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Impact of FFS on farmer's adoption of IPM options for tomato: A case study from the Gezira State, Sudan

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Abstract

In Sudan pests and diseases are the major problem of vegetables production. Tomato crop is considered as the most important vegetable crop in the country according to its economic and nutrition value. There are many pest and diseases retarding tomato production such as whitefly, American bollworm, TYLCV and powdery mildew. Therefore some IPM options for tomato and onion were validated in FFS in order to help farmers in controlling the most important pests and diseases. The main objective of this study was to determine the impact of FFS on farmer's adoption of IPM options for tomato in the Gezira State, Sudan. Field survey was used to collect data from three Farmer Field Schools in the Gezira State namely: Um Dagarsi, Hantoub and Faris in the 2009/2010 growing season. All FFS participants were used, i.e. 30 FFS- participants from each school. Equal number of non-FFS participants (90) was used for comparison, by using the simple random sampling technique. The collected data were statistically analyzed and interpreted using percentage, frequency distribution and chi-square test. The results showed that the FFS schools were positively affected farmer's adoption of IPM options for tomato. It can be concluded that the FFS approach is very efficient in the transfer of farm technology for vegetable farmers through their participation in various activities of FFS schools. Thus, FFS approach must become national policy, share authority of extension organizations in control and execution of FFS activities with farmer unions for more effective participations of clientele in all activities of the schools and More efforts should be exerted in distribution of all inputs to farmers with reasonable prices through various agricultural centres.

Keywords: Farmers field schools, Integrated pest management, IPM on vegetables, Tomato, IPM options for tomato, Agricultural extension, FFS participants , Non-FFS participants, Sudan

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1. Introduction

Vegetables are considered an important food group and major source of vitamins and minerals for humans. In Sudan, as in the majority of African countries, small-scale farmers under irrigated or rained conditions produce vegetable crops. The main vegetables cultivated in the various parts of the country are tomato, onion, okra, eggplant, potatoes, cucumbers, watermelon, carrot, sweet pepper, and hot peppers. Central Sudan (particularly the Gezira and Rahad Schemes) as well as private farms along the Blue Nile Banks supervised by The Gezira State Agricultural Extension, are the main producer of vegetable crops. Guddoura (1997) (cited in Guddoura et al., 1993) mentioned that vegetables contribute directly to the GDP at rate of nearly 40%. Taking the value of the agricultural output by the commodity, vegetables and fruits production comprised more than 12% of the total agricultural output compared to 21% contributed by grains, 17% by cotton and 9% by oil seeds.

Although traditional vegetable production in Africa was conducted with a minimum of inputs, as vegetables assume major economic importance and quality becomes an issue, there is greater use of improved seeds, fertilizers and pesticides. The intensification of vegetable production has also created pest problems that were not so important in traditional agriculture. At present, too many pesticides are used with no apparent reduction in pest outbreaks. Small scale-farmers in particular do not know which pesticides to use or when and how to apply them safely.

In Sudan, losses in vegetable production due to pest and disease attacks are found greater. Due to this unfavourable factor farmers have a tendency to overuse pesticides, they may apply any pesticides to reduce losses and increase their yield which led to large misuse and risks for health and environmental hazards. Dabrowski (1997) stated that in its fourth phase, the FAO/ARC Project in Sudan initiated activities on developing, implementing and validation of IPM on vegetables where pesticides were commonly used in a very inappropriate manner with regard to the types of chemicals used, dosage rates, application methods or safety procedures.

Tomato is the second most important economic vegetable in Sudan occupying about 28 percent of the total area, annually producing about 294,000 tonnes, which represents around 27 percent of the country's total vegetable production Dawelbeit et al., 2010) (cited in Ahmed, 1994). Ahmed et al. (1997) reported those insects such as whitefly (Benicia tabaci), American bollworm (Helicoverpa armigera) and onion thrips (Thrips tabaci) and the diseases TYLCV and powdery mildew in tomato are major retarding factors to production. Therefore some IPM options for tomato and onion were validated in FFS in order to help farmers in controlling these most important pests and diseases. These selected IPM options for tomato include land preparation using deep ploughing and disc harrowing in addition to leveling and ridging, sowing methods using direct seeding, fertilizer/ha using recommended dose 86 kg N, intercropping using coriander on banks of all small canals and separating ridges, use of soft chemicals (pyrethriods) if necessary, weed control by removal of all weeds especially alternative hosts for TYLCV and PM ,irrigation every 4-5 days and stoppage of spraying pesticides at 50% fruit setting.

