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Characteristics of rice produced under direct and indirect SRI practices in Chimala Area in Mbarali District Tanzania

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Abstract: The current status of rice production in Chimala Area in Mbarali is dominated by conventional rice growing practices with limited adoption of the system of rice intensification (SRI), which has been reported of having more advantages. This study evaluated the characteristic of rice produced under SRI and conventional practices in Chimala Area in Mbarali District of Mbeya Region in Tanzania. The evaluation considered the farm management practices, rice yields and the characteristic of the rice grains. The unlevelled characteristics of the farms and the variation of the soil influence the rice yields and the quality of the grains. The transplanting age of the seedling was within the age limit preferred when SRI practices are implemented and the limited water availability for conventional rice growing practice necessitated the intermittent wetting and drying of the rice fields which is preferred for SRI practices. The application of agrochemicals such herbicides limit the aeration of the root system and the development of a healthy roots system. Bird scaring is among the activities which increased the production cost of rice grown under SRI practices. Rice yields under SRI practices where more than 16ton/ha against less than 8ton/ha for conventional rice growing practices. The rice grains grown under SRI practices was observed to be suitable for seeds. With regard to milling, conventionally grown rice produced more good rice (69%) SRI (51%) grown. However, the large percentage of husks (24%) likely suggest that rice grains produced under SRI are more protected and further provide evidence as a good rice seed producing practice. The quality of cooked rice indicate that rice produced under SRI practices has higher aroma and fragrance when compared to that produced under conventional practices. Further studies should consider the effect of the number of seedling per hill, application of herbicide instead of applying push weeder and the suitability of using by-product, rice husks as a source of energy.

Keywords: System of rice intensification, transplanting age, farm management practices, bird scaring, cooked rice.

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1. INTRODUCTION

In the past, rice used to be a luxury food and in recent years it has become the major source of calories for the rural and urban population with demand growing at an annual rate of 5% (Oikeh et al., 2008). This increase is ascribed to population growth and increase in income levels as well as the widening gap between the demand and supply for food. It is fair to note that the major rice producers in developing countries like Tanzania are subsistence farmers (Katambara et al., 2013, Kahimba et al., 2014). These subsistence farmers form 80% of food producers (Kahimba et al., 2014). The rice growing practices can be classifies as conventional and non-conventional (Katambara et al., 2013). The conventional include upland rice production practices, lowland rice production practices and paddy rice production practices. The non-conventional rice growing practices include the system of rice intensification (SRI) practices (Stoop et al., 2002; Uphoff et al., 2002). The processes of growing upland rice depends on rainfall as a source of soil moisture. Low land rice growing practices is similar to upland rice and the major difference being the risk of inadequate moisture due to rainfall variability and low soil fertility of the upland farmlands. The other common constraints that the upland and low land rice growing farmers face include biotic constraints (weeds, insects, diseases, nematodes and vertebrates pest) and abiotic constraints (soil acidity and erosion) with correspond effects on the rice yields (Oikeh et al., 2008). Paddy rice production practice is sometimes referred to as traditional rice growing practices and is practiced on irrigated land. The SRI has been reported to have many advantages and benefits over the conventional paddy rice, however the various parameters are site specific (Katambara et al., 2013, Kahimba et al., 2014) and this study attempts to evaluate the performance of SRI against paddy rice as practiced in Chimala Area in Mbarali District, Mbeya Region.

