Smallholder Farmers’ Adoption Drivers for the System of Rice Intensification Practice:
The Case of Mkindo Irrigation Scheme, Tanzania

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Abstract
Intermittent irrigation is among the activities done when practicing the System of Rice Intensification to increase rice yields as well as farmers’ profit margin in a sustainable manner. Regardless of this, little information is known with regard to the drivers toward to or not to adopt System of Rice Intensification practices by subsistence farmers. The study that attempted to shade light on the extent of adoption of System of Rice Intensification practices by rice farmers was conducted at Mkindo Rice Irrigation Scheme in Morogoro region. Experimental research design and expert sampling plan was employed in which structured interview schedule was used to collect cross sectional data of 100 System of Rice Intensification and non-System of Rice Intensification participants. Descriptive statistics information was obtained using SPSS package version 20. Survey results showed that high grain yield (58.93%) and increased return to labour (51.79%) were key factors that influenced rice farmers to adopt System of Rice Intensification. Contrary, lack of training (79.54%), awareness (77.27%) and skills acquisition (52.27%) on System of Rice Intensification practices were factors that negatively influenced the adoption of System of Rice Intensification practices. It is therefore concluded that high grain yield and increased return to labour influenced rice farmers to adopt SRI technology. Conversely, lack of training and awareness on System of Rice Intensification technology were key barriers to System of Rice Intensification adoption. It is therefore recommended that smallholder rice farmers should be trained and made aware of high grain yield and increased returns to labour associated with System of Rice Intensification technology so as to adopt it.

Key words: Adoption, on-adoption, systems of rice intensification, Mkindo irrigation scheme.
1.0 Introduction

The cultivation of rice represents a way of life and a means to livelihood asset ensures food security for people in many parts of the world. Globally, 55 percent of the area under rice cultivation is irrigated and contributes 75 percent of the total rice production (Thiyagarajan & Gujja, 2013). Rice sector in Tanzania is among the major sources of employment, a source of income and food security for farming households, and are liable food supply for the urban population (CFC, 2012). Regardless of this, Tanzania’s rice productivity is low and varies from 1.2 to 2.4 tons/ha under rain-fed farming. The low yields obtained by subsistence rice growers is attributed to combined effects of the use of low yielding varieties, inadequate and unevenly distributed rainfall, weed infestations, prevalence of pests and diseases, and marginal use of the irrigation potential (CFC, 2012; URT, 2009).

In addition, agricultural activities are affected by inadequate and unreliability of rainfall, which causes periodic droughts (URT, 2009). It is for this reason that irrigation is considered a necessity for providing protection against drought, a means of stabilizing rice production, hence assurance of household food security (URT, 2009). Nevertheless, the demand of water for irrigation to feed the growing population in Tanzania outstrips the amount of water available for irrigation (Katambara et al., 2013). As such, this calls for new technologies and farming practices that ensure more food production while minimizing water uses (Katambara et al. 2013; Namara et al., 2003).

The System of Rice Intensification (SRI) is an innovative agro-ecological methodology that aims to increase yields and farmers’ profits by creating the most suitable environment for the rice plants to grow. SRI is based on a set of rice cultivation principles, which considers practices such as transplanting age, water regimes and plant spacing. SRI practices is not considered as technology (Dill et. al. 2013), however its adoption by smallholder rice growers is still a challenge. This study investigated the reasons for SRI’s adoption or non-adoption among farmers at Mkindo Rice Irrigation Scheme in Morogoro Region, Tanzania.
The Systems of Rice Intensification principles are geared towards timely seed preparation, nursery preparation, transplanting, soil aeration, fertilization, and irrigation scheduling (Dill et al., 2013; Katambara et al., 2013; Namara et al., 2003). Thus, SRI substantially changes traditional and conventional cultivation practices that rice farmers have used for centuries into profitable, mixed scales and commercial operations to reduce both non-income activities and poverty (URT, 2009). As a result, strong and healthy rice plant is produced that is more resistant to pests and increases yields with fewer inputs compared to rice produced under conventional rice cultivation practices (IFAD, 2013). Furthermore, sustainable irrigation development under SRI practices is a basis for improved food and livelihood security and reduction of poverty in Tanzania (URT, 2009). Similarly, reliable irrigation service delivery can also persuade risk conscious farmers to invest in better production practices and diversify into higher value rice farming systems (URT, 2009). This is why SRI technology was introduced at Mkindo Irrigation Scheme where rice is grown mostly in two major seasons, Vuli (October - December) and Masika (March– May). There is limited information on trends of adoption and non-adoption of SRI by farmer from Mkindo Irrigation Scheme. This study, therefore, investigated the reasons for SRI adoption or non-adoption at Mkindo rice irrigation scheme.

