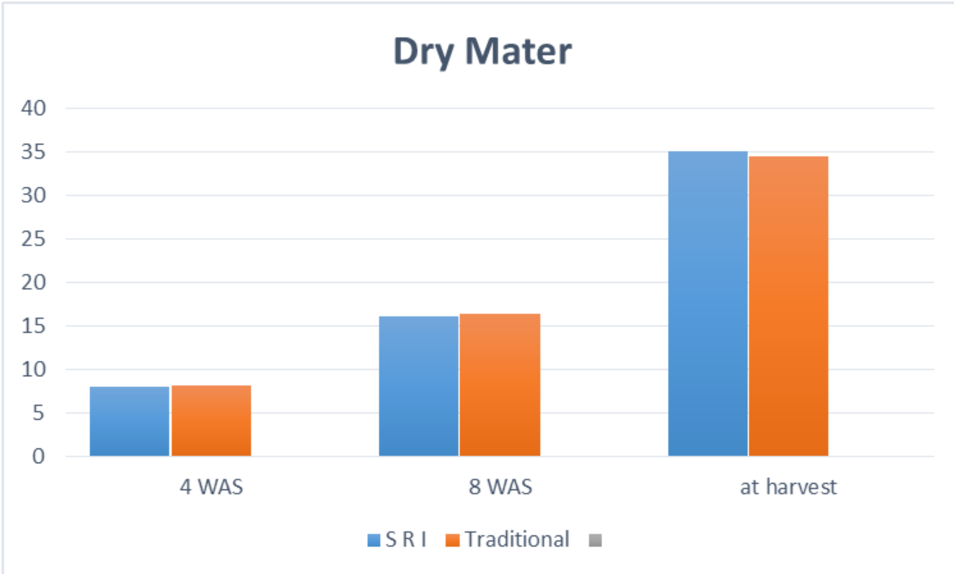

Figure 5. Dry mater of rice as influenced by method of crop establishment

Yield attributing attributes as influenced by different method of crop establishment

Seed diameter (mm): The diameter of the seed was not influenced by the method of cultivation, table 5. In fact, figure 6 show equality in the seed diameter as influenced by the cropping system. This may be due to the contents of photo-assimilates in the plant tissue. The higher the concentration of photo-assimilates in the plant tissue, the better the quality of the grain yield. Finally, grain yield is not only determined by partitioning of current photo-assimilates, but also depends upon remobilization of non-structural carbohydrates stored in stems, particularly under conditions where environmental stress impairs leaf photosynthesis (Wardlaw 1990). During grains setting, the entire photo-assimilates within the plant move to the storage organ (grain). Some amount of carbohydrates formed before flowering are stored in culms and leaf sheaths and later re-translocated to the grain (Reddy and Reddi, 2005).

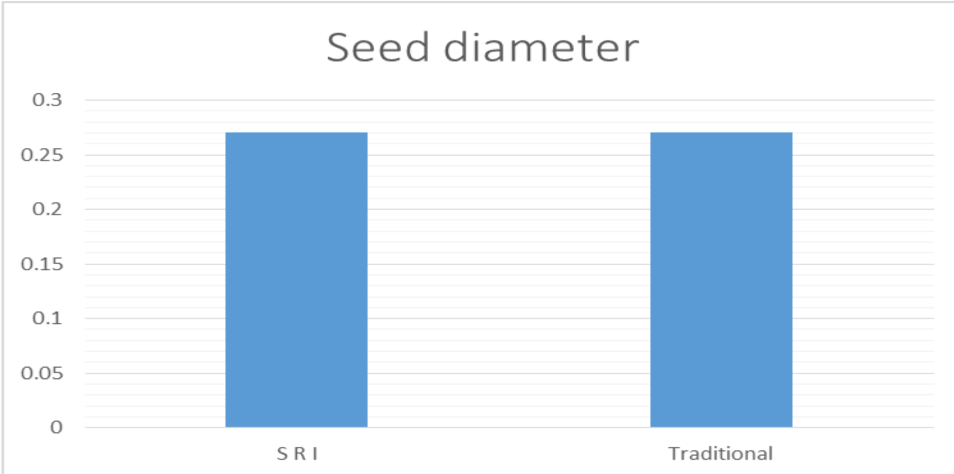

Figure 6: Seed diameter as influenced by cropping pattern.