2. Characteristics of rice growing practices in Chimala area

Rice growing practices in Chimala area can be classified into two categories, SRI practices and traditional rice growing practices (paddy rice). The farmers involved in SRI practices are expected to abide with the underlying principles of SRI which include seed sorting, sowing, transplanting younger seedlings, weeding, and water management (Stoop et al. 2002, Katambara et al., 2013). A brief description of the principles include:

- *Sorting out of the seeds*: This involves the use of a salt-water solution whose concentration is capable of floating a raw egg and the seeds that sink in such a solution are regarded as good seeds.
- *Raising seedlings in garden like nurseries:* This ensures a careful management of seedlings and easy uprooting as well as transplanting.
- *Uprooting and transplanting time:* The time between uprooting and transplanting should be between 15-30 minutes and the roots should be kept moist during this time (Stoop et al., 2002).
- *Early transplanting of age of 8 to 15 days-old seedlings:* In addition to the provision of adequate buffer for the seedling from being damaged during transplanting, full tillering and optimal production occurs when the seedling are transplanted before entering the fourth phyllochron of growth (Stoop et al., 2002).
- *Single, widely spaced transplants:* This ensures that the plants have enough space for tillering as well as to allow the mechanical weeder to pass through without harming the plants.
- *Early and regular weeding:* This ensures that weeds do not compete with the rice plant. Also the mechanical weeder aerates the soil. The roots need oxygen so as to be strong and healthy for optimal tillering and development of healthy rice grains.
- *Carefully controlled water management:* Alternate wetting and drying makes the rice plant healthy since the roots are supplied with moisture as well as air. This allows the root to uptake adequate nutrients from various soil horizons.

- *Application of compost:* the compost materials are rich with nutrients as well as organisms whose activities favour the growth of rice. Above all, it is environmentally friendly to use compost than industrial fertilizers.
- *No use of herbicides:* the non-use of herbicides favours the sustainability of the ecosystem and the micro-organisms whose activities are suitable for the growth of rice plants.

On the other hand, farmers involved in traditional rice growing practices are expected to maintain their paddies flooded with water and other agrochemicals to increase their rice yield. However, due to the limited availability of water, this tradition practice has been hampered and also the adoption of SRI practices is rather slow. This study attempted to quantitatively identify the knowledge gap that exists in the rice growing sector ranging from chemical applied, suitability of the rice grains to be used as rice seeds and the influence of farm management practices on rice yields.

3. DESCRIPTION OF THE STUDY AREA AND METHODOLOGY

3.1 Study area

Chimala Area constitute several irrigation schemes and those that were involved in the study are Moto Mbaya Irrigation Scheme, Herman Irrigation, Scheme, Mbuyuni Irrigation Scheme, Utoro Irrigation Scheme and Ipatagwa Irrigation Scheme. The irrigation schemes are served by the Rural Urban Development Initiatives (RUDI). RUDI is a local non-governmental organisation dealing with empowering micro-small enterprises (MSE) and farming communities through improved market linkage and distribution channel for their products. Farmers' characteristics with respect to farming practices are indicated in Table 1.

Table 1: Characteristics of subsistence rice farmers (Source: RUDI Chimala offices)

Irrigation Scheme	Number of farmers practices		
	SRI	Paddy rice	Total farmers
Motombaya Irrigation Scheme,	8	535	543
Herman Irrigation, Scheme,	3	161	164
Mbuyuni Irrigation Scheme,	14	1111	1115
Utoro Irrigation Scheme	15	1735	1750
Ipatagwa Irrigation Scheme	25	975	1000
Kapunga Irrigation scheme	6	754	760

3.2 Methodology

The methodology applied attempted to compare the characteristics of the rice grains and general rice farm management practices between SRI and Paddy farming. Eight farmers involved in rice farming where randomly selected from the schemes. These farmers where practicing both paddy rice farming practices and SRI practices and willing to be interviewed. The following components were considered.

Rice farm management practices

The rice farm management practices investigated include physical characteristics of the farms, soil characteristics, herbicides used to suppress the growth of weeds, suitability of grains to be used as seeds, characteristics of the rice grains after milling and cooked rice. This information was obtained from the famers through interviews.

Rice yield

The data on the total rice harvested and the area were rice was grown was measured and equation 1 was used.

$$Yield = \frac{Total\ rice\ havested}{Total\ area\ grown\ rice} \qquad (1)$$

Characteristics of the rice grains

(a) The evaluation of the rice growing practice for seed production using salt solution that is capable of floating a raw egg. Figure shows the prepared solutions.

