Factors for Continue Adoption of Soil and Water Conservation Technologies for Watersheds Management in India

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ABSTRACT

The Indian Institute of Soil and Water Conservation (IISWC) and its research Centres have developed successfully many model watersheds in India in the past and implemented large number of Soil and Water Conservation (SWC) technologies for sustainable management of watersheds. Though many evaluation studies regarding hydrology and crop production have been conducted on these watershed projects in the past, assessment of continue adoption of SWC technologies has not been done. This research study was conducted during 2012-15 as core project at Vasad as lead centre along with IISWC headquarter Dehradun, and Centres Agra, Bellary, Chandigarh, Datia, Kota & Ooty, with the specific objective to measure the extent of continue adoption behaviour of farmers towards adopted SWC technologies and also ascertain the factors responsible for their continuance for watershed management. Data collection schedule was developed along with indices for measurement of continue adoption behaviour of farmers towards SWC technologies. Proportionate stratified random sampling plan was adopted for selection of at least 50 respondent farmers from selected 38 watersheds in the country and data collection was done through personal interview method. The study revealed that about three-fourth (73%) SWC technologies continued adopted by farmers of watersheds developed by IISWC and its centres in the country. It was also revealed that farmers continued adopted bunding (62.7%), land leveling (37.1%), terracing (29.3%), check dam (22.8%), gully plug (11.2%) and pond (6.2%) technologies by beneficiary farmers in their fields for sustainable management of watersheds. Reduction in runoff & soil loss, ground water recharge and more yield were the most important reasons for continued adoption of these SWC technologies for sustainable management of the watersheds developed by IISWC and its Centres in the country.

Key words: *Continue adoption, Soil and Water Conservation Technology, Watershed management*

IISWC is premier institute of Indian Council of Agricultural Research (ICAR), Government of India, engaged in research and extension activities on soil and water conservation. IISWC has developed many watershed projects successfully in India and implemented many soil and water conservation technologies for watershed management. Task of a national level institute does not stop at mere transferring the SWC technologies, it is very much imperative to ensure its proper adoption and accomplishment of the purpose for which it was adopted on a longer term. 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 on longer time period. The findings of this research study would provide a sight in reasons behind the continued adoption of SWC technologies or their discontinuance are some of the vital sources for policy makers to suggest their strategic solutions for watershed programmes.

Adoption is "the mental process an individual passes from first hearing about an innovation to its final adoption" (Rogers, 1995). He also opined that 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 and Shoemaker (1971), considered the adoption process as a learning process, often influenced by group dynamics and involving four stages in the awareness, evaluation, trial and the adoption. Van Tongeren (2003) investigated the discontinuance of farming innovations and found that the end of subsidies and educational programming explained the majority of discontinuance. It is believed that an effective way to increase productivity is broad-based adoption of new farming technologies (Minten and Barrett, 2008). Adoption of improved technologies will not improve food security and reduce poverty if barriers to their continued use are not overcome (Oladele, 2005). Discontinuance is a decision to reject an innovation after it has previously been adopted (Rogers, 2003). He also reported two types of technology discontinuance are (1) replacement discontinuance is a decision to reject an idea in order to adopt a better idea that supersedes it and (2) disenchantment discontinuance is a decision to reject an idea as a result of dissatisfaction with its performance. Leuthold (1967) concluded from his study of a statewide sample of Wisconsin farmers that the rate of discontinuance was just as important as the rate of adoption in determining the level of adoption an innovation at any particular time. In any given year, there were about as many discontinuers of an innovation as there were first-time adopters.

