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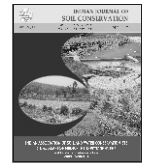

Post-adoption behaviour of farmers towards soil and water conservation technologies of watershed management in Northern Shivalik foothills

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ABSTRACT

The study was undertaken at ICAR-Indian Institute of Soil and Water Conservation Research Centre, Chandigarh from November, 2012 to June 2015 in five watersheds developed by the Centre, with the objectives to study the post-adoption behaviour of farmers regarding watershed technologies. The watersheds selected were (i) Aganpur Bhagwasi (district Patiala, Punjab), (ii) Johranpur (district Solan, Himachal Pradesh), (iii) Mandhala (district Solan, Himachal Pradesh), (iv) Kajiana (district Panchkula, Haryana), and (v) Sabeelpur (district Panchkula, Haryana). The post-adoption behaviour of 225 beneficiary farmers who adopted different Soil and Water Conservation (SWC) technologies for watershed management were studied in detail regarding their present status of continue-adoption, diffusion, dis-adoption and also technological gap. Combining the data for all the five watersheds, it was observed that 79% of the farmers continued to adopt SWC technologies even after withdrawal of the project. Twenty one percent dis-adopted the technologies and 23% were adopting with technological gap. Diffusion of adopted SWC technologies also occurred, and 16% of SWC technologies were diffused to other farmers' fields in nearby areas for natural resource conservation on watershed basis. The analysis revealed that the adoption and spreading of SWC practices is not a technical problem that can only be solved by research, but also a socio-cultural and economic problem, with many constraints playing a role.

1. INTRODUCTION

Transfer of technology is an important aspect of any research system that engages in generation of technologies. However, the onus of the system does not stop at mere transferring of a technology. It is very much imperative to ensure its proper adoption and accomplishment for the purpose for which it was adopted on a longer term. Rogers (1983) was one of the first to measure adoption and he termed adoption process as 'Innovation Decision Process' through which an individual passes from first knowledge of an innovation to forming an attitude towards the innovation, to a decision to adopt or reject, to implement the new technology or idea, and to confirm this decision. In case of an agricultural research system, the situation is still complex as the beneficiaries are farmers and the technologies are adopted in field conditions. They are bound to face varied circumstances in the wake of adopting a technology and continuing it for longer time period (Valera and Plopino, 1987). Post-adoption behaviour is a decision of a farmer regarding whether to continue with an adopted technology with or without a technological gap, or discontinue adoption of another new technology, or his unwillingness to continue with adopted technology (Bagdi, 2015). Post adoption process has two basic components: (1) the continuance/discontinuance decision; and (2) the length of continued use (Black, 1983). Ellis (1988) and Wauters *et al.* (2010) observed that in developing countries the introduction of many new technologies has met with only partial success as measured by observed rates of adoption. Discontinuance is a decision to reject an innovation after it has previously been adopted. When the farmers are satisfied with whatever new technology they have adopted, they are likely to hold on to it; but if they feel that it does not meet their needs, they will discard it (Rogers, 2003). Demake (2003) assessed the factors responsible for discontinuance of SWC technologies and found that small farm size and lack of hired labour explained the majority of discontinuance. The continued use of SWC technologies seemed mainly determined by the actual profitability and the labour requirements for recurrent maintenance and use. Moreover, in villages with better future prospects (where SWC was promoted within an integrated development strategy), farmers also performed better maintenance of their measures and replication rates were higher (De Graaff *et al.*, 2008). If many farmers in a specific project area or village adopt a certain measure, farmers in neighbouring villages may also adopt the measure without project assistance (spontaneous diffusion), as was experienced in Mali (Bodnar *et al.*, 2006).

It is imperative to appraise the behaviour of the farmers with regard to continuance or discontinuance of adopted technologies, diffusion or infusion that took place and technological gaps that occurred in due course etc. The need to examine the adoption of SWC technology options to improve agricultural production becomes imperative in order to evaluate the impact of their uptake by the resource-poor farmers (Olarinde *et al.*, 2012). Therefore, it was realized that the post-adoption behaviour of beneficiary farmers who have adopted different SWC technologies for watershed management should be studied in detail regarding their present status of continue-adoption, diffusion, dis-adoption and also technological gap.

Indian Institute of Soil and Water Conservation (IISWC), Research Centre, Chandigarh has undertaken many watershed projects successfully in the country in the past and implemented many soil and water conservation technologies for watershed management. Therefore, it was realized that the post-adoption behavior of beneficiary farmers who have adopted different soil and water conservation technologies for watershed management should be studied in detail regarding their present status of continue-adoption, dis-adoption, diffusion, infusion, and also technological gap.

2. MATERIALS AND METHODS

Study Area

The study was conducted during 2012-2015 in five watersheds, developed by ICAR-IISWC, Research Centre, Chandigarh. The developed watersheds were selected to study the present condition regarding watershed technologies after passing of few years. Therefore, post-adoption behaviour of beneficiary farmers was studied regarding SWC technologies adopted by them for watershed management. The watersheds selected were (i) Aganpur Bhagwasi (district Patiala, Punjab), (ii) Johranpur (district Solan, Himachal Pradesh), (iii) Mandhala (district Solan, Himachal Pradesh), (iv) Kajiana (district Panchkula, Haryana), and (v) Sabeelpur (district Panchkula, Haryana).

Selection of Respondents

The farmers of selected watersheds who have adopted SWC technologies were selected as respondents in the study. About 26 to 50 respondents were selected from each watershed from all existing categories of farmers. A list of SWC technologies was prepared which were implemented during each watersheds development programme. In addition, technology-wise inventory of respondent farmers who have adopted the technologies was prepared with the help of Detailed Project Report (DPR), as well as by organizing meetings with farmers. The inventory listed names of farmers along with size of land holding and the adopted technology. This information was used to prepare inventories of farmers for all technologies adopted during the watershed development programmes. Stratified proportionate random sampling plan was adopted to select respondents from different inventories or lists of farmers. A detailed structural interview schedule was developed by the investigators, and data regarding personal, psychological and post-adoption behaviour variables were recorded on a structured schedule by interviewing the respondents personally.

Categorization of Respondents

The respondents were separated into three categories in relation to the score data of the variables-continued adoption, discontinuance of technology, technological gap and diffusion towards SWC technologies for watershed management with help of the following criteria:

S.No.	Range of Score	Category
a.	< Minimum Score + CI	Low
b.	> Minimum Score + CI to < Maximum Score - CI	Moderate
c.	> Maximum Score - CI	High

Where, CI is the class interval. Class Interval (CI) was computed using the following formula:

$$CI = \frac{Maximum\ score - minimum\ score}{Number\ of\ classes}$$

Measurement of Post-adoption Behaviour of Farmers

To measure the extent of post-adoption behaviour variables, *viz.*, continued adoption, discontinuance of technology, technological gap and diffusion, a detailed methodology was developed including data collection schedules, scoring procedure and data analysis with following developed indices:

(i) Technology Continue Adoption Index (TCAI)

Out of number of technologies adopted by a group of farmers in the watershed, there is every chance that the particular technology is being continued with the same specifications or with some technological gaps or discontinued completely. When the implementation of a new technology or idea is being continued with the same specifications over a long period of time, it is considered as continued adoption of that technology by a farmer and is explained by given formula:

$$TCAI = \frac{\text{Number of SWC technologies continued to be adopted by a farmer}}{\text{Number of SWC technologies initially adopted by a farmer}}\ x\ 100$$

Overall Technology Continue-Adoption Index (watershed level):

$$Overall\ TCAI = \frac{\sum_{i=1}^{N} TCAI_i}{N}$$

Where, $\sum_{i=1}^{N} TCAI_i$ is the sum total of technology continued adoption indices of i[th] farmer and N is the total number of farmers. The possible range of the index expressed as a percentage is between 0 and 100. The higher value means higher continued adoption.

(ii) Discontinuance of Technology Index (DTI)

This is the percentage of technologies discontinued from the total number of technologies initially adopted by a farmer. This is explained by the given formula:

$$DTI = \frac{\text{Number of SWC technologies discontinued by a farmer}}{\text{Number of SWC technologies initially adopted by a farmer}}\ x\ 100$$

Overall Discontinuance Index (watershed level):

$$Overall\ Discontinuance\ \ Index = \frac{\sum_{i=1}^{N} DTI_i}{N}$$

Where, $\sum_{i=1}^{N} DTI_i$ is the sum total of discontinuance of technology indices of i[th] farmer and N is the total number of farmers. The possible range of the index expressed as a percentage is between 0 and 100. The higher value means higher discontinuance.