Figure 1: (a) Submerged egg before adding salt (b) A floating egg after adding salt

(b) The evaluation of the quality of the grains after milling using grading machines. The amount of quality rice, broken rice and husk were recorded and Equations 2 were used to evaluate the percentage.

$$Quality\ rice = \frac{Total\ unbroken\ rice}{Total\ rice\ before\ milling} \times 100 \qquad (2a)$$

$$Broken\ rice = \frac{Total\ broken\ rice}{Total\ rice\ before\ milling} \times 100 \qquad (2b)$$

$$Husks = 100 - Quality\ rice - Broken\ rice \qquad (2c)$$

(c) The evaluation of the quality of cooked rice involved the cooking of rice under similar conditions, duration and using the same amount of ingredients (rice, salt, cooking oil and water). A testing panel of 24 people was involved in evaluation the quality of cooked rice through filling a questionnaire.

4. RESULTS AND DISCUSSION

4.1 Rice farm management practices

(a) Physical characteristics of the rice farms

Although SRI does not require special farm structures, the farms must be prepared to conveniently enable the process of conveying water with minimum water losses. The physical inspection showed that majority of the rice farms where not well levelled to the extent that irrigating the whole area required larges amount of water. This resulted to some portion of rice farm experience low soil moisture conditions for the case of conventional rice. These facts and many others necessitated the conventional rice growing practices to experience the intermittent irrigation water regime which actually creates anaerobic soil condition that favours growth of extensive roots system, increase in number of micro-organisms in the soil and nutrients uptake (Stoop, 2011, Thakur et al., 2013).

(b) Soil characteristics of the farms

The physical observations of the soil characteristics suggested that the soil nutrients also varies. This was evidenced by the variations in rice plants characteristics within the same field. This is further worsened by the anaerobic soil condition which limits the number of micro-organisms that are responsible for high rate of nitrification (Sooksa-nguan et al., 2009) and in areas that were flooded there is a potential of Fe toxicity (Dobermann, 2004). This issues requires further studies on soil analysis and the subsequent proposal of the farm management regime suitable to improve the farms yields.

(c)The observed transplanting planting dates, spacing and number of seedling per hole

With regards to the transplanting age, farmers who practiced SRI transplanted seedlings at the age of 8 to 9 days and one seedling per hill, while those practicing conversation rice production practices, planted the seedlings at the age of 14 days and more than one seedling per hill. As reported in various studies (Katambara et al., 2013, Stoop, 2005, Kahimba et al., 2014), suitable spacing for transplanting should be 25cm by 25cm and both farmers observed this spacing. In addition, one of the principles of SRI practices suggests that the seedlings should be transplanted within the age between 8 and 15 days (Stoop, et.al. 2002). Considering this, the farmers practicing conventional growing practices, practiced what can be considered as indirect-SRI rice growing practices which is further necessitated by the limited irrigation water to flood the rice paddies that merited the prevalence of aerobic soil conditions due to non-limited oxygen supply and necessary microbiological activities (Stoop, 2011, Thakur et al., 2013). Although, SRI practices requires high reliability of water so as to irrigate when required to do so and is a water saving practice (Katambara et al., 2013, Ndiiri et al., 2012, Mati and Nyamai, 2012, Satyanarayana et al., 2007), the limited water may likely affect rice growth. The effect that the number of seedling per hill have when they are transplanted with 8 to 15 days old needs further investigations.

(d) Application of herbicides

The farm management regime indicates that both, SRI and conventional rice growing practiced by the farmers applied herbicides during the early days after transplanting instead of weeding using push weeders. From the agricultural point of view and with respect to general health of the rice plant, the process of weeding aerates the soil and makes oxygen available to the roots and other biological organism involved in facilitating some biochemical processes. Healthy roots facilitated the groups of more productive tillers that are responsible for increasing the yields as well and the biomass above and below the ground. Healthy rice plants are not likely affected by floods or wind (Katambara et al., 2013). Vishnudas (2009) noted that the application agrochemicals destroys the soil biodiversity, there is a need to investigate on the effect that the application of herbicide have on the development of productive tillers and the yield in general.