Hundred grain weight (test weight): The average hundred grain weight was 2.38 g, table 5. The hundred grain weight was not influenced by method of crop establishment as in figure 7. Mahajan and Sarao (2009) in the similar treatments found no significant difference in test weight among transplanted rice (TPR), system of rice intensification (SRI) and direct seeded rice (DSR). Soga and Nozaki (1957) and Yoshida (1981) too reported that 1000-grain weight remained stable as far as there was no water stress during grain filling, and Ashraf *et al.* (1999) and Trillana *et al.* (2001) reported grain weight to be the least affected by the environment. There was no significant difference between the methods of crop establishment on the hundred grain weight, the methods of crop establishment were statistically at par to each other.

Table 5: Yield attributes of rice as influenced by method of crop establishment

Treatments	Seed diameter (mm)	100 seeds weight (g)	Grains/panicle
S R I	0.27[a]	2.35[a]	158.33[a]
Traditional	0.27[a]	2.41[a]	138.33[a]
LSD (P=0.05)	0.85	0.45	0.12
SE±	0.018	0.076	10.13
Grand mean	0.27	2.38	148.33

Yield attributes; Treatments means followed by common letter (s) within column are not significantly different among each other at P≤0.05 level of significance.

Number of grains per panicle: The average number of grains per panicle was 148.33, table 5. Number of filled grains per panicle was not significantly influenced by method of crop establishment. Although statistically there was no significant difference among the different methods of cultivation, but the highest number of grains per panicle was observed in SRI method (163 grains/panicle) and the lowest number of grains per panicle was in traditional method (120 grains/panicle) that shows that there is economic difference to the farmer as in figure 8. Sanjeewane *et al.* (2009) reported higher number of filled grains per panicle in SRI (132.5) than in DSR with other SRI management practices (107.8). The longer SRI panicles carried nearly 1.7 times more number of grain compared to panicles obtained from conventional recommended TPR plots (Thakur *et al.* 2010). Thus, lower number of filled grains per panicle in traditional method might be due to shorter panicle length and higher sterility percentage.

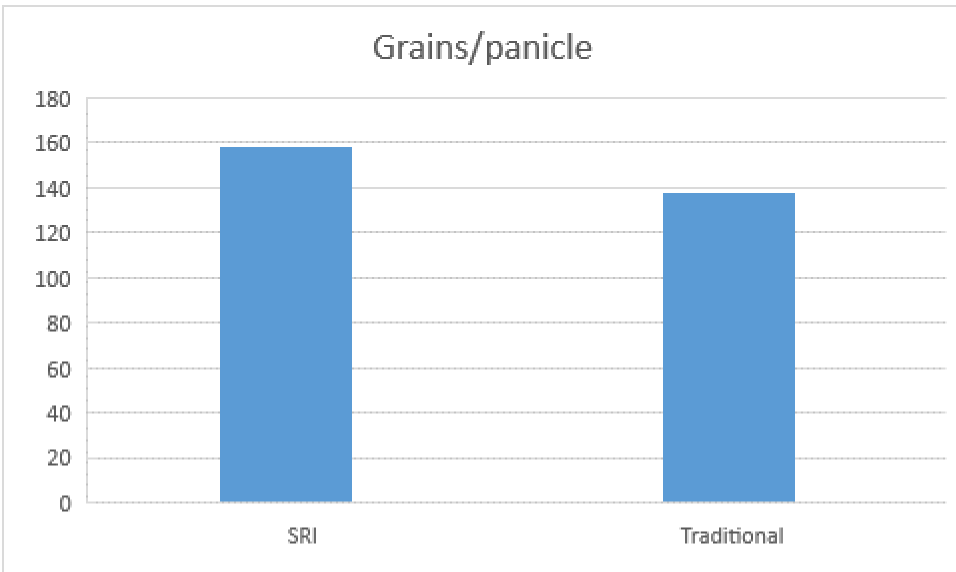

Figure 8. Number of filled grains per panicle as influenced by cropping system.

Yield as influenced by method of crop establishment

Grain yield: The grain yield was not influenced by crop establishment method. The data regarding the grain yield (kg/ha) are presented in table 6. With the significant difference in tillering as influenced by the different methods of crop establishment, there supposed to be a significant difference in the grain yield but the grain yield in SRI method was due to the number of effective tillers per unit area as well as higher number of filled grains per panicle and panicle length, though statistically, the grain yield was at par to each other as influenced by the method of crop establishment, but figure 9 show an increment in yield as compared to SRI. Sanjeewane *et al.* (2009) reported transplanted rice (8 days old seedlings) with alternate wetting and drying irrigation (AWD) had higher yield (6.8 mt/ha) than direct seeded rice with AWD (4.7 mt/ha). The yield in case of SRI method was due to more number of productive tillers, and increased 100-grain weight.