Continue adoption is the decision of farmer to continue with an adopted technology with or without technological gap. De Graaff et al. (2005) divided the process of technology adoption into three phases: acceptance, actual adoption, and continued use. De Graaff et al. (2008) revealed that the continued use of SWC technologies seemed mainly determined by the actual profitability and, related to that, the labour requirements for recurrent maintenance and use. Moreover, in villages with better future prospects (where SWC technologies were promoted within an integrated development strategy) farmers also performed better maintenance of their measures and replication rates were higher. Posthumus, (2005) reported that SWC measures might simply not be profitable for the farmer, because of too high investment costs and too low benefits. In these cases, incentives will be needed if SWC measures are to be promoted (from public point of view) or the benefits should be increased by combining SWC measures with high-value crops and improved market access. Amsalu et al. (2007) reported SWC interventions should consider not only the biophysical performance of the measures but also economic returns to investments at reasonable discount rates in order to enhance sustained use of the measures. IISWC and its Centres have developed many watershed projects successfully in India since last six decades and implemented many SWC technologies for watershed management. Therefore, it was realized that the continue adoption behaviour of beneficiary farmers who have adopted different SWC technologies for watershed management should be studied in detail. The present study addresses the following three questions:

- What is the extent of continued adoption of SWC technologies in watersheds developed by IISWC and its Centres in India?
- What are the SWC technologies continued adopted in the watersheds developed by IISWC and its Centres in India?
- What are the factors responsible for continued adoption of SWC technologies in the watersheds developed by IISWC and its Centres in India?

METHODOLOGY

Study area : he research study was carried out during 2012-15 in eight states of India as a core project at the Indian Institute of Soil and Water Conservation (IISWC), Research Centre, Vasad, (Gujarat) as lead centre along with IISWC headquarter Dehradun, Uttrakhand state, and its centres viz., Agra (Uttar Pradesh), Bellary (Krnataka), Chandigarh (Haryana), Datia (Madhya Pradesh), Kota (Rajasthan) & Ooty (Tamil Nadu). The already developed watersheds by IISWC and its Centres that were at least three years old after completion were selected for the study, 4 or 5 watersheds were selected at each centre. A total of 38 watersheds were selected from eight research centres of IISWC in India as given below (Table 1).

Table 1
Centre-wise selected watersheds and number of respondents

Sr. No.	Name of Centre	Name of selected watersheds with number of respondents	Total Respondents
1.	Vasad	Navamota (50), Rebari (50), Sarnal (50), Antisar (50),Vejalpur-Rampura (50)	250
2.	Agra	Etmatpur (50), Boman (50), Raghupur (50), Jalalpur (50)	200
3.	Bellary	Joladarasi (50), Chinnatekur (50), PC Pyapli (54), Mallapuram (54),Chilakanahatti (58)	266
4.	Chandigarh	Aganpur-Bhagwasi (50), Mandhala (49), Johranpur (26), Sabeelpur (50),Kajiana (50)	225
5.	Datia	Bajni (50), Jigna (50), Kalipahari (50), Agora (50), Durgapur (50)	250
6.	IISWC, Dehradun	Fakot (50), Raipur (50), Sabhawala (51), Langha (60)	211
7.	Kota	Chhajawa (50), Badakhera (50), Haripura (50), Hanotiya (50), SemliGokul(50)	250
8.	Ooty	Salaiyur (50), Chikkahalli (50), Eramanaikkanpatti (50), Putthuvampalli (50), Thulukkamuthur (50)	250