(c) Rice loss due to birds being attracted a certain rice variety

In Senegal Rift Valley, de Mey et al. (2012) report that birds accounted for 13.2% of the potential rice production loss and occurred during the wet seasons of 2003–2007. Among the various rice varieties that are grown, it has been noticed that SARO 5 TXD 306 and SARO TXD 307 are highly affected by birds during the milk stage of the rice plants and the cost of bird scaring is higher for these varieties. This practice of scaring birds was also reported by Ruelle and Bruggers (1982) as the most practiced in Tanzania in addition to repellent nets and agronomic practices. Also, in Uganda, scaring birds is a labour task necessary to avoid bird damages and is carried out for a month or more before harvesting. This exercise contributes to 40% of the hired labour (Miyamoto et al., 2012, Ojehomon et al., 2012). It is likely that birds are attracted to SARO 5 TXD 306 and SARO TXD 307 due to either higher nutrition or more food and is evidenced by higher weight per unit volume. Other factors that leads to the SARO 5 TXD 306 and SARO TXD 307 rice plants attracting more birds need to be investigated and so as to make informed decision on the alleviation.

4.2 Rice yield

Rice production process is just like any other business where profits need to be realized so that the livelihood of the farmers are improved. In this regard, attempts to investigate in the cost of production indicated that the cost of rice production through the SRI practices was found to be higher than the conventional rice growing practices (Figure 2). The cost ranges from USD 700 to more than USD 2500. This wide range is attributed to some farmers not accounting their personal labour into cost of production. However, when the yield is considered in terms of weight, the rice produced under SRI practices was found to have higher weight per unit volume than that produced under conventional practices (Figure 3). The yield under SRI practices ranges from above 3 ton/ha to more than 16ton/ha, this wide range is largely ascribed to the scarcity of irrigation water. This facts likely provides evidence on why birds prefer rice growing under SRI practices. Although rice vendors prefer to use volume as a measure, the overall cost comparison suggest that rice produces under SRI practices is more profitable when the mode of conversion is weight and not volume.