The rice plant utilizes two sources of nutrients in order to satisfy its demand when forming and filling grain. One source is the nutrients already contained in the rice shoot. These nutrients are remobilized to the grain sink at the post-anthesis stage. This remobilization leads to less shoot nutrient content at the maturity stage compared to that pre-anthesis. The second source is the indigenous nutrient supply. The utilization of this source, however, is closely linked to the capacity of the roots to take up nutrients. That capacity itself is a function of root growth and proliferation. (Vijayakumar *et al*., 2006).

Hayashi M. (2011) reported that in conventional method there was a longer period of growth in the paddy field; an absence of transplantation shock, and a higher plant population density, some early to intermediate maturing genotypes gave higher yields in direct seeded rice compared with transplanted rice (TPR). Similarly, during 2007, varietal performance was studied in SRI system. SRI transplanting (10 days old seedling) resulted 11.8 and 27.9% increase in yield over conventional transplanting method and SRI direct seeding method, respectively (Mahajan and Sarao. (2009). In SRI plants, delayed senescence could derive from having increased root growth, higher leaf area and chlorophyll content, and perhaps by gene expression of enzymes contributing to photosynthesis during the latter part of the growth cycle (Ookawa *et al*., 2004; Suzuki *et al*., 2001).

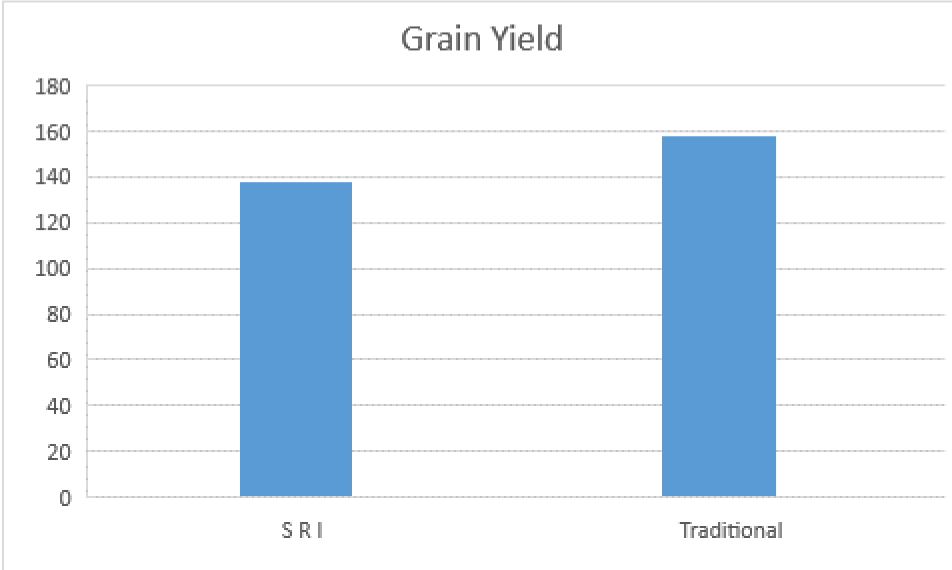

Figure 9: Grain yield as influenced by cropping system.

Table 6: Grain yield of rice as influenced by method of crop establishment

Treatments	Grain yield (kg)	Straw yield (kg)	Harvest index
S R I	2670.00[a]	3068.30[a]	46.12[a]
Traditional	2768.30[a]	3358.30[a]	45.12[a]
LSD (P=0.05)	0.77	0.41	0.51
SE±	319.63	321.52	1.38
Grand mean	2719.20	3213.30	45.62

Yield: Treatments means followed by common letter (s) within column are not significantly different among each other at P≤0.05 level of significance.

Straw yield: Straw yield (kg/ha) was significantly not influenced by the method of crop establishment, table 6. The straw yield in SRI and conventional method were significantly at par, but economically higher straw yield was obtained with traditional method as shown in figure 9.