Van Den Berg (2004) refers to Farmers Field Schools (FFS) as a form of adult education through which farmer's learning can be achieved from their observations and demonstrations. Abdel Rahman (2003)

reported that Farmers Field Schools (FFS) in the Sudan are a system for training farmers and disseminating IPM options for the major vegetable crops. The FFS aim to make it possible for farmers to gain control over their lives. In this context, knowledge, skills, positive attitudes and interaction are the core of improvement. These schools are excellent tools for reaching farmer's groups. They strengthen linkages and interaction between vegetable farmers, extensionists, researchers, mangers and specialists at different levels .FFS help their members to reduce their production costs. They also create a healthy environment of work which is expected to encourage vegetable farmers and their trainers to work together to solve their problems and challenge their main constraints.

Dabrowski reported that (quoted in Alsaffar et al., 1997b) the success of IPM farmers field schools (FFSs) in some Asian countries encouraged its introduction to other developing countries. In 1993, Sudan became the first African country to apply the system, modify it to suit the socio-economic structure of the rural community, evaluate it and present it as a model that can easily be assimilated and adopted by small farmers in the rest of the Sudan and other parts of Africa. The IPM FFS is a group of 20-30 farmers meeting once a week under a tree, next to their fields to be trained in knowledge, skills and attitudes so as to become more effective communicators who depend on themselves to solve their problems.

2. Materials and methods

This study was carried out in three Farmer Field Schools in the Gezira State namely: Um Dagarsi, Hantoub and Faris in the 2009/2010 growing season. All FFS participants were used, i.e. 30 FFS- participants from each school. Equal number of non-FFS participants (90) was used for comparison, by using the simple random sampling technique. The population was used to determine the impact of Farmer Field Schools on farmer's adoption of IPM options for tomato. A questionnaire consisting of eight questions was constructed and the personal interview technique was used to administer the questionnaire. The collected data were statistically analyzed and interpreted using percentage, frequency distribution and chi-square test.

3. Results and discussion

3.1. Characteristics of FFS and non-FFS participants

3.1.1. Age

The age plays important role on farmer's adoption of new technologies. The results showed that the majority of FFS participants (66.67%) were between 36-50 year old compared to (44.45%) of non-FFS participants (Table 2).

3.1.2. Education

The education plays important role on farmer's adoption of new technologies. The results showed that the majority of FFS-participants and non-FFS participants (72.22%, 58.89%) were literate respectively (Table1).

3.1.3. Participation in FFS weekly field training

The participatory approach suggests that effective agricultural extension can be achieved only by participation of farmers and other stakeholders in all aspects of agricultural extension activities because it has positive effect in group learning and executions. Participation in FFS activities throughout the growing season plays important role on farmer's adoption of new technologies. The results revealed that the majority of FFS-participants (55.56%) are participating in FFS activities in four seasons (Table3).

3.2. Recommended IPM package components for tomato

Many studies pointed out that recommended cultural practices component for vegetables which can be called the core activity of IPM in vegetables is very important because it seeks to modify the physical environment, biotic factors such as soil texture, structure and composition (tillage, fertilizers, organic matter), temperature and humidity (irrigation, plant density). It can help to divert adverse atmospheric conditions (sowing date, intercropping, protective boundary crops) to the betterment of the crop and the determent of pests or pathogens. Also they lead to a reduction in pest population and therefore they can be used as good instruments to reduce vegetable pest attacks.

3.3. Land preparation

Land preparation used to prepare fine seedbed for vegetable seed or transplant. The mechanical operations needed are dictated by the initial condition of the field, but under normal condition they encompass discing the soil to a depth of 18-20 cm to thoroughly disturb the root zone. Harrowing to break large soil masses and leveling to smooth up the soil. The field could be used in the flat state or, if required can be ridged at the desired ridge spacing. The time to start land preparation is of important particularly when working with heavy clay soils.