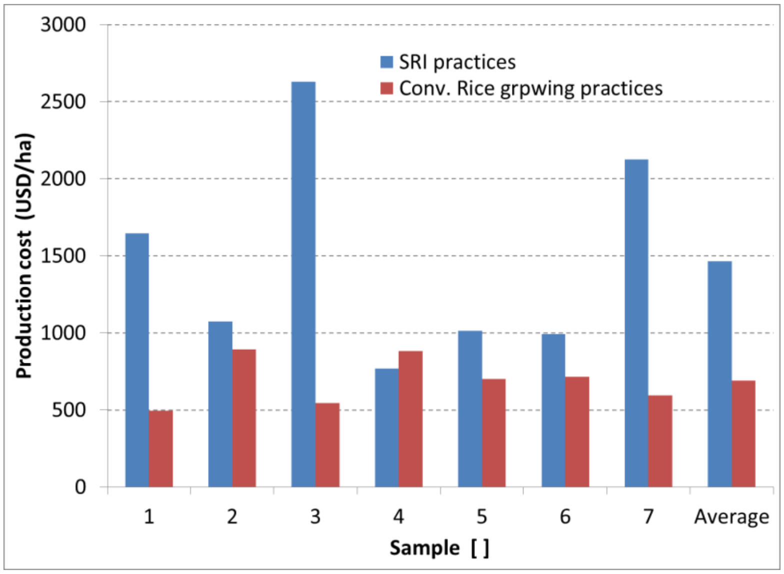

Figure 2: Cost of production of rice

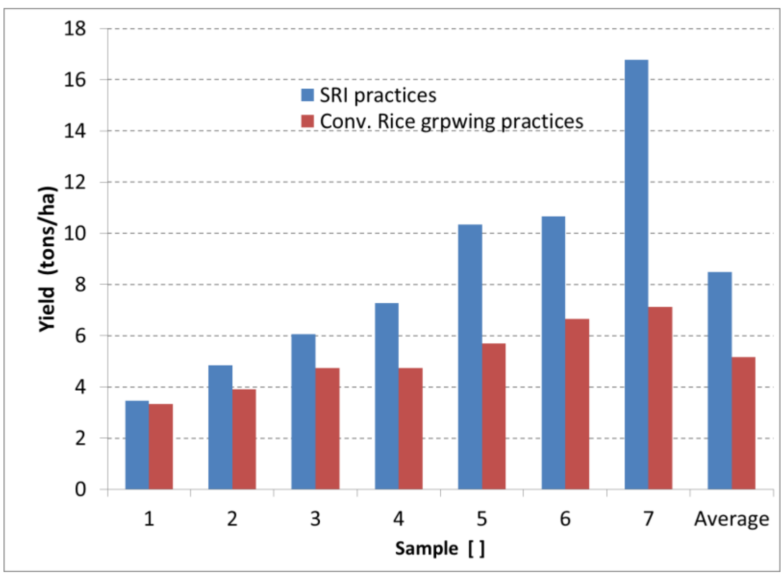

Figure 3: Rice yields for rice grown under SRI and conventional practices

4.3 Characteristics of the rice grains

(a) Suitability of SRI practices as a rice seed producing practice

Although, physically the rice grown under SRI practices was noticed be healthier than that produced under conventional practices, the suitability of the rice grains to be used as seeds was investigated using the decantation approach using a solution of table salt and water. The appropriate solution was the one whose concentration is capable of floating a raw egg. Figure 4 shows that SRI practices is suitable for producing health seeds with 75% of the grains being suitable for seeds. It is fair to note that the small deference is likely be due to indirect-SRI practice experienced in the study area. However more studies are required so as to verify this argument.

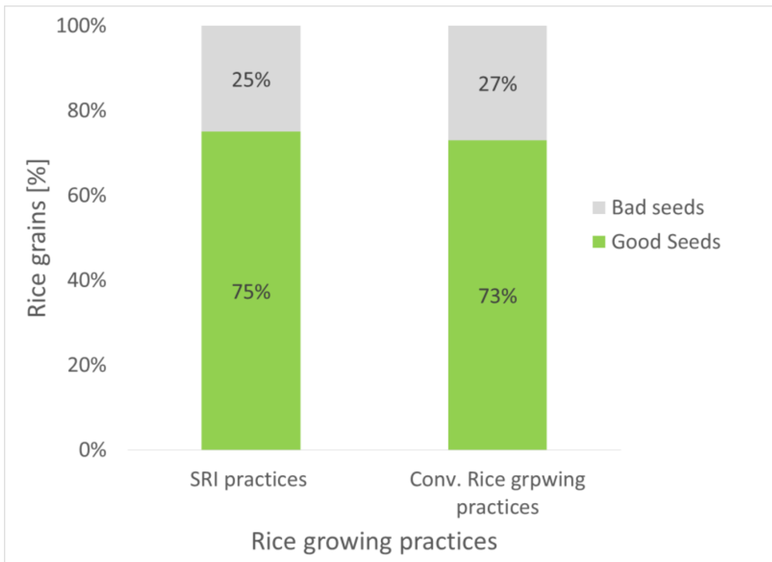

Figure 4: Suitability of rice grains to be used as seeds

(b) Quality of milled rice

Although some studies investigated the degree of breakage during milling and reported that, as the drying temperature increased from 40 to 70°C and relative humidity decreased, the degree of breakage increased (Aguerre et al., 1986). This current study maintained similar condition and obtained that conventional rice produced more good (69%) grains that SRI practices (51%) (Figure 5). It is fair to note that rice produced under SRI practiced was found to have higher weight per unit volume and produced less poor grains (2%) contrary to conventional rice (7%). It likely that more economic gain can be achieved when the rice produced under SRI practices is sold in terms of weight than volume and by-products (husk) are used in production of briquettes and other production and calls for further studies.