3.0 Description of Study Area and Methodology

3.1 Description of the Study Area

Mkindo Irrigation Scheme is located in Mkindo village in Hembeti Ward, Mvomero District in Morogoro Region, Tanzania. Geographically, the Mkindo Irrigation Scheme lies between latitude 6°16’ and 6°18’ South and longitude 37°32’ and 37°36’ East (Figure 1). The altitude ranges from below 345 to slightly above 365 metres amsl. By road, Mkindo is 85 km from Morogoro Municipality. Mkindo is characterised by an average annual temperature of 24.4°C, with a minimum of 15.1°C in July and a maximum of 32.1°C in February. The mean relative humidity is 67.5%. The area has bimodal rainfall regime with short rains from October to December (OND) (Vuli) and long rains from March to May (MAM) (Masika). The average total rainfall per year is between 1200 mm to 1500 mm (Bracebridge, 2006).

The Mkindo Irrigation Scheme has a well-organized irrigation infrastructure. The Scheme was constructed between 1980 and 1983. The Scheme started producing rice in 1985 with only 17 ha
under cultivation. Currently the Scheme serves a larger area of about 100 ha and the potential irrigable area is 500 ha.

Figure 1

Location of the Study Area

Source: Kombe (2012)
3.2 Research Design
The present study employed a completely randomized experimental research design since the intervention was randomly allocated among farmers and created a suitable comparable platform for the farmers who are practicing SRI against those who are not practicing SRI, but were statistically equivalent to one another (Baker, 2000; Newman, 2007). It is fair to note that an experimental approach involved control group generation approach; and as such the random assignment serves as a perfect counterfactual with no selection biasness. Also, this approach is simple when the issue of interpreting the results is concerned; since it employs the difference between means of the treatment group samples and the control group (Baker, 2000). With respect to sampling, the study employed expert sampling approach to identify cases that constitute required information that may vary in perspectives and common experiences on rice production (SRI and conventional) technologies so as to meet research objectives (Saunders et al., 2009, Mugenda & Mugenda, 2003). SRI and non-SRI rice growers therefore were intentionally chosen for their special knowledge on Mkindo Rice Irrigation Scheme for both Vuli and Masika rice production seasons (Krysik & Finn, 2007).

3.2 Data Collection Instruments and Analysis
Similar to Saunders et al. (2009), the data for the study was collected using structured single and multiple response questionnaire interview schedule survey in which one-to-one basis between interviewer and respondent was conducted at Mkindo rice irrigation scheme whereby quantifiable information was collected. The data generated at the household level were subjected to descriptive analyses using Statistical Package for the Social Sciences (SPSS version 20) to characterize the samples obtained from farmers’ rice crop management practices. Descriptive research pertains to the characteristics of the problem and assessment of the factors influencing the incidence and intensity of adoption and non-adoption of SRI.
4.0 Results and Discussion

4.1 Characteristics of SRI and Non-SRI Respondents

4.1.1 Respondents Interviewed on Rice Growing Practices and their Marital Status

Findings (Figure 2) show that 44%, followed by 35% of respondents interviewed were Non –SRI and SRI participants, respectively, while 21% practiced both SRI and conventional modes of rice production at Mkindo irrigation scheme. The reason of practising both SRI and conversional mode in not known. In addition, due to benefits associated with SRI and when other factors are held constant for Mkindo Irrigation Scheme, majority of rice farmers will adopt the technology. With respect to respondent category, 65% of interviewed respondents were the household heads while 23% were spouse and this will likely to influence children to practice SRI.

About 78% of interviewed respondents who were married; suggesting that married farmers had the need to practice SRI technology to meet family binding commitments such as food security. Equally, Nakano et al. (2014) observed that SRI trainees achieved high average yields such that non-participants were attracted to practice it.