Land preparation can be used to advantage in controlling a multitude of soil flora and fauna harmful to crop plants. Leveling improves irrigation and discourages development of water logging conditions which so easily prevail in heavy soil. This is conducive to quick germination, emergence and robust root growth. Better irrigation management due to leveling is decisive in decreasing wilt and rot diseases in nurseries and small plants etc .Ridge formation in heavy soils will ease irrigation water movement in furrows and added precaution against water logging since water will be available to the roots through capillary movement. Ridges are especially useful in helping to avoid salt injury since salts naturally move towards the top of ridges away from plant root zones, taking hold in sides of the ridges as is the norm in clay soils. The results indicate that all FFS participants (100%) compared to (88.89%) of non-FFS participants respectively were adopted the recommended land preparation (deep ploughing, disc harrowing, leveling and ridging (Table 4). This result agrees with results reported by Ahmed et al. (1997) and Kannan (1997) who found that the land preparation of FFS participants was identical in the Pilot Farmer Field Schools (PFFS) of Gezira Scheme and Rahad Scheme respectively.

3.4. Sowing methods

Different vegetable crops have different optimum sowing and transplanting dates under Sudan conditions. Satisfying the climatic requirement of crops has lead to production of healthy plants which are tolerant of attack by pests and diseases. Synchronization of sowing date to crop needs is also a prophylactic measure since advancement or postponement of sowing dates helps in avoidance of pests having a limited period of breeding in the year like thrips in onion and aphid in cucurbits, okra and pepper. The results revealed that the majority of FFS participants (55.56%) compared to (22.22%) of non-FFS participants respectively were adopted the recommended sowing methods (direct seeding) (Table 4).

This result agrees with results reported by Ahmed et al. (1997) who found that the direct seeded tomato was more successful than the transplanted one early in the season in the field of FFS participants in PFFS of Gezira Scheme. The incidence of TYLCV in the direct seeded tomato was delayed, lower and less sever.

3.5. Fertilization

The only inorganic fertilizers used in large quantities in the Sudan are those supplying N (urea 46% N) and P (triple superphosphate 46% P_2O_5). The Gezira soil vertisols inherently deficient in organic matter (only 0.2%) and low in N (only 0.02%). Exogenous N must be added to optimize growth and yield. At present the only N fertilizer available is urea and most vegetables respond positively to its addition up to 86kgN/ha. The results showed that the majority of FFS participants (96.67%) compared to (66.67%) of non-FFS participants respectively were adopted the recommended dose of urea (86 kg N) (Table 4). This result agrees with results reported by Ahmed et al. (1997), Saadabi et al. (1997) and Kannan (1997) who found that the FFS participants were adopted the recommended dose of urea (86 kg N) in the PFFS of Gezira Scheme, FFS of Gezira State and Gezira Scheme and PFFS of Rahad Scheme respectively.

3.6. Intercropping

Intercropping, the simultaneous cultivation of more than one crop species in close association is used in controlling diseases in many parts of the world. In Sudan it was found that coriander (Coriandrum sativum) and fenugreek (Trigonella foenumgraecum) are the most promising crop species for intercropping with tomato. In Gezira State coriander showed more promise since tomato plants intercropped with it were more robust in growth with few whitefly and jassid and lower TYLCVA incidence. The results indicate that the majority of FFS participants (68.89%) compared to (38.89%) of non-FFS participants respectively were adopted the recommended plant species (coriander) for intercropping with tomato on banks of all small canals and separating ridges (Table 4).

This result agrees with results reported by Ahmed et al. (1997), Saadabi et al. (1997) and Kannan (1997) who found that the FFS participants were adopted the use of coriander as an insect repellent plant in their tomato fields in the PFFS of Gezira Scheme, FFS of Gezira State and Gezira Scheme and PFFS of Rahad Scheme respectively. The coriander when used as a companion crop with tomato can replace the use of insecticides

in controlling TYLCV and the yield obtained under this system was higher than the monocrop that received insecticide spraying.

3.7. Use of soft chemicals

Vegetable crops are consumed fresh by consumers therefore use of soft chemicals (pyrethriods) which have low toxicity when necessary is of vital importance for both farmers and consumers. The results showed that the majority of FFS participants (63.33%) compared to (16.67%) of non-FSS participants respectively were adopted the recommended insecticides to be used on tomato when necessary (Table 4).

This result agrees with results reported by Ahmed et al. (1997) and Saadabi et al. (1997) who found that the FFS participants were adopted the use of soft chemicals (pyrethriods) when necessary which exhibited high efficiency in controlling insect pests in their tomato fields in the PFFS of Gezira Scheme and FFS of Gezira State and Gezira Scheme respectively. FFS participants became more aware towards reduction of insecticide application .The average number of spraying on tomato was reduced by 1.8 spray in Gezira State and 1.4 in Gezira Scheme.

3.8. Weed control

A weed-free vegetable farm is a prerequisite for healthy crop growth. Weeds successfully compete with vegetables for nutrients, water and light. Aside from direct competitive effects, weeds are injurious to crop plants because they act as safe havens for insect pests and storage places for disease – causal organisms. The results indicate that the majority of FFS participants (86.67%) compared to (11.11%) of non-FFS participants respectively were adopted the recommended weed control practice and removed all weeds from their fields especially alternative hosts for TYLCV and powdery mildew (Solanum dubium, Acalypha indica, Abutilon pannosum ,Sonchus cornutus and Datura stramonium) (Table 4).

This result agrees with results reported by Ahmed et al. (1997) and Saadabi et al. (1997) who found that the FFS participants were adopted the recommended weed control practice and removed all alternative weed hosts from their tomato fields in the PFFS of Gezira Scheme and FFS of Gezira State and Gezira Scheme respectively.

3.9. Irrigation

Irrigation is an important cultural practice for the life of vegetables. Plant factors regulating irrigation are growth, habit, size of plant and physiological age. The physical soil structure, texture and structure also are important components in determining frequency and quality of water needed. Climate factors also affect the irrigation management**.** Also irrigation can be used as protective measure against pests and diseases. The results revealed that all FFS participants (100%) compared to (27.78%) of non-FFS participants respectively were adopted the recommended irrigation frequencies (Table 4).

This result agrees with results reported by Ahmed et al. (1997) and Kannan (1997) who found that the FFS participants were adopted the recommended irrigation frequencies (interval) in their tomato fields in the PFFS of Gezira Scheme and PFFS of Rahad Scheme respectively. It was evident that watering the crop lightly every 4-5 days instead of 7-10 days during summer and winter respectively have direct impact on blossom end rot (BER). There was no incidence of BER on FFS fields compared to the high incidence in the fields where irregular or prolonged watering interval regimes were practiced.

3.10. Stoppage of spraying pesticides at 50 % fruit setting

It was found that after tomato fruit setting, TYLCV was very minor and did not contribute to fruit yield losses, therefore stopping spraying of insecticides chemical at 50 % fruit setting is ideal to get the maximum control of whitefly on tomato and consequently TYLCV and to have a crop yield free from insecticidal residues. The results indicate that the majority of FFS participants (55.56%) compared to (5.56%) of non-FFS participants respectively were adopted the recommended stoppage of spraying at 50 % fruit setting (Table 4).

This result agrees with results reported by Ahmed et al. (1997) and Saadabi et al. (1997) who found that the FFS participants were adopted the stoppage of chemical control of whitefly at 50 % fruiting in their tomato fields in the PFFS of Gezira Scheme and FFS of Gezira State and Gezira Scheme respectively. This practice indicated that after flowering the TYLCV infections effect is very minor and does not contribute to yield losses. Therefore stopping the spraying of insecticides at 50 % flowering is ideal to get the maximum control of the whitefly and consequently TYLCV and to have a crop free from insecticide residues.

3.11. Chi-square test

Chi-square test was used to show the association between number of seasons of participation in FFS and adoption of recommended IPM package components for tomato by FFS participants. The results showed that there was significant association between number of seasons of participation in FFS and adoption of recommended IPM package components for tomato by FFS participants (Table 4).

This result agrees with results reported by Saadabi et al. (1997) who found that the FFS training programme has provided farmers with solid information on IPM options for tomato.