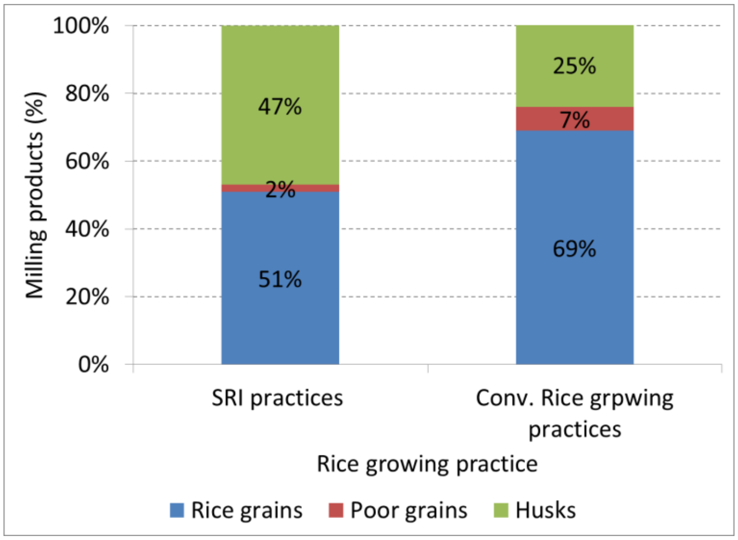

Figure 5: Quality of milled rice

(c) Quality of cooked rice

Although there might be scientific approaches of evaluating the quality of cooked rice, the approach applied herein involved a testing panel of 24 people who filed a questionnaire and was found to be adequate for the study. The parameters evaluated are texture, fragrance, flavour and aroma (Table 1). The rice grown under conventional practices was observed to have better texture than the rice produced under SRI practices. The rice grown under SRI practices was observed of having better flavour and aroma that rice produced under conventional prices. This is also likely attributed to the rice variety. With respect to fragrance, the rice produced under SRI practices was observed to having high degree of fragrance than that produced under conventional practices.

Table 2: Quality of cooked rice

Scoring Grade (%)	Poor (60-69)	Fair (70-79)	Good (80-89)	Excellent (90-100)
SRI				
Texture	14	22	21	12
Flavour and aroma	14	26	25	4
Fragrance	18	21	25	5
Conventional rice				
Texture	7	21	29	12
Flavour and aroma	16	18	28	8
Fragrance	17	25	19	8

5. CONCLUSIONS AND RECCOMMENDATION

The evaluation of the characteristic of rice produced under direct and indirect SRI practices in Chamala Area in Mbarali District Mbeya Region of Tanzania has been done. Based on the principles of SRI rice growing practices and that of the conventional rice growing practices referred as in direct SRI practices, the rice farm management practices, rice yields and the characteristic of the rice grains were evaluated. The study concluded that characteristics of the farms and soil influence the rice yields while transplanting age of the seedling was within the age limit preferred when SRI practices are implemented. The limited water availability necessitated the intermittent wetting and drying of the rice of rice fields. The application of agrochemicals such herbicides limit the aeration of the root system and development of healthy roots. The rice production cost is increased by labourers who scare the birds. Rice yields on SRI practices where more than 16ton/ha and the SRI practice is suitable for seed production since the rice grains are healthy. With regard to milling, convention rice growing practices produced more good rice (69%) than SRI (51%). However, the large percentage of husks suggest rice produced under SRI is well protected and further provide evidence as a good rice seed producing practice. The quality of cooked rice indicate that rice produced under SRI practices has aroma and fragrance when compared to that produced under conventional practices. Further studies should consider the effect of the number of seedling per hill, application of herbicide instead of applying push weeder and economic gain on rice husk as source of energy.

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