Figure 2
Respondents Interviewed and their Marital Status

4.1.2 Gender and age of Respondents

Findings presented in Figure 3showthat 68% and 32% of respondents were males and females, respectively, a fact suggesting that, majority of rice farmers interviewed were males. This further provides evidence that male farmers were more likely to participate in SRI technology in rice production than their counter parts female. This could be attributed to the observed benefits accrued to SRI participants who attract more male than female farmers. Also, results showed that
35% followed by 29% of respondents fall under the age categories 35-45 and 46-58 of years, respectively compared to 3% which falls 72-84 years. This suggests that majority of the respondents were in the productive economic age indicating that they were more likely to adopt SRI technology in rice production activities than the elderly. The current findings agree with observation made by Devi and Ponnaras (2009) and Meshram et al. (2012) who found that age influences the adoption behaviour of rice farmers.

Figure 3
Gender and Age of Respondents

<table>
<thead>
<tr>
<th>Sex</th>
<th>Male (68%)</th>
<th>Female (32%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20-32 years (23%)</td>
<td>33-45 years (35%)</td>
</tr>
<tr>
<td>39-71 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>72-84 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1.3 Education Level, Main Occupation, and Household Size of Respondents

Observed findings showed that 68% followed by 21% of participants had non-formal education on agriculture and rice growing practices and had no education, respectively, while 10% and 1% of the rest had attained primary school and ordinary level secondary education, respectively (Figure 5). This proposes that, majority of participants have some competences and skills acquired in practice and they participated in both SRI and Conventional Rice Production. Furthermore, all the interviewees were rice farmers, suggesting that the livelihood in Mkindo depends on rice production activities. Also, findings indicated that 52% and 45% of interviewed rice producers had a household size of 5-8 and 1-4, respectively, while 3% had a household size of 9-12. Results likely suggest that household size of rice farm is a key push factor for SRI technology adoption to meet income and non-income family requirements. Results obtained concur with observations made by Namara et al. (2003) that rich and the poor farmers were equally likely to practice SRI technology for different reasons that the rich were more educated and more inclined to experiment with new methods while the poor had more urgent need to raise the productivity of their limited land and their relatively more abundant labour (Namara et al., 2003).
4.1.4 Household Rice Production Experience, Farm Ownership and Source of Income

Findings showed that 46% followed by 25% of both SRI and non-SRI respondents interviewed had experience of 2–11 and 12–21 years, respectively, while 5% of them had experience of 42–51 years in rice production (Figure 5). Results propose that rice farmers in Mkindo have been practicing conventional mode of rice production for a number of decades. According to the experience acquired in rice production, therefore, it is a breeding ground for rational farmers to adopt SRI technology based on marginal benefits and costs in comparison to conventional mode of rice production. Figure 6 shows the experience in rice production as reported by interviewed rice farmers, evidenced by their mode of rice farm ownership whereby majority (51%) purchased the land followed by inherited (31%) and rented (18%) rice farms. Results suggest that rice farmers’ willingness to purchase and rent rice farms is their driving force to achieve optimal food self-sufficiency and income. More harvest can be attained through practising SRI and rice is the main primary source of income depending on market price of the harvested rice (99%). Equally, Notze (2012) and Dev et al. (2012) found that training on new technology, experience, and share of rice acreage under SRI had a positive influence on adoption.
4.2 Seasonal Participation in Rice Farming

Findings (Table 7) show increased seasonal participation in rice farming from Vuli 2010 (79%) to Masika 2014 (97%) with slight small changes between 2012 and 2013 production seasons. Probably, persistent increase in participation in rice production could be attributed to community engagement on SRI technology since its inception while slight changes in participation for either SRI or conventional practice could be associated with poor access to financial support to meet costs in Vuli production season. Similar arguments were observed by Namara et al. (2003) and Reddy and Shenoy (2013) who found a wide variation of adoption among SRI participants, with the majority of the adopters used only a portion of their farms and they dis-adopted after a season or two largely because of heavy labour requirements.
4.2.1 Participation in SRI Technology in Different Rice Production Seasons

Figure 8 shows the findings on whether respondents practised SRI technology in different production seasons. Results indicate that participation in SRI technology in rice production increased from 21% in Vuli 2010 to 50% in Vuli 2013 which then declined by 2% in Masika 2014. Results indicate a gradual increase in SRI technology participation as presented with a response “Yes”. This could be attributed to the observed benefits accrued to earlier adopters of SRI technology in rice production. Present findings contradict with findings obtained by Namara et al. (2003) who observed a wide variation of adoption among SRI participants, with the majority of the adopters using the methodology on only a portion of their farms and they dis-adopted after a season or two largely because of heavy labour requirements. Also, Notze (2012) found that gains from adoption had influence in participation in rice production.
4.2.2 Reasons and Challenges for Practicing SRI Technology

Research question on reasons and challenges for practicing SRI technology intended to investigate the motives for SRI technology adoption and its hindrance for its adoption by beneficiaries in rice production. Findings (Figure 9) showed that: high yield grain (59%); increased return to labour (52%); reduced requirement of seeds (36%); and less requirement of water (36%) were reported by adopters as key driving factors for SRI technology adoption at Mkindo Rice Irrigation Scheme. These reasons could be attributed by the participants’ objective in practicing SRI technology of earning optimal livelihood and food security.

Contrary to reasons for SRI technology adoption, weed control (77%), handling younger seedlings (59%), control of water scheduling (50%) and rodents’ prevalence (45%) accordingly, were reported by SRI participants as the main challenges for its adoption (Figure 10). Results suggest that these challenges had cost implication in practicing SRI technology, which could lead to diminishing marginal returns in rice production. Similar findings were observed by Ressurreccion et al. (2008) who found that savings from purchase of rice seeds and high grain...
yield were chief benefits derived from SRI farming while more weeding, complicated water management procedures were among of the downside of SRI farming.

Figure 9
**Reason for Practicing SRI**

![Bar chart showing reasons for practicing SRI]

Figure 10
**Challenges for SRI Adoption**

![Bar chart showing challenges for SRI adoption]

4.2.3 Reasons for not Practicing SRI Technology for Rice Production

Research question on reasons for dis-adoption of SRI technology sought to get reasons for why rice farmers were reluctant to adopt SRI technology for rice production at Mkindo irrigation scheme while others have adopted it. Present study findings (Figure 11) showed that lack of
training (79.54%) followed by lack of awareness (77.27%) were reported by non-SRI participants as the main motives for not adopting SRI technology, while lack of extension services was the least reason. Results propose that lack of training and awareness on SRI technology hinders rice farmers to make rational decision on whether to adopt it or not because they lack non-formal education and information asymmetry on the technology. The present study findings agree with Devi and Ponnaras (2009) who found that lack of skilled labor, awareness, and training on new technology and experience hinders SRI adoption. However, current findings contradict with findings obtained by (Namara et al., 2003) who found that high labor demand and the tedious nature of practices involved such as transplanting and manual weeding were the main obstacles for SRI adoption.

Figure 11
Reasons for Not Practicing SRI Technology

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of training</td>
<td>80</td>
</tr>
<tr>
<td>Lack of awareness</td>
<td>77</td>
</tr>
<tr>
<td>Lack of skilled labour</td>
<td>52</td>
</tr>
<tr>
<td>Lack of experience</td>
<td>43</td>
</tr>
<tr>
<td>Lack of extension services</td>
<td>7</td>
</tr>
</tbody>
</table>
5.0 Conclusion and Recommendation

Based on findings that high grain yield (59%), increased return to labour (52%), reduced seeds requirement, and less water requirements (36%); it is therefore concluded that high grain yield and increased labour requirements are the key factors that influences rice farmers to adopt SRI technology. However, weed control (77%), handling younger seedlings (59%), water scheduling control (50%) and rodents (45%) were reported as challenges that face SRI adopters. Thus, it is concluded that weed control, handling younger seedlings and water scheduling control are challenges that inhibit SRI adopter to dis-adopt the technology in rice production in long term.

Moreover, lack of training (80%), awareness (77%) and skills (52%) on SRI technology of rice production hinders the adoption of SRI technology by non-adopters. It is therefore concluded that lack of training, awareness and skills acquisition on SRI technology are barriers to entry in using SRI technology at Mkindo Rice Irrigation Scheme.

Based on these conclusions, it is therefore recommended that high grain yield and increased return to labour should be improved to attract more SRI adopters. Also, there should be alternative means for controlling weeds (biological/chemical control), handling younger seedlings, and water scheduling control so as to reduce production costs. Moreover, it is recommended that rice farmers should be trained in phases and be made aware of SRI technology principles so as to attract more rice farmers to adopt SRI technology.

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