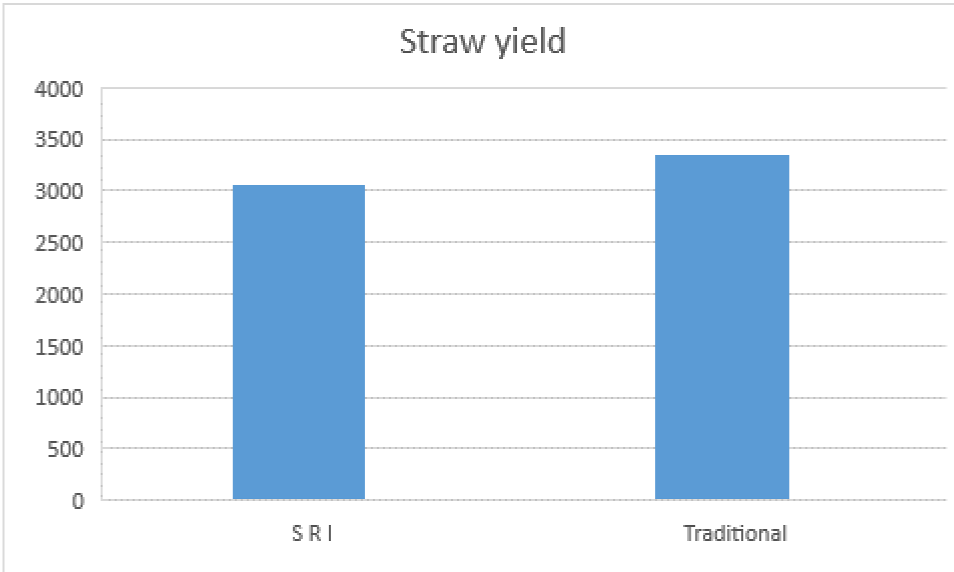

Figure 10. Straw yield as influenced by cropping system.

Harvest index (HI): Harvest index indicates the efficiency of assimilate partition to the parts of economic yield of the rice plants (i.e. panicle). Higher harvest index indicates better assimilate transport to the panicle. There was no significant difference was observed on Harvest index (HI) due to different method of crop establishment, table 6. The average harvest index in the experiment was 45.62 which were at par to each other as influenced by crop establishment figure 10. This may be due to the effects of continues flooding in SRI method. There was a significant interaction between establishment method and water management for HI (Sanjeewane *et al.* 2009).

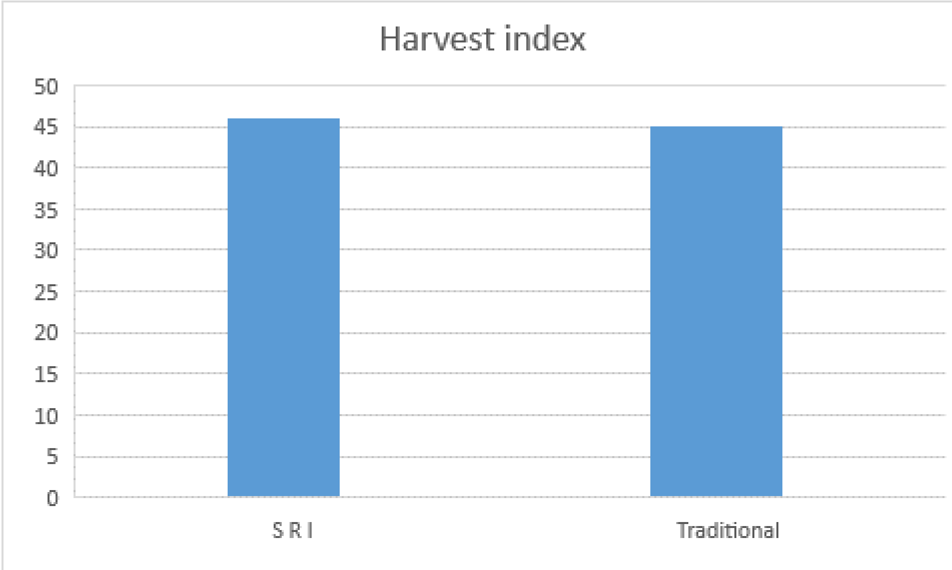

Figure 11. Harvest index (HI) as influenced by cropping system.