(iii) Technology Gap Index (TGI)

This index pertains to continuing with a technology, but the adoption is not of the complete technology *i.e.* with a technological gap. The score for the gap in each technology was given by the experts of respective fields by examining the technology and the magnitude of the technological gap. This was done for the technologies so adopted by a farmer. Each farmer's score regarding technological gap was estimated as follows:

$$TGI = \frac{\sum_{i=1}^{N}\left[\frac{R-A}{R}\right]}{N} X\,100$$

Where, R is the maximum possible score on complete adoption of a technology as per the suitable design in the watershed (*i.e.* 10), A is the score obtained by a beneficiary farmer on his incomplete adoption of a technology, and N is the total number of technologies adopted. The possible range of the index expressed as a percentage is between 0 and 100. Higher value means higher technological gap.

Overall Technological Gap Index (watershed level):

$$\text{Overall Technological Gap Index} = \frac{\sum_{i=1}^{K} TGI_i}{K}$$

Where, $\sum_{i=1}^{N} TGI_i$ is the sum total of technological gap indices of i^{th} farmer and K is the total number of farmers.

(iv) Technology Diffusion Index (TDI)

Diffusion signifies group phenomena, which suggests how an innovation (technology in this case) spreads outside. Diffusion of technological innovations has been defined as the spread of 'successful' innovations as they combine with or displace existing 'inferior' alternatives (Sarkar, 1998). Thus, diffusion is concerned with the extent (spatially and temporally) to which the new innovation is put to productive use. Early adopters are often referred to as innovators, and diffusion process as the spread of the innovation to other members of the population (Feder and Umali, 1993). The index is explained by the below given formula:

$$TDI = \frac{\text{Number of SWC technologies diffused by a farmer}}{\text{Number of SWC technologies initially adopted by a farmer}} \times 100$$

The possible range of index expressed as a percentage is between 0 and 100. High value means higher diffusion.

Overall Technology Diffusion Index (watershed level):

$$\text{Overall Technology Diffusion Index:} \ \frac{\sum_{i=1}^{N} TDI_i}{N}$$

Where, $\sum_{i=1}^{N} TDI_i$ is the sum total of technology diffusion indices of i^{th} farmers and N is the total number of farmers.

3. RESULTS AND DISCUSSION

Levels of Continue Adoption of SWC Technologies by Farmers

The data in Table 1 shows the levels of continued adoption of SWC technologies by farmers in the watersheds developed by ICAR-IISWC, Research Centre, Chandigarh. It was revealed that the majority of farmers have continued the adopted SWC technologies at a medium level at Mandhala (58%) and Aganpur-Bhagwasi (56%) and Kajiana (50%) watersheds, whereas the majority of farmers (53.07%) have continued adopted SWC technologies at low level at Sabeelpur. Less than 27% of farmers have continued the adopted SWC technologies at high levels in their fields for natural resource conservation in all the watersheds developed by the Centre. The overall pooled data revealed that a maximum 49.33% of farmers have continued adopted SWC technologies at medium level for natural resource conservation for sustainable management of watersheds. Similarly, 33.77% of farmers have also continued adopted SWC technologies at a low level, and only 16% of farmers have continued adopted SWC technologies at a high level for SWC in various watersheds developed by the Centre.

Levels of Discontinuance of SWC Technologies by Farmers

The data in Table 2 presents the level of discontinuance of SWC technologies by farmers in selected watersheds. The majority of farmers have discontinued technologies at Aganpur (70%), Mandhala (64%) and Kajiana (54%) watersheds at a low level, while a majority of farmers discontinued SWC technologies at Sabeelpur (53%) at moderate level. A very few farmers have discontinued SWC technologies at a high level from their fields. The overall pooled data revealed that more than fifty percent of farmers have discontinued SWC

Table: 1
Levels of continued adoption of SWC technologies by farmers (TCAI) in selected watersheds (N =225)

Level of continued adoption of SWC technologies	Percentage farmers in different watersheds					
	Aganpur Bhagwasi N=50	Johranpur N=26	Mandhala N=50	Kajiana 50	Sabeelpur N=49	Pooled N=225
Low	10 (20.0)	9 (34.6)	11 (22.0)	20 (40.0)	26 (53.1)	76 (33.8)
Medium	28 (56.0)	10 (38.5)	29 (58.0)	25 (50.0)	19 (38.8)	111 (49.3)
High	12 (24.0)	7 (26.9)	10 (20.0)	5 (10.0)	4 (8.2)	38 (16.9)

The data in parentheses indicate percentage to respective N value

Table: 2
Levels of discontinuance of SWC technologies by farmers (DIT) in selected watersheds (N = 225)

Level of continued adoption of SWC technologies	Percentage farmers in different watersheds					
	Aganpur Bhagwasi N=50	Johranpur N=26	Mandhala N=50	Kajiana 50	Sabeelpur N=49	Pooled N=225
Low	35 (70.0)	12 (38.9)	32 (64.0)	27 (54.0)	18 (36.7)	124 (54.2)
Medium	12 (24.0)	10 (38.5)	13 (26.0)	19 (38.0)	26 (53.1)	80 (35.4)
High	3 (6.0)	4 (15.4)	5 (10.0)	4 (8.0)	5 (10.2)	21 (10.4)

The data in parentheses indicate percentage to respective N value

technologies at a low level. About one-third (35%) of the farming population discontinued SWC technologies at a moderate level and only 10.4% of farmers discontinued SWC technologies at a high level due to non-suitability to their field conditions or inability to continue the adopted technologies in various watersheds.

Levels of Technological Gap in SWC Technologies Adopted by Farmers

A particular SWC technology comprises a set of components, parameters of a design or package of practices, which should be adopted together at farmers' fields for better results. Sometimes the SWC technologies adopted by farmers at their farms do not give similar results in village situation as compared to results at experimental farm. It means there is gap in technology developed at experimental farms and the technology adopted by farmers in their fields. The reason may be that the farmers are not adopting the technologies as per the recommended parameters or components for a particular technology. The data presented in Table 3 indicated that the majority of farmers have adopted SWC technologies with a technological gap at a low level at Mandhala (74%) and Aganpur-Bhagwasi (72%). The majority of farmers of Kajiana and Johranpur watersheds adopted SWC technologies with technological gap at a medium level. About 57% of the farmers in Sabeelpur watershed adopted SWC technologies with a gap at a high level. The overall pooled data revealed that 45% of farmers adopted SWC technologies with a technological gap at a low level, 33% at medium level and only 22% adopted SWC technologies with technological gap at a high level in the five watersheds developed by the centre.

Levels of Diffusion of SWC Technologies by Farmers

It was observed from the levels of diffusion that a majority of farmers of Johranpur (54%), Kajiana (62%), Sabeelpur (72%) and Bhagwasi (78%) watersheds diffused SWC technologies at a low level, while the majority (50%) of farmers of Mandhala diffused SWC technologies at a moderate level from their fields to other farmers' fields for natural resource conservation from the watersheds developed by the Centre (Table 4). Similarly, the overall pooled data also revealed that a majority (63%) of farmers diffused SWC technologies at low level, followed by 28% at moderate level, and 9% farmers diffused SWC technologies at a high level from the watersheds developed by the Centre to other farmers' fields for soil and water conservation.

Post-adoption Behaviour of Farmers towards SWC Technologies

The data in Table 5 revealed the extent of post-adoption behaviour of farmers towards different SWC technologies implemented during various watershed development programmes carried out by

Table: 3
Levels of technological gap of SWC technologies by farmers (TGI) in selected watersheds (N =225)

Level of continued adoption of SWC technologies	Percentage farmers in different watersheds					
	Aganpur Bhagwasi N=50	Johranpur N=26	Mandhala N=50	Kajiana 50	Sabeelpur N=49	Pooled N=225
Low	36 (72)	7 (26.9)	37 (74)	12 (24)	9 (18.4)	101 (44.9)
Medium	10 (20)	15 (57.7)	8 (16)	30 (60)	12 (24.5)	75 (33.3)
High	4 (8)	4 (15.4)	5 (10)	8 (16)	28 (57.1)	49 (21.8)

The data in parentheses indicate percentage to respective N value

Table: 4
Levels of diffusion of SWC technologies by farmers (TDI) in selected watersheds

Level of continued adoption of SWC technologies	Percentage farmers in different watersheds					
	Aganpur Bhagwasi N=50	Johranpur N=26	Mandhala N=50	Kajiana 50	Sabeelpur N=49	Pooled N=225
Low	39 (78)	14 (54)	22 (44)	31 (62)	36 (72)	142 (63)
Medium	6 (12)	9 (35)	25 (50)	14 (28)	9 (18)	63 (28)
High	5 (10)	3 (21)	3 (6)	5 (10)	4 (8)	20 (9)

The data in parentheses indicate percentage to respective N value

Table: 5
Extent of post-adoption behaviour of farmers towards SWC technologies in selected watersheds

Extent of post-adoption behaviour of farmers	Number of farmers at different watersheds					
	Aganpur Bhagwasi N=50	Johranpur N=26	Mandhala N=50	Kajiana 50	Sabeelpur N=49	Pooled N=225
TCAI	75.4	70.2	88.1	78.6	65.7	79.1
DTI	24.6	19.8	10.8	21.8	34.3	20.8
TGI	26.1	12.2	16.2	18.9	30.3	22.8
TDI	9.4	18.3	22.7	14.8	8.6	15.7

the Centre. The TCAI values were maximum for Mandhala watershed which meant that more than 88% of SWC technologies were continued to be adopted by farmers in this watershed followed by Kajiana (78.6%), Aganpur (75.4%) and Johranpur (70.2%). The pooled TCAI value also showed that overall 79% of SWC technologies were continued to be adopted by farmers in the watersheds developed by the Centre for the cause of natural resources conservation. According to DTI values, less than 25% of SWC technologies were discontinued or dis-adopted by farmers in the selected watersheds, except Sabeelpur (34%). Woldeamlak (2007) also reported that major factors that discouraged farmers from adopting introduced SWC technologies on their farms were observed to be labour shortage, land tenure insecurity, and problem of fitness of the technologies to the farmers' requirement and to the farming system circumstances. Regarding TGI, it was observed that less than one-fifth of SWC technologies were adopted along with technological gap by the farmers in the selected watersheds, except Sabeelpur (30%) and Aganpur Bhagwasi (26%). The overall pooled TGI data also revealed similar findings. About 22% of SWC technologies were adopted with a technological gap by farmers out of the total continuously adopted technologies in the selected watersheds. Diffusion of SWC technologies was also evaluated using the Technology Diffusion Index (TDI) and it indicated that less than 18% of SWC technologies were diffused to other farmers' fields in nearby areas from the fields of farmers who had adopted SWC technologies during the watershed development programs, except from Mandhala. Similarly, the overall pooled TDI data also revealed a similar condition. About 16% of SWC technologies were diffused to other farmers' fields in nearby areas from the watersheds developed by the Centre for the cause of soil and water conservation on watershed basis.

4. CONCLUSIONS

The study results showed that 79% of SWC technologies were continuously adopted by beneficiary farmers in watersheds developed by ICAR-IISWC, Research Centre, Chandigarh in the region for the cause of natural resources conservation. The farmers discontinued 21% of SWC technologies from their fields in the watersheds, which means that 79% of SWC technologies were continuously adopted by beneficiary farmers in these watersheds. It was also revealed that 23% of SWC technologies were adopted with a technological gap by farmers in the watersheds. The diffusion of adopted SWC technologies also occurred, and 16% of SWC technologies were diffused to other farmers' fields in nearby areas for natural resource conservation on a watershed basis. Therefore, it can be concluded from the study that in the government sponsored watershed development programmes, about three-fourth of SWC technologies were continuously adopted for natural resources conservation and about one-fourth of technologies were discontinued due to the non-suitability or the inability of farmers to continue with the technologies. Out of the total continuously adopted technologies, about one-fifth of the technologies were adopted with a technological gap. About one-fourth of technologies were also diffused in fields of areas nearby to the developed watersheds through farmers' efforts. The study suggests that simply demonstrating technologies that improve productivity or have soil conservation value may be insufficient. Majority of farmers continued adopting the SWC structures implemented during watershed development projects with technological gap due to lack of proper maintenance by beneficiary farmers because of their poor economic condition. The majority of farmers suggested that the subsidy should also be provided to farmers for maintenance of structures or financial provision should be made in planning of watershed projects for future maintenance of structures (Kessler, 2006). Understanding farmer specific characteristics and behavior as well as production environment where farmers operate is an essential requirement before dissemination of any SWC technology at farm level for higher adoption. The adoption and spreading of SWC practices is not a technical problem that can only be solved by research, but also a socio-cultural and economic problem, with many constraints playing a role.

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