Note : *The data in parentheses are number of farmers selected in a watershed*

Selection of respondents: The farmers of selected watersheds who have adopted soil and water conservation technologies were selected as respondents in the study. At least 50 respondents were selected from each watershed from all the existing categories (marginal, small, medium and large size of land holding farmer) of farmers in the watershed. A list of all SWC technologies was prepared which were implemented during development of each watershed project. A SWC technology-wise inventory of respondent farmers was prepared, who have adopted the technology with the help of Detail Project Report (DPR) or by organizing meetings with farmers. The inventory of each technology listed the names of farmers with size of land holding. This procedure was used to prepare inventories of farmers for all the technologies adopted during development of each watershed project. A proportionate stratified random sampling plan was adopted to select respondents from different inventories or lists of farmers. At least 50 respondents were selected from each watershed, from all the existing categories of farmers in the watershed. Thus, in total 1902 respondent farmers were selected from 38 watersheds. A structured data collection schedule was developed by the investigators. Data regarding personal, psychological and continue adoption behaviour variables were recorded on the schedule by interviewing the respondent farmers personally. Data regarding age, education, occupation, family type, size of land holding, animal types & quantity, income per annum, type of house, materials possession, agricultural implements and equipments, social participation, economic motivation, mass media exposure etc. were included in personal variables. Scientific orientation, innovativeness, risk taking ability, knowledge of farmers towards soil & water conservation and attitude of farmers towards participation in watershed programme were included in psychological variables. These variables were studied with help of standardized structured schedules and responses of respondents were recorded on different continua. The data of personal and psychological variables were analyzed using descriptive statistics. A structured schedule was also developed to study the variable continue adoption of SWC technologies and reasons for continue adoption. The responses of the respondents were recorded on open ended questions. The data were analyzed using the developed Technology Continue Adoption Index (TCAI) to measure the extent of continue adoption of SWC technologies in watersheds developed by IISWC and its Centres.

Measurement of continue adoption of SWC technologies by farmers : To measure the extent of continue adoption of SWC technologies by farmers the following indices were developed:

(i) Technologies Continue Adoption Index (TCAI) : Number of SWC technologies continued adopted by a farmer out of total initially adopted technologies and it could be worked as given below:

$$TCAI = \frac{\text{number of SWC technologies continued adopted by a farmer}}{\text{number of SWC technologies initially adopted by a farmer}} \times 100 \quad \text{........... (1)}$$

Overall Technologies Continue Adoption Index (OTCAI) : (Watershed Level)

$$OTCAI = \frac{\sum_{=}^{N} TCAI_i}{N} \quad \text{................ (2)}$$

where,

$\sum_{=} TCAI_i =$ sum total of technology adoption indices of i^{th} farmers

N = Total number of farmers

(ii) Particular Technology Continue Adoption Index (PTCAI) : Number of farmers continued adopted a particular SWC technology out of total initially adopted farmers in a watershed area and it could be worked out technology - wise for different SWC technologies as given below :

$$PCTAI = \frac{\text{number of farmers continued adopted a particular SWC technology}}{\text{number of SWC technologies initially adopted by a farmer}} \times 100 \quad \text{...... (3)}$$

Overall Particular Technology Continue Adoption Index (OPTICAI) : It could be worked on large area or region basis including all watersheds for a particular SWC technology as given below :

$$OTCAI = \frac{\sum_{=} TCAI_i}{N} \quad \text{................ (4)}$$

where,

$\sum_{=} TCAI_i =$ sum total of particular technology continue adoption indices of i^{th} watersheds

N = Total number of watersheds in a area or region.

RESULTS AND DISCUSSION

Extent of continue adoption of SWC technologies: The study has attempted to empirically measure the extent of continue adoption of SWC technologies by farmers in watersheds developed by IISWC and its centres in the country with the help of Overall Technology Continue Adoption Index (OTCAI) developed by authors. Table 2 shows the data regarding OTCAI and found that more than ninety per cent of SWC technologies continued adopted by farmers in Antisar (95.4%) and Rebari (92.5%) watersheds and followed by about three-fourth (74.2%) of SWC technologies continued adopted by farmers of Navamota watershed. More than two-third of SWC practices continued adopted by farmers in Vejalpur (70.3%) and Sarnal (66.1%) watersheds developed by research centre Vasad. Further, the average OTCAI value shows that more than three-fourth (79.7%) of SWC practices continued adopted by farmers in these five watersheds developed by research centre Vasad in Gujarat state.

At IISWC Dehradun, the OTCAI data revealed that above eighty per cent (84.7%) of SWC technologies continued adopted by farmers in Sabhawala watershed and majority (59.7%) of SWC technologies continued adopted by farmers in Langha watershed. More than forty per cent of SWC practices continued adopted by farmers in Raipur (47.15%) and Fakot (44.43%) watersheds. The average OTCAI value revealed that 59% of SWC practices continued adopted by farmers in these four watersheds developed by IISWC, Dehradun in Uttrakhand state of India.

The Table 2 also shows that more than eighty per cent of SWC technologies still continued adopted by farmers in Mandhala (89%), Kajiyana (86.5%) and Sabeelpur (83.8%) watersheds, followed by three-fourth (75.4%) of SWC technologies continued adopted by farmers in Aganpur Bhagwasi watershed and more than two-third (70.8%) of SWC practices continued adopted by farmers in Johranpur watershed developed by research centre Chandigarh in Haryana state. The average OTCAI data show that more than three-fourth (81.1%) of SWC practices still continued adopted by farmers for natural resource conservation in these five watersheds developed by research centre Chandigarh in Haryana state.

OTCAI data revealed that majority more than ninety per cent of SWC technologies continued adopted by farmers in Chilakanahatti (98.40%) and Mallapuram (91%) watersheds, followed by more than three-fourth of SWC technologies continued adopted by farmers in PC Pyapli (82.69%) and Joladarasi (79.6%) watersheds, and 61.5% of SWC technologies continued adopted by farmers in Chinnatekur watershed developed by research centre Bellary. The average OTCAI value shows that more than eighty (82.82%) per cent of SWC technologies continued adopted by farmers for sustainable management of these five watersheds developed by research centre Bellary in Karnataka state.

It was determined that 97% of SWC technologies still continued adopted by farmers in Haripura watershed. More than eighty per cent of SWC technologies were continued adopted by farmers in Chhajawa (88.8%) and Badakheda (86.4%) watersheds, followed by more than two-third of SWC practices continued adopted by farmers in Semli Gokul (71%) watershed and 50% of SWC technologies continued adopted by farmers in Hanotiya watershed developed by research centre, Kota. The average OTCAI revealed that more than three-fourth (78.7%) of SWC technologies continued adopted by farmers for sustainable management of these five watersheds developed by research Centre Kota in Rajasthan state.

At research centre Agra, it was found that majority more than fifty per cent of SWC technologies continued adopted by farmers in Etmatpur (56.6%), Boman (53.9%) and Jalalpur (53.1%) watersheds and followed by 49.3% of SWC practices still continued adopted by farmers in Raghupur watershed. Similarly, the average of OTCAI also shows 53.2% of SWC practices continued adopted by farmers in these four watersheds developed by research centre Agra in Uttar Pradesh state.

The OTCAI data in Table 2 indicate that majority more than ninety percent of SWC technologies still continued adopted by farmers in Thulukkamuthur (97.9%) and Putthuvampalli (94.27%) watersheds, followed by more than three-fourth of SWC technologies continued adopted by farmers in Sailyur (83.2%), Chikkahali (81%) and Eramanaikkanpatti (78.9%) watersheds for their sustainable management at research centre Ooty. The average OTCAI revealed 87.1% of SWC practices continued adopted by farmers for sustainable management of these five watersheds developed by research centre Ooty in Tamil Nadu state of the country.

The OTCAI data revealed that majority more than three-fourth of SWC technologies continued adopted by farmers in Durgapur (68.5%) watershed. More than sixty per cent of SWC technologies continued adopted by farmers in Agora (63.0%), Kalipahari (62.9%) and Jigna (62.6%) watersheds. Followed by 57% of SWC practices continued adopted by farmers in Bajni watershed. Similarly, the average OTCAI value shows that 62.8% of SWC practices continued adopted by farmers for sustainable natural resource conservation in these five watersheds developed by research centre Datia in Madhya Pradesh state.

The overall extent of continued adoption of SWC technologies in the watersheds developed by IISWC and its research centres was studied with help of average of OTCAI values of all the centres and it was measured 73 per cent of SWC technologies still continued adopted by farmers for sustainable management of different watersheds developed by IISWC and its centres in the country under government sponsored programmes.

Table 2
Extent of continue adoption of SWC technologies by farmers in different watersheds projects implemented by IISWC and its research centres in India

n = 1902

Sr. No.	Name of research Centre	Name of watersheds	Overall Technologies Continue Adoption Index (OTCAI)	OTCAI average
1.	RC, Vasad, Gujarat	Navamota (n=50)	74.2	79.7
		Rebari (n=50)	92.5	
		Saranal (n=50)	66.1	
		Antisar (n=50)	95.4	
		Vejalpur (n=50)	70.3	
2.	IISWC, Dehradun, Uttrakhand	Fakot (n=50)	44.4	59.0
		Raipur (n=50)	47.2	
		Sabhawala (n=51)	84.7	
		Langha (n=60)	59.7	
3.	RC, Chandigarh, Haryana	Aganpur Bhagwasi (n=50)	75.4	81.1
		Mandhala (n=49)	89.0	
		Johranpur (n=26)	70.8	
		Sabeelpur (n=50)	83.8	
		Kajiyana (n=50)	86.5	

4.	RC, Bellary, Karnataka	Joladarasi (n=50)	79.6	82.8
		Chinnatekur (n=50)	61.5	
		PC Pyapli (n=54)	82.7	
		Mallapuram (n=54)	91.0	
		Chilakanahatti (n=58)	98.4	
5.	RC, Kota, Rajasthan	Chhajawa (n=50)	88.8	78.7
		Badakheda (n=50)	86.4	
		Haripura (n=50)	97.0	
		Hanotiya (n=50)	50.0	
		Semli Gokul (n=50)	71.0	
6.	RC, Agra, Uttar Pradesh	Etmatpur (n=50)	56.6	53.2
		Boman (n=50)	53.9	
		Raghupur (n=50)	49.3	
		Jalalpur (n=50)	53.1	
7.	RC, Ooty, Tamil Nadu	Salaiyur (n=50)	83.2	87.1
		Chikkahali (n=50)	81.0	
		Eramanaikkanpatti (n=50)	78.9	
		Putthuvampalli (n=50)	94.3	
		Thulukkamuthur (n=50)	97.9	
8.	RC, Datia, Madhya Pradesh	Bajni (n=50)	57.0	62.8
		Jigna (n=50)	62.6	
		Kalipahari (n=50)	62.9	
		Agora (n=50)	63.0	
		Durgapur (n=50)	68.5	
	Overall			**73.0**

Continue adoption status of important SWC technologies: IISWC and its research centres implemented various SWC technologies for development of various watersheds in India in past. The most important soil and water conservation technologies continued adopted by majority of farmers were bunding, check dam, land leveling, pond, gully plug and terracing. The Overall Particular Technology Continue Adoption Index (OPTCAI) data in table 3 show extent of continued adoption of these SWC technologies in watersheds developed by IISWC and its centres in India. The OPTCAI data revealed that overall majority 62.7 per cent farmers continued adopted bunding technology in their fields for sustainable management of watersheds, while the bunding technology was initially adopted by 71 per cent farmers during watershed development projects. Land leveling technology continued adopted by 37.1 per cent farmers whereas 42.7 per cent farmers adopted it initially during implementation of watershed projects by IISWC and its centres in the country. Terracing technology continued adopted by 29.3 per cent farmers but initially it was adopted by 35.2 per cent farmers. Check dam technology continued adopted by 22.8 per cent farmers but during implementation of watershed projects it was adopted by 25.4 per cent farmers in their fields. Gully plug technology was continued adopted by 11.2 per cent farmers whereas 14.2 per cent farmers initially adopted it. 6.2 per cent farmers continued adopted pond technology but 6.8 per cent farmers initially adopted it during development of various watersheds by IISWC and its centres in India. Woldeamlak Bewket (1998) found that majority of the surveyed farmers have stated that they have intentions to maintain the conservation structures as part of their regular farming practices once the external intervention is withdrawn.

Table 3
Extent of continue adoption of most adopted SWC technologies by farmers in different watershed projects implemented by IISWC and its research centres in India

Sr. No.	Name of Technologies continue adopted in watersheds	Overall Particular Technology Continue Adoption Ind ices (OPTCAI)								OPTCAI average
		Vasad	Dehradun	Chandigarh	Bellary	Kota	Agra	Ooty	Datia	
		Navamot-a, Rebari, Sarnal, Antisar, Vejalpur (N=250)	Fakot, Raipur, Sabha-wala, Langha (N=211)	Aganpur Bhagwasi, Mandhala, Johranpur, Sabeelpur, Kajiyana (N=225)	Joladarasi, Chinnate-kur, Pyapli, Mallapu-ram, Chilaka-nahatti (N=266)	Chhajawa, Badakhe-da, Haripura, Hanotiya, Semli Gokul (N=250)	Etmatpur, Boman, Raghupur, Jalalpur (N=200)	Salaiyur, Chikkaha-li, Ermanai-kkanpatti, Patthuva-mpalli, Thulukk-amuthur (N=250)	Bajni, Jigna, Kalipa-hari, Agora, Durga-pur (N=250)	
1.	**Bunding**	60 (61.5)	-	46.3 (46.3)	-	65.2 (86)	85 (97.5)	75 (79)	44.8 (56)	62.7 (71.0)

2.	Check Dam	18.8 (22)	-	19.5 (22.5)	33.8 (34.7)	46 (48)	20 (22)	12 (16)	9.6 (12.8)	22.8 (25.4)
3.	Land Leveling	33.5 (34)	-	-	56 (56)	37 (37.5)	40.5 (63)	23 (23)	32.4 (42.4)	37.1 (42.7)
4.	Pond	5 (6)	-	-	8.0 (10.4)	5 (5)	4 (4)	11.5 (11.5)	3.6 (4)	6.2 (6.8)
5.	Gully Plug	12.5 (19.5)	12 (14)	-	-	9 (9)	-	-	-	11.2 (14.2)
6.	Terracing	7 (7)	76 (86)	-	-	-	5 (12.5)	-	-	29.3 (35.2)

Note: Figures presented in parentheses are the percentages of farmers adopted the technologies earlier at the time of implementation of watershed project.

Reasons for continued adoption of bunding technology : The pooled data in Table 4 show that majority (54.5%) of farmers continued adopted bunding technology because it reduces runoff and soil loss in watersheds developed by regional research Centres of IISWC in the country. The second important reason was moisture conservation as perceived by 47.4 per cent farmers of different watersheds. The third important reason was more yield due to continued adoption of bunding as perceived by 32.2 per cent farmers in all the selected watersheds. Increase in infiltration was considered as fourth important reason by 12.8% farmers. Due to bunding no runoff of manure & fertilizer, make land more level and silt deposition were other important reasons for continued adoption of it as considered by 9.4, 9 and 5.8 per cent farmers respectively in the watersheds developed by regional research centres of IISWC in the country.

Table 4
Reasons for continue adoption of bunding as perceived by farmers of selected watersheds at different centres of IISWC

Sr. No.	Reasons for continue adoption of bunding technology	Number of farmers in watersheds developed by Centres of IISWC						Pool
		Vasad	Chandigarh	Bellary	Kota	Agra	Ooty	
		Antisar (N=200)	Mandhala, Johranpur, Sabeelpur (N=175)	Pyapli, Mallapuram, Chilakanahatti (N=266)	Haripura, Hanotiya, Semli Gokul (N=250)	Raghupur, Jalalpur (N=200)	anpatti (N=100)	
1.	Moisture Conservation	65 (32.5)	88 (50.3)	157 (59.0)	45 (18.0)	149 (74.5)	61 (61.0)	565 (47.4)
2.	To reduce run off and soil loss	78 (39.0)	95 (54.3)	145 (54.5)	94 (37.6)	182 (91.0)	55 (55.0)	649 (54.5)
3.	No runoff of manure & fertilizer	17 (8.5)	41 (23.4)	3 (1.1)	-	-	9 (9.0)	70 (9.4)
4.	More yield	35 (17.5)	127 (72.6)	45 (16.9)	9 (3.6)	129 (64.5)	38 (38.0)	383 (32.2)
5.	Makes land level	19 (9.5)	-	15 (5.6)	-	-	17 (17.0)	51 (9.0)
6.	Silt deposition	2 (1.0)	30 (17.1)	5 (1.9)	-	-	-	37 (5.8)
7.	More infiltration	21 (10.5)	48 (27.4)	13 (4.9)	-	-	13 (13.0)	95 (12.8)

Note : The data in parentheses are in percentage

Reasons for continued adoption of check dam technology : The pooled data in Table 5 show that one-fifth (20.7%) of farmers continued adopted check dam in their fields for water harvesting. Similarly, runoff control was also considered important reason for continued adoption of check dam by one-fifth (20.2%) of farmers. Ground water recharge and improve water table in wells were the other important factors for continued adoption of check dam technology by 4.9 and 2.9 per cent farmers respectively in their fields in the watersheds developed by research centres of IISWC in the country.

Table 5
Reasons for continue adoption of check dam as perceived by farmers of selected watersheds at different centres of IISWC

Sr. No.	Reasons for continue adoption of check dam technology	Number of farmers in watersheds developed by Centres of IISWC							Pool
		Vasad	Dehradun	Chandigarh	Bellary	Kota	Agra	Ooty	
		Navamota, Rebari, Sarnal, Antisar, Vejalpur (N=250)	Sabhan-wala (N=51)	Aganpur Bhagwasi, Mandhala, Sabeelpur (N=149)	Pyapli, Mallapu-ram, Chilaka-nahatti (N=166)	Chhajawa, Badakheda, Haripura, (N=150)	Boman (N=50)	Salaiyur, Ermanaikk-anpatti, -palli, Thulukkam-uthur (N=200)	
1.	Water harvesting	24 (9.6)	-	94 (63.1)	9 (5.4)	52 (34.7)	-	10 (5.0)	189 (20.7)
2.	Runoff control (soil & water)	31 (12.4)	6 (11.8)	45 (30.2)	-	64 (42.8)	10 (20.0)	16 (8.0)	172 (20.2)
3.	Improve water table in wells	2 (0.8)	-	-	8 (4.8)	-	-	8 (4.0)	18 (2.9)
4.	Ground water recharge	10 (4.0)	-	-	1 (0.6)	-	8 (16.0)	14 (7.0)	33 (4.9)

Note : The data in parentheses are in percentage

Reasons for continued adoption of land leveling technology : Table 6 shows pooled data regarding important reasons for continued adoption of land leveling by farmers of various watersheds developed by centres of IISWC in the country. It was found that maximum more than one-third (34.4%) of farmers considered the increased in crop production was the first most important reason for continued adoption of land leveling technology in their watersheds. Reduction in runoff was considered second important reason for continued adoption of land leveling as perceived by 30 per cent of farmers of different watersheds developed by four centres. Uniform application of water was third important reason of continued adoption of land leveling as considered by 23.9 per cent of farmers of watersheds developed by four centres. Moisture conservation and less soil loss were considered other important reasons for continued adoption of land leveling technology as perceived by 21.6 and 17.4 per cent farmers respectively of various watersheds developed by different centres of IISWC in the country.

Table 6
Reasons for continue adoption of land leveling as perceived by farmers of selected watersheds at different centres of IISWC

Sr. No.	Reasons for continue adoption of land leveling technology	Number of farmers in watersheds developed by Centres of IISWC						Pool
		Vasad	Bellary	Kota	Agra	Ooty	Datia	
		Navamota, Antisar, Vejalpur (N=250)	Joladarasi (N=50)	Chhajawa, Badakheda, Haripura, (N=150)	Etmatpur, Boman, Raghupur, Jalalpur (N=200)	Chikkahali, Ermanaikk-anpatti, -palli Thulukka-muthur (N=200)	Bajni, Jigna, Kalipaha-ri, Agora, Durgapur (N=250)	
1.	Reduction in runoff	2 (0.8)	12 (24.0)	-	113 (56.5)	-	98 (39.2)	225 (30.0)
2.	Less soil loss	4 (1.6)	-	-	-	-	83 (33.2)	87 (17.4)
3.	Uniform application of water	2 (0.8)	-	24 (16.0)	-	40 (20.0)	137 (54.8)	203 (23.9)
4.	Increase in crop production	58 (23.2)	14 (28.0)	15 (10.0)	98 (49.0)	28 (14.0)	165 (66.0)	378 (34.4)
5.	Moisture conservation	20 (8.0)	4 (8.0)	12 (8.0)	106 (53.0)	42 (21.0)	-	184 (21.6)

Reasons for continued adoption of terracing technology : The pooled data in Table 7 show that 16.9 per cent of farmers continued adopted terracing technology in their watersheds because of reduction in soil erosion in their fields in watersheds developed by IISWC & its three centres in the country. Increased in crop yield was considered important reason for continued adoption of terracing technology by 14.1 per cent of farmers in the watersheds. Moisture conservation was the important reason for continued adoption of terracing technology as perceived by 9.3 per cent of farmers in the watersheds. Yield from sloppy lands was also a reason for continued adoption of terracing as considered by 0.7 per cent farmers of Navamota, Rebari and Sarnal watersheds developed by Vasad research centre.

Table 7
Reasons for continue adoption of terracing as perceived by farmers of selected watersheds at different centres of IISWCa

Sr. No.	Reasons for continue adoption of terracing	Number of farmers in watersheds developed by Centres of IISWC				Pool
		Vasad	Dehradun	Chandigarh	Agra	
		, Sarnal (N=150)	Fakot, Raipur (N= 100)	Aganpur Bhagwasi, Mandhala, Johranpur (N=125)	Etmatpur, Boman, Raghupur (N=150)	
1.	**Reduction in soil erosion**	5 (3.3)	35 (35)	38 (30.4)	11 (7.3)	89 (16.9)
2.	**Increase in crop yield**	1 (0.7)	18 (18)	45 (36)	10 (6.7)	74 (14.1)
3.	**Moisture conservation**	7 (4.7)	25 (25)	-	5 (3.3)	37 (9.3)
4.	**Yield from sloppy lands**	1 (0.7)	-	-	-	1 (0.7)

Note : *The data in parentheses are in percentage.*

Reasons for continued adoption of pond technology : Ground water recharge was the first most important reason to continued adoption of pond technology as considered by highest 16.9 per cent of farmers in their fields in different watersheds developed by five research Centres of IISWC in the country (Table 8). The second most important reason for continuing pond technology was water harvesting for irrigation as perceived by 13.4 per cent farmers of watersheds. The third important reason was well recharge due to continued adoption of pond as considered by 7.6 per cent of farmers of three centres. The other important reasons for continued adoption of pond technology were animal drinking water and water use for pisciculture as considered by 5.4 and 2.8 per cent farmers respectively of watersheds developed by different centres of IISWC in the country.

Table 8
Reasons for continue adoption of pond as perceived by farmers of selected watersheds at different centres of IISWC

Sr. No.	Reasons for continue adoption of pond technology	Number of farmers in watersheds developed by Centres of IISWC						Pool
		Vasad	Chandigarh	Bellary	Kota	Agra	Ooty	
		Navamota, Rebari, Vejalpur (N=150)	Mandhala, Sabeelpur, Kajiyana (N=149)	Joladarasi, