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Role of farmer field schools in adoption of innovative rice production practices in Mvomero district, Tanzania

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ABSTRACT

Farmer Field Schools (FFS) provide farmers with an opportunity to experiment new technologies which help them to make informed decisions that eventually lead to increased production and income. This study assessed the role of FFS in adoption of innovative rice production practices in Mvomero district, Tanzania. Adoption was conceptualized as an act in which FFS members accept and use the recommended rice production practices in their own fields. A cross-sectional survey was conducted among 188 respondents (FFS members) selected through a multi-stage sampling technique. Frequencies were run to determine the adoption level (proportion of FFS members who adopted the innovative rice production practices). Additionally, T-test and Chi-square tests were run to assess the influence of FFS members' socio-economic characteristics on the adoption of innovative rice production practices. The results of the study showed that a total of 15 recommended rice production practices were promoted using FFS in the study area and more than 75% of FFS members were found to be aware of them. Further, 80% of the innovative rice production practices promoted were adopted by more than 65% FFS members. Household size, total land size, land planted with rice, marital status, literacy and non-farm income influenced the adoption of some of innovative rice production practices. The findings suggest that FFS played an important role in awareness creation among FFS members whereby a total of 15 innovative rice production practices were promoted. Additionally Farmer Field Schools improved FFS members' knowledge and experience which facilitated the increased adoption of innovative rice production practices among FFS members. It is therefore evident that FFS provide a good opportunity for the dissemination of innovative rice production practices and other agricultural technologies and their use. It is recommended that the FFFS approach be further scaled out.

Key words: Farmers Field Schools, rice production, Tanzania

RÉSUMÉ

Les enseignements pratiques offrent aux agriculteurs l'occasion d'expérimenter de nouvelles technologies aidant à prendre des décisions éclairées pouvant éventuellement accroitre et production et revenus. Cette étude a évalué le rôle de ces enseignements dans l'adoption de pratiques innovantes de production de riz dans le district de Mvomero, en Tanzanie. L'adoption a été conceptualisée comme un acte par lequel les bénéficiaires acceptent et appliquent les techniques recommandées pour la production de riz dans leurs propres champs. Une enquête transversale a été menée auprès de 188 enquêtés sélectionnés au moyen d'une technique d'échantillonnage à plusieurs étapes. Des fréquences (proportion des enquêtés ayant adopté les pratiques innovantes) ont été utilisées pour déterminer le niveau d'adoption. De plus, des tests T de Student et de Chi-carré ont été effectués pour évaluer l'influence des variables socioéconomiques des enquêtés sur l'adoption des pratiques. Les résultats ont révélé qu'au total, 15 pratiques recommandées pour la production de riz ont été promues à travers ces enseignements pratiques, et que plus de 75% des bénéficiaires en avaient connaissance. De plus, 80% des pratiques innovantes promues ont été adoptées par plus de 65% des enquêtés. La taille des ménages, la surface des terres, les champs de riz, le statut matrimonial, le niveau d'alphabétisation et le revenu non agricole ont influencé l'adoption de certaines méthodes. Les résultats suggèrent que les enseignements pratiques ont joué un rôle important dans la sensibilisation des bénéficiaires. De plus, ces enseignements ont amélioré les connaissances et expériences des bénéficiaires, ce qui a facilité l'adoption accrue de ces pratiques de production de riz. Il est donc évident que ces enseignements pratiques offrent une bonne occasion de divulguer des pratiques novatrices de production de riz et d'autres technologies agricoles et leur application. Il est recommandé que cette approche par enseignements pratiques soit étendue davantage.

Mots clés: Enseignements pratiques, production de riz, Tanzanie

BACKGROUND

Agricultural extension plays an important role in economic development of agrarian dependent countries such as Tanzania. Post independent Tanzania introduced several extension approaches as a strategy aimed at improving agricultural production in the country but these however have had limited successes if any. Their failures were orchestrated by several weaknesses have embedded in them like being limited to demonstration of technologies, top-down in nature, donor dependent, limited use of farmers' knowledge, and using the already packaged information arising from blanket recommendations (Mwaseba *et al.*, 2008). These approaches included: improvement and transformation approaches (Lugeye, 1995), training and visit system (Mwaseba *et al.,* 2008), and farming systems research and extension approach (CMMYT, 1984). In responding to the failure of the previous approaches, the Government of Tanzania, through the Ministry of Agriculture Food Security and Cooperatives introduced Farmer Field Schools (FFS) as an alternative approach in transforming agriculture.

Farmer Field School (FFS) is a season long training of farmers involving participatory activities, hands-on analysis and decision making (Rola *et al*., 2002). It is a participatory agricultural extension approach based on experiential learning or learning by discovery (FAO, 2003).The first FFS were established in 1989 in Central Java - Indonesia during a pilot season by 50 United Nations Food and Agriculture Organization plant protection officers to test and develop field training methods as part of their Integrated Pest Management (IPM) training of trainers' course (Mwaseba *et al.*, 2008). The FFS approach represents a paradigm shift in agricultural extension from top down to bottom up. The training programme utilizes participatory methods "to help farmers develop their analytical skills, critical thinking, and creativity, and help them learn to make better decisions" (Kenmore, 2002).

In Tanzania, the FFS approach is not a new phenomenon; it was introduced in 1996 whereby Mkindo Farmers' Agricultural and Rural Training Centre was established in Morogoro region by the Indonesian Farmers' Fund as part of a cooperation agreement between Tanzania and Indonesia. The centre acts as the national centre for training farmers and trainers on irrigated rice (FAO, 2008). In 2002, the Ministry of Agriculture Training Institute (MATI) Uyole, Mbeya introduced FFS in Namtumbo district in Ruvuma region and in some areas in Mbeya region which played a very important role in enhancing participatory skills in agriculture and livestock production to farmers (Mwaseb*a et al.,* 2008). However, since their introduction no systematic study has focused at analysing the extent to which FFS contribute to successful dissemination and technology adoption. Consequently, this study was developed with an objective of assessing the role FFS have in the adoption of innovative rice production practices among FFS members in Mvomero district in Tanzania.

STUDY DESCRIPTION

The study was carried out in Mvomero district in Tanzania. The district is located in the North-East of Morogoro region between latitudes 8^0 00' and 10^0 00' South of the Equator and between longitudes $37^0$00' and $28^0$22' East of the Greenwich (MOVEK, 2008). The study adopted a cross-sectional research design whereby data were collected at a single point in time. A multi-stage sampling technique was employed in order to come up with the study sample. In the first stage, four wards out of 18 wards were purposely selected with the aim of getting wards with functional and viable FFS in the district. The wards selected were Mvomero, Mtibwa, Dakawa and Hembeti. In the second stage, six out of 23 villages were selected purposely in order to get the right villages with functional and viable FFS. These villages included Mvomero, Misufini, Mkindo, Hembeti, Lukenge and Wami-Dakawa. In the third stage, fifty two (52) active FFS were selected whereby all FFS members were given an opportunity to be included in the sample. A total of 188 FFS members were obtained.

RESULTS AND DISCUSSION

The results presented in Table 1 below show that FFS promoted a total of 15 innovative rice production practices. The promotion of these practices was done using various methods including training, demonstration, field visits, meetings and agro-ecosystem analysis. The results also show that the awareness of FFS members on recommended rice production practices promoted was very high (above 75%). For example, FFS members' awareness on the use of improved rice variety (SARO 5), seed bed preparation, water bunds, levelling, transplanting and early weeding-twice was 100%. This implies that FFS members were well informed of those practices as a result of being members of FFS and active participants in FFS related activities. High degree of awareness of the recommended rice production practices promoted signifies the role FFS in awareness creation. The FFS created a room for sharing of information among members. These results agree with those of Anandajayasekeram *et al*. (2007) who reported that FFS enhanced farmer to farmer extension information.

However, awareness of 25 cm x 25 cm spacing and 20 cm x 10 cm x 40 spacing was low as compared to the rest of innovative rice production practices promoted using FFS in the study area. Some of the respondents clearly pointed out that they were not well informed of the 25 cm x 25 cm spacing and 20 cm x 10 cm x 40 cm spacing because they joined their respective FFS a bit late. They decided to join after seeing that their fellow farmers who were FFS members were getting higher yields. This implies that it is very important for FFS members to attend all activities from the commencement of the season-long training to the end. It is for this reason that FFS trainings should always be held in the community where farmers live so that they can easily attend weekly and maintain the field school studies as pointed out by Mwaseba *et al.* (2008) and Gallagher (1999). Additionally, some of the FFS members clearly pointed out that they were not conversant with the recommended spacing because the practice was yet to be taught in their respective FFS by the time this study was conducted. It should be noted that a farmer (FFS member) was considered to be aware of the recommended rice production practices if he /she was able to give some details about a practice.

Table 1: Awarness of the recommended rice production practices by farmers in Mvomero district, Tanzania

Recommended practices	**FFS members aware**		**FFS members not aware**	
	Frequency	**Percent**	**Frequency**	**Percent**
Improved rice variety (SARO 5)	188	100.00	0	0.00
Seed bed preparation	188	100.00	0	0.00
Water bunds construction	188	100.00	0	0.00
Levelling	188	100.00	0	0.00
Transplanting	188	100.00	0	0.00
Early weeding-twice	188	100.00	0	0.00
Seed selection	187	99.50	1	0.50
Fertilizer application (T.D.1)	187	99.50	1	0.50
Fertilizer application (T.D.2)	187	99.50	1	0.50
Spraying to control insects-pests	187	99.50	1	0.50
Spraying to control weeds	187	99.50	1	0.50
Spraying to control diseases	187	99.50	1	0.50
Spacing -20 x 20 (3weeks)	173	92.02	15	7.98
Spacing - 25 x 25 (8-15days)	154	81.90	34	18.1
Spacing - 20 x10 x40	143	76.10	45	23.9

The results in Table 2 show that the majority (80%) of innovative rice production practices which were promoted through FFS were adopted by FFS members. Early weeding-twice and construction of water bunds were adopted by all respondents. Seed bed preparation, levelling, transplanting and seed selection were adopted by 98.9% of the respondents (FFS members) as shown in Table 2 above. The study revealed that the level of adoption was very high. This was attributed to high yields which FFS members obtained in both FFS study fields and FFS members' own fields which surpassed yields obtained with traditional practices which were locally known as "Kilimo cha mazoea.

Additionally, it was attributed to the high degree of awareness among FFS members on the innovative rice production practices promoted and their advantages. The results are in line with Asfawl *et al.* (2011) who reported that farmers who were aware of the advantages of new technologies were more likely to adopt such technologies and allocate more land in the subsequent year. On the same note, Drechsel *et al.* (2005) reported that, to start an adoption process, at least some farmers had to experience the advantages of an innovation to be adopted.

However, there was high rate of non-adoption of the 20 cm x 10 cm x 40 cm and 25 cm x 25cm spacing practices. The results show that this practice was adopted by less than 49% of the respondents. This was attributed to the fact that these practices were found to be more labour demanding. It was reported that 25 cm x 25 cm spacing had a component of additional weeding since it required alternate wetting and drying which created a favourable environment for the growth of weeds (Katambara *et al.*, 2013). Therefore, this implies that less labour demanding rice production practices were more likely to be adopted as compared to more labour demanding practices.

Improved rice variety (SARO 5). The results presented in Table 2 show that the majority of FFS members (97.3%) had adopted improved rice variety (SARO 5) in their own fields. This was attributed to high yields observed by FFS members in both FFS study fields and FFS members' own fields as compared to local varieties like Mbawambili, Kula na bwana, Domo la fisi and Super. These findings concur with what farmers said during FGDs whereby they reported that SARO 5 had higher yields than local varieties. Additionally, the findings concur with what was said during key informant interviews that local varieties had good aroma but had low yields. According to Tulole *et al.* (2011), local rice varieties are relatively low yielding, averaging 1.5– 2.1 tons per acre. Similarly, Saka *et al.* (2005) reported that improved rice varieties had significantly higher mean yield than local varieties with a yield advantage of 38.7%. Tenge *et al*. (2013) reported that the improved variety was preferred due to its high yielding potential. Additionally, SARO 5 matured earlier than local varieties. It was reported that SARO 5 was semi-aromatic and matured earlier (120 days) than local varieties (180 days) (URT, 2011). According to Rogers (2003), an innovation that is perceived to be superior over others and having visible results will be rapidly adopted. These results are supported by the results presented in Table 3 below.

The results in Table 3 show that there was a significant difference ($P<0.05$) in household sizes between adopters of improved rice variety (SARO 5) and non-adopters. Adopters had significantly larger household sizes than non-adopters. This was attributed to the fact that the improved variety had higher yielding potential which was more likely to meet food demands for larger households as compared to local varieties like Mbawambili, Kula na bwana, Domo la fisi and Super. However, differences in age, education, land sizes, literacy rate and non-farm income were not significant.

Seed selection. The results presented in Table 2 show that the majority of FF members (97.9%) had adopted seed selection practice. This was attributed to the fact that this practice helped FFS members to get better quality seeds resulting into increase in rice yields. These findings concur with what was reported by key informants that selecting seeds using water + salt was better than winnowing since it had higher assurance of getting better quality seeds. Better seeds (well filled / heavy grains) ensured high germination percentage, produced seedlings with high growth vigour (URT, 2011) and healthier plants with resistance to drought, pests and diseases (IITA, 1972). These results are supported by the results presented in table 4 below.

Table 2. Level of adoption of recommended rice production practices (n=188)

Recommended practices	FFS members aware		FFS members not aware	
	Frequency	Percent	Frequency	Percent
Early weeding-twice	188	100.00	0	0.00
Water bunds construction	188	100.00	0	0.00
Seed bed preparation	186	98.9	2	1.1
Levelling	186	98.9	2	1.1
Transplanting	186	98.9	2	1.1
Seed selection	184	97.9	4	2.1
Improved rice variety (SARO5)	183	97.3	5	2.7
Spraying to control insects-pests	177	94.1	11	5.9
Spraying to control diseases	177	94.1	11	5.9
Fertilizer application (T.D.2)	163	86.7	25	13.3
Spraying to control weeds	161	85.6	27	14.4
Fertilizer application (T.D.1)	151	80.3	37	19.7
Spacing -20 x 20 (3weeks)	123	65.4	65	34.6
Spacing - 25 x 25 (8-15days)	92	48.9	96	51.1
Spacing - 20 x 10 x 40	26	13.8	162	86.2

Table 3. T-test results for the adoption of improved rice variety (SARO 5)

Socio-economic characteristics	Mean for adopters	Mean for non-adopters	t-values	P-value
Household size	5.2	3.2	2.2277	0.0271*
Age	42.5	50.6	-1.4376	0.1522
Education	7.0	5.6	1.2552	0.2110
Total land size (ha)	3.3	5.1	-0.9619	0.3374
Land planted with rice (ha)	2.3	2.6	-0.3110	0.7561

**= significant at 5%*

Table 4. T-test results for the adoption of seed selection

Socio-economic characteristics	Mean for adopters	Mean for non-adopters	t-values	P-value
Household size	5.3	2.8	2.4400	0.0156*
Age	42.6	49.5	-1.1002	0.2727
Education	7.1	5.3	1.3947	0.1648
Total land size (ha)	3.4	5.9	-1.2579	0.2100
Land planted with rice (ha)	2.3	3.0	-0.6640	0.5075

**= significant at 5%*

The results presented in Table 4 show that there was a significant difference (P<0.05) in household sizes between adopters of seed selection and non-adopters.
Adopters had significantly larger household sizes (5.3 members) than non-adopters (2.8 members). This implies that the level of adoption of seed selection was higher among FFS members with larger household sizes than those with smaller household sizes. This was attributed to the fact that bigger households had more labour force which facilitated seed selection process than smaller households. The results are in line with Tura *et al.* (2010) who argued that household size influenced the adoption of improved maize variety due to the supply of family labour. However, differences in age, education, landholding size, literacy rate and non-farm income were not significant.

Seed bed preparation. The results presented in Table 2 show that almost all (98.9%) of FFS members had adopted the nursery bed preparation practice in their own fields. This implies that the majority of FFS members were growing their rice seedlings in nursery beds prior to transplanting them into water bunds. This was attributed to the fact that nursery beds provided a conducive environment for the growth of healthy seedlings which in one way or another contributed to increased rice yields as compared to the broadcasting practice. Nursery beds produced healthy and vigorous seedlings with good tillering potential (URT, 2011). These results are supported by the results presented in Table 5 below.

The results presented in Table 5 show that there was significant difference (P<0.1) in total land holding sizes between adopters of nursery bed preparation and non-adopters. Adopters of nursery bed preparation practice had significantly smaller land holding sizes (3.3 ha) than non-adopters (8.5 ha). This implies that the adoption of nursery bed preparation was negatively related to total land holding size. This was attributed to the fact that the majority of FFS members (85.1%) had smaller total land sizes (<=5 ha). These results agree with those of a study by Kassie *et al.* (2012) whereby landholding size was found to be negatively related to the adoption sustainable agricultural practices. Additionally, nursery beds did not necessarily require big land size. However, differences in household size, age, education, sex, literacy rate, marital status and non-farm income were not significant.

Levelling. The results in Table 2 show that levelling was adopted by the majority of FFS members (98.9%). This gives an impression that FFS members levelled their rice fields (water bunds) prior to transplanting of rice seedlings. This was attributed to the fact that levelling allowed equal supply of water throughout the rice field, hence smooth growth of rice seedlings. One of the members said "Unlevelled rice field can lead to some rice plants get little water than others" (Farmers from Mkindo village). The results are in line with information in a report by URT (2011) that perfect levelling facilitates even spread of water across the field, resulting in better crop and uniform crop stand and maturity. These results are supported by the results presented in Table 6 below.

The results presented in Table 6 show that there was a significant difference (P<0.1) in total land sizes between adopters of levelling and non- adopters. Adopters of levelling had significantly smaller total land sizes (3.3 ha) than non-adopters (8.5 ha). This implies that the adoption of levelling was negatively related to total land holding. This was attributed to the fact that bigger landholding size required more time, labour and money. However, differences in household size, age, education, sex, literacy rate, marital status and non- farm income were not significant.

Table 5: T-test results for the adoption nursery bed preparation

Socio-economic characteristics	Mean for adopters	Mean for non-adopters	t-values	P-value
Household size	5.2	3.5	1.1769	0.2407
Age	42.6	53.0	-1.1752	0.2414
Education	7.0	7.0	0.0175	0.9861
Total land size (ha)	3.3	8.5	-1.8427	0.0670*
Land planted with rice (ha)	2.2	4.0	-1.1490	0.2520

**= significant at 10%*

Table 6. T-test results for the adoption of levelling

Socio-economic characteristics	Mean for adopters	Mean for non-adopters	t-values	P-value
Household size	5.2	3.5	1.1769	0.2407
Age	42.6	53.0	-1.1752	0.2414
Education	7.0	7.0	0.0175	0.9861
Total land size (ha)	3.3	8.5	-1.8427	0.0670*
Land planted with rice (ha)	2.2	4.0	-1.1490	0.2520

**= significant at 10%*

Spacing 20 by 20. The results presented in Table 2 show that about two-thirds (65.4%) of FFS members had adopted 20 cm x 20 cm spacing. This implies that good number FFS members were using 20 cm x 20 cm spacing practice in their rice fields. This was attributed to the fact that FFS members were well informed of the importance of spacing (Table 2) as it was reported by one of the members who said "Good spacing reduces chances of plants competing for water, space, air and nutrients." Good spacing allows the plant roots to grow profusely both vertically and horizontally, cover a larger area and tap more nutrients which results in the development of larger plants with larger numbers of tillers and grains (Furahisha, 2013). These results are supported by the results presented in Table 7 below.

The results presented in Table 7 show that there was a significant difference (P<0.1) in non-farm income between adopters of 20 cm x 20 cm spacing and non-adopters. Adopters of the 20 cm x 20 cm spacing practice had significantly more members (80 people) with no access to non-farm income than none adopters (34 members). In other words, the adoption of the 20 cm x 20 cm spacing practice was negatively related to non-farm income. This implies that FFS members with no access to non-farm income had more probability of adopting the 20 cm x 20 cm spacing practice than those with access to non-farm income. This was attributed to the fact that the majority of FFS members had no access to non-farm income (Table 4). Additionally, the adoption of the 20 cm x 20 cm spacing practice was attributed to an input subsidy programme which supplemented the cost of production. However, differences in household size, landholding size, age, education, sex, literacy rate and marital status were not significant.

Table 7. Chi-square test results for the adoption of 20 x 20 spacing

Socio-economic characteristics	Categories of socio-economic characteristics	Number of adopters	Number of non-adopters	Total	P-Value
Sex	Male	60	34	92	0.645
	Female	63	31	96	
	Total	123	65	188	
Marital status	Married	95	53	148	0.493
	Others	28	12	40	
	Total	123	65	188	
Literacy rate	Can read and write	112	62	174	0.282
	Can't read write	11	3	14	
	Total	123	65	188	
Non-farm income	With non-farm income	43	31	74	0.089*
	Without non-farm income	80	34	144	
	Total		123	65	188

**=Significant at 10%*

Spacing 20 cm x 10 cm x 40 cm. The results presented in Table 2 show that 20 cmx 10 cm x 40 cm spacing was adopted by a small proportion (13.8%) of FFS members (26.0 members). This implies that the majority of FFS members (86.2%) did not adopt this spacing. This was attributed to the fact that this type of spacing occupied more land hence necessitated larger land sizes, given the same number of seedlings. The majority of FFS members (85.1%) had smaller land holding sizes (<=5ha) Table 8.

The results in Table 8 above show that there was a significant difference (P<0.05) in household sizes between adopters of 20 cm x 10 cm x 40 cm spacing and non-adopters. Adopters of 20 cmx 10 cm x 40 cm spacing had significantly larger household sizes (6.0 members) than non-adopters (5.0 members). This implies that FFS members who had larger household sizes had an advantage of adopting 20 cm x 10 cm x 40 cm spacing than those with smaller household sizes. This was attributed to the fact that larger household sizes had more labour force which was needed during transplanting process. It should be noted that transplanting is a labour demanding activity. These results agree with the study by Kassie *et al.* (2012) who found that household size was positively related to the adoption of sustainable agricultural practices due to the supply of labour force.

Table 8 further shows that there was a significant difference (P<0.1) in land holding sizes planted with rice between adopters of 20 cm x 10 cmx 40 cm spacing and non-adopters. Adopters had significantly larger land holding sizes (3.0 ha) than non-adopters (2.1 ha). This was attributed to the fact that this type of spacing occupied more land space hence necessitated larger landing size. It should be noted that it was for the same reason that this type of spacing was adopted by a small proportion of FFS members (Table 2). This implies that innovative rice production practices which by nature occupied more land were less likely to be adopted than those that occupied less land. However, differences in age, education, sex, marital status, literacy rate and no-farm income were not significant.

Spacing 25 cm x 25 cm. The results presented in Table 2 show that less than half of FFS members (48.9%) had adopted 25x 25 spacing. This means that the majority (51.1%) of FFS members did not adopt this type of spacing. This was attributed to the fact that this type of spacing occupied more land space as compared to 20 cm x 20 cm spacing given the same number of seedlings. In other words, this type of spacing had lower plant density as compared to 20 cm x 20 cm spacing. Additionally, this type of spacing was considered to be more risky since it involved transplanting only one seedling per planting station. One of the members said "This type of spacing occupies more land space and it is very risky to transplant one seedling per planting station" (Farmers from Mkindo village). Drechsel *et al.* (2005) reported that risks and uncertainties affected farmers' attitude towards innovations and adoption behaviour. However, differences in socio-economic characteristics between adopters and non-adopters were not significant.

Table 8: T-test results for the adoption of 20 x 10 x 40 spacing

Socio-economic characteristics	**Mean for adopters**	**Mean for non-adopters**	**t-values**	**P-value**
Household size	6.0	5.0	2.2561	0.0252**
Age	46.7	42.1	1.7731	0.0779*
Education	6.4	7.1	-1.2115	0.2272
Total land size (ha)	4.5	3.5	1.5544	0.1218
Land planted with rice (ha)	3.0	2.1	1.8698	0.0631*

= significant at 10%* *= significant at 5%*

Fertilizer application (Top dressing phase 1 and 2). The results presented in table 2 show that more than half of the FFS members had adopted fertilizer application (both top dressing phases 1 and 2). It was found that 80.3% of FFS members had adopted top dressing phase 1, while 86.7% of FFS members hadadopted top dressing phase 2. This implies that the majority of FFS members were applying fertilizer in rice production. This was attributed to the high degree of awareness of the importance of fertilizer in rice production. These findings agree with what was reported during key informant interviews that fertilizer application increased rice yields. Similarly, these findings concur with Evenson and Gollin (2003) that increase in rice yield could be achieved through the increase in chemical fertilizer application. It should be noted that it was for the same reason that Drechsel *et al.* (2005) argued that, for adoption process to start at least farmers had to experience the advantages of an innovation. These results are supported by the results presented in Table 9 below.

The results in Table 9 show that there was a significant difference (P<0.1) in land sizes planted with rice between adopters of top dressing phase 2 and non-adopters. Adopters had significantly larger land holding sizes planted with rice (2.4 ha) than non-adopters (1.6 ha).

The results of a chi-square test for adoption of top dressing phase 2 are presented in Table 10. There was a significant association (P<0.05) between marital status and adoption of top dressing phase 2. Adopters had significantly more married members (133 members) than non-adopters (15 members). The results imply that the level of adoption of fertilizer application was higher among FFS members who were married than those who were single (unmarried, widows, divorced). This was attributed to the fact that married members had more labour force which was needed in fertilizer application as compared to singles, widows and others. Marriage situation created a room for sharing of responsibilities. Just as it was pointed out by Mikwamba (2011) that, in a marriage situation, the work output that each person produced was much more than when each person worked independently.

Table 10 further shows that there was a significant association (P<0.1) between literacy rate and adoption of top dressing phase 2. Adopters of top dressing phase 2 had significantly more members who were able to read and write (153) than non-adopters (21). This was attributed to the fact that high literacy rate among FFS members put them at an advantage of reading and understanding various agricultural messages related to innovative rice production practices promoted through FFS including fertilizer application.

Early weeding-twice. The results presented in Table 2 show that the adoption of the early weeding-twice practice among FFS members in the study area was 100%. This means that all FFS members (188) had adopted weeding practice in their own rice fields, implying that FFS was very successful in promoting the adoption of weeding practice. This was attributed to high degree of awareness on the importance of weeding for the growth of healthy rice plants. Awareness of the farmers is the first key stage to adoption of new technology (Subedi *et al.*, 2009). The findings from key informant interviews revealed that late weeding decreased rice yields. It is advised that weeding should be done early enough, preferably two (2) weeks after transplanting and three (3) weeks after the first weeding to avoid yield loss (URT, 2011). Unsuccessful weed control can result in the almost total loss of rice yield (Furahisha, 2013).

Table 9. T-test results for the adoption of top dressing phase 2

Socio-economic characteristics	Mean for adopters	Mean for non-adopters	t-values	P-value
Household size	5.1	5.2	-0.2026	0.8396
Age	42.7	42.8	-0.0584	0.9535
Education	7.1	6.5	1.0620	0.2896
Total land size (ha)	3.5	2.4	1.4055	0.1615
Land planted with rice (ha)	2.4	1.6	1.7371	0.0840*

**= significant at 10%*

Table 10. Chi-square test results for the adoption of top dressing phase 2

Socio-economic characteristics	Categories of socio-economic characteristics	Number of adopters	Number of non-adopters	Total	P-Value
Sex	Male	84	10	94	0.283
	Female	79	15	94	
	Total	163	25	188	
Marital status	Married	133	15	148	0.014**
	Others	30	10	40	
	Total	163	25	188	
Literacy rate	Can read and write	153	21	174	0.080*
	Can't read write	10	4	14	
	Total	163	25	188	
Non-farm income	With non-farm income	65	9	74	0.712
	Without non-farm income	98	16	114	
	Total	163	25	188	

**= significant at 10%   **= significant at 5%*

Chemical spraying to control insects, weeds and diseases. The results presented in Table 2 show that a good proportion of FFS members in the study area had adopted chemical spraying practice. The adoption of spraying chemicals to control diseases represented 94.1% of respondents mean while spraying to control insects represented 94% of respondents. Additionally, the adoption of spraying to control weeds represented 85.6% of respondents. This implies that FFS were very successful in promoting the adoption of spraying practice. This was attributed to the fact that the majority (98.5%) of FFS members were well informed of the importance of spraying on the growth rice plants as Table 1 shows. This implies that FFS increased the use of spraying from ≤ 50% in 2012 as reported by Mtengeti *et al.* (2012) to > 85% in 2014. However, differences in socio-economic characteristics between adopters and non- adopters were not significant.

Transplanting. The results presented in Table 2 show that 98.9% of FFS members had adopted transplanting rice in their own fields. This implies that the majority of FFS members were transplanting rice production instead of broadcasting. This was attributed to the fact that transplanting led to higher yields. Additionally, transplanting used less seeds compared to broadcasting. These findings agree with what was said by farmers during FGDs whereby they reported that broadcasting led to unhealthy plants and low yields due to competition for air and nutrients. Additionally, these results are supported by Evenson and Gollin (2003) who reported that transplanting in rice production resulted in increased yields.

The results presented in Table 11 show that there was a significant difference ($P<0.1$) in total land holding between adopters of transplanting and non-adopters. Adopters had significantly smaller total land holding sizes (3.4 ha) than non-adopters (8.5 ha). This implies that total land holding size was negatively related to the adoption of transplanting. This was attributed to the fact that this practice was labour demanding besides being time consuming. Therefore, labour demanding practices are less likely to be adopted in situations where labour supply is limited. However, differences in other socio-economic characteristics were not significant.

Water bunds construction. Water bund refers to an enclosure made of soil in which paddy seedlings are transplanted (NRCS, 2011). The results presented in Table 2 show that 100% of the FFS members had adopted water bunds in their own fields. This implies that FFS succeeded very well in promoting the adoption of water bunds such that all members had adopted the practice. This was attributed to the fact

Table 11. T-test results for the adoption of transplanting

Socio-economic characteristics	Mean for adopters	Mean for non-adopters	t-values	P-value
Household size	5.2	3.5	1.1769	0.2407
Age	42.6	53.0	-1.1752	0.2414
Education	7.0	7.0	0.0175	0.9861
Total land size (ha)	3.4	8.5	-1.8427	0.0670 *
Land planted with rice (ha)	2.3	4.0	-1.1490	0.2520

**= significant at 10%*

that rice production required good water management which was made possible by the construction of water bunds besides other practices like levelling. Water bunds increases efficient utilization of water (Tenge *et al.,* 2013). Additionally, water bunds facilitates water harvesting in rain fed systems and prevents fertilizer loss (URT, 2011).

CONCLUSION

Farmer Field Schools played an important role in awareness creation among FFS members. A total of 15 innovative rice production practices were promoted. Additionally, Farmer Field Schools improved members' knowledge and experience which facilitated increased adoption of innovative rice production practices among FFS members. Thus, FFS approach should be promoted for tasting and dissemination of agricultural technologies and best practices.

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STATEMENT OF NO CONFLICT OF INTEREST

We the authors of this paper hereby declare that there are no competing interests in this publication.

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