Economic return

Table 7: Economic parameters of rice cultivation as influenced by method of crop establishment

Treatments	Economic Parameters			
	Total cost (₦)	Gross return (₦)	Net return (₦)	B:C ratio
SRI	292,800	531,420	238,620	1.81
Traditional	244,000	543,750	299,750	2.23

Cost of cultivation: In this experiment two different methods of crop establishment were tested. The cost of cultivation was calculated for the different method of crop establishment. The cost of cultivation was calculated for one-hectare area from the cost involved in experimental plots. Research involves extra costs that are not necessary in the farmer's field are not included in the cost. The cost for watching birds at maturity stage of crop was not included here because it is not needed in farmer's field. Cost of cultivation was almost similar for all treatment, table 7. In general SRI method involves higher cost than conventional method. Major variables that differs the cost of cultivation in this experiment were seed, fertilizer and labor management. The higher cost in SRI was mainly due to the cost of labor. The cost of cultivation calculated in this experiment was ₦ 292,800.00 per hectare for SRI, ₦ 244,000 for traditional method per hectare. The difference in the cost of cultivation ₦ 48,800 is economically significant to the farmer.

Gross return: The gross return per hectare was almost similar in all the methods of crop establishment, table 7. In general, the reasonable gross return from SRI method was due to higher grain and straw yield per ha.

Net return: The net return per hectare varied with ₦ 61,130 by the method of crop establishment, table 7 which indicates that the net returns are almost similar as influenced by crop establishment method. Similarly, the higher net return from the traditional method was due to the low cost of cultivation as compared to SRI method.

Benefit-cost ratio: Benefit-cost ratio B:C is the ratio of gross returns to cost of cultivation which can also be expressed as return per ₦ invested. Any value greater than 2.0 is considered safe as the farmers gets ₦

11.04 for every ₦ invested (Reddy and Reddi, 2005). Similar as the gross return per hectare and net return per hectare, B:C ratio was significantly influenced by the method of crop establishment, table 7. The significantly higher B:C ratio was calculated in traditional method (2.23), which is considered safe in terms of income.

CONCLUSIONS AND RECOMMENDATIONS

A field experimentation to determine the rate of tillering, productivity and economic return of rice under different methods of crop establishment was carried out at the Teaching and Research Farm of the Faculty of Agriculture during 2017 cropping season. Two different methods of crop establishment; system of rice intensification and traditional method in randomized complete block design were tested. The results of the experiment are summarized below.

Plant height was significantly influenced by method of crop establishment at all the observation dates. Maximum plant height was observed at 8 WAS of traditional method (104.6 cm) which is significantly higher than SRI (88.7 cm). At harvest maximum plant height was observed in traditional method (90 cm) followed by SRI method (65.8 cm). It is obvious that the reduction in plant height was attributed to the senescence of leaves and bending down of panicle and the height was measured up to the bend.

The number of tillers per square meter was significantly influenced by the different methods of crop establishment as presented in table 2. Different methods of crop establishment influenced tillers per square meter in all the observation taken. Significantly higher number of tillers per square meter was observed in traditional method in all the observations. Maximum number of tillers per square meter observed in traditional was (105) and in SRI was (89). This may be due to the better tillering and faster growth with suitable temperature and soil moisture regime present in the soil.

The period of panicle initiation (PI) was not significantly different among the different methods of cultivation; the average hundred grain weight was 2.38 g, table 5. The hundred grain weight was not influenced by experimental factor i.e. method of crop establishment. Crop establishment methods at 4WAS, 8WAS and at harvest were statistically at par to each other in the case of dry mater.

Grain yield, straw yield and yield attributes were statistically not influenced by the crop cultivation method.

The average number of grains per panicle was 148.33, table 5. Number of filled grains per panicle was significantly not influenced by method of crop establishment.

The average cost of cultivation calculated in this experiment was ₦ 292,800.00 per hectare for SRI, ₦ 244,000 for traditional method per hectare. In general, the gross return per hectare was almost similar in all the methods of crop establishment, table 7. Likewise, the net return per hectare which varied with ₦ 61,130 by the method of crop establishment indicating that the net returns are almost similar as influenced by crop establishment method. Similarly, the higher net return from the traditional method was due to the low cost of cultivation as compared to SRI method.

Higher B:C ratio was observed in traditional method (2.23) which is considered safe.

Among the different method of crop establishment, traditional method was superior in all the vegetative except in the panicle initiation period which were at par with SRI, and the cost of cultivation was not higher, but the B:C ratio was consider safe (2.23) compared to SRI method. In the case of dry mater and yield, there was no significant difference among the methods of cultivation.

RECOMMENDATION

On the basis of net return and cost of production, traditional method is considerably safe. It is also recommended to other researchers to conduct a similar work with the intention to establish proper adoptable cultivation method.

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