3.12. Tomato yield

Improving tomato yield with low production costs without risks for human health and environmental hazards represent the final goal which should be achieved using IPM options for tomato crop. The results revealed that the tomato yield obtained by FFS participants in the three FFS schools differed significantly. The increase in yield was 266.92%, 49.72% and 50% in Um Dagarsi, Hantoub and Faris respectively (Table 5). The differences in the yield between the three schools are related to the adoption rate of IPM options for tomato in addition to differences in natural conditions and farmer's experience in tomato production. The average yield of FFS-participants is higher than that of non-FFS-participants by 93.24%.

This result agrees with results reported by Ahmed (1997) who found that IPM package for tomato out yielded farmer's traditional practices in Bashkar, Faris and Rahad farmer field schools. Also This result agrees with results reported by Braun et al. (2006) who reported that despite the ongoing debate on the impact of FFS on IPM, the available data resources show a rather consistently positive picture of short and medium term impact with farmers able to improve their agricultural productivity and to increase their leadership role in community based activities.

Table 1. Distribution of farmers according to their education level

Education level	**FFS-Participants**		**Non-FFS participants**	
	No.	%	No.	%
1- Illiterate	10	11.11	15	16.67
2-primary school	15	16.67	22	24.44
3-Intermediate school	25	27.78	29	32.22
4- Secondary school	31	34.44	19	21.11
5-Universty & above	9	10	5	5.56
Total	90	100	90	100

Table 2. Distribution of farmers according to their ages

Age group	**FFS-Participants**		**Non-FFS participants**	
	No.	%	No.	%
1- 20 –35	20	22.22	30	33.33
2- 36 – 50	60	66.67	40	44.45
3- 51 and above	10	11.11	20	22.22
Total	90	100	100	100

4. Conclusion

From this study it can be concluded that the FFS approach is very efficient in the transfer of farm technology for vegetable farmers through their participation in various activities of FFS schools.

4.1. Recommendations

Based on the results of this study and in order to improve the efficiency of FFS approach, the authors recommends the following:

1. FFS approach should become national policy**.**
2. Share authority of extension organizations in control and execution of FFSs activities with farmer unions for more effective participations of clientele in all activities of the schools.
3. More efforts should be exerted in distribution of all inputs to farmers with reasonable prices through various agricultural centres.

Table 3. Distribution of farmers according to their participation in FFS per season

participation in FFS per season	**FFS-Participants**		**Non-FFS participants**	
	No.	%	No.	%
1- Zero	0	00	90	100
2- One season	5	5.56	00	00
3- Two seasons	15	16.67	00	00
4- Three seasons	20	22.21	00	00
5- Four seasons	50	55.56	00	00
Total	90	100	90	100

Table 4. Distribution of farmers according to adoption of recommended IPM package components for tomato

Package components	FFS-Participants				Non-FFS participants				Significance
	Recommended		*Not recommended*		*Recommended*		*Not recommended*		
	No.	%	No.	%	No.	%	No.	%	
1- Land preparation	90	100	00	00	80	88.89	10	11.11	0.00
2- Sowing methods	50	55.56	40	44.44	20	22.22	70	77.78	
3- Fertilizer/ha	87	96.67	03	3.33	60	66.67	30	33.33	
4- Intercropping	62	68.89	28	31.11	35	38.89	55	61.11	
5- Use of soft chemicals	57	63.33	33	36.67	15	16.67	75	83.33	
6- Weed control	78	86.67	12	13.33	10	11.11	80	88.89	
7- Irrigation	90	100	00	00	25	27.78	65	72.22	
8- Stoppage of spraying pesticides at 50 % fruit setting	50	55.56	40	44.44	05	5.56	85	94.44	

Significance level 0.05 or less

Table 5. Tomato yield of FFS participants compared to non-FFS participants

FFS school name	Yield t/ha		
	FFS- participants	*Non-FFS participants*	*% increase*
1- Um Dagarsi	4.88	1.33	266.92
2- Hantoub	5.33	3.56	49.72
3- Faris	2.67	1.78	50
4- All	12.88	6.67	93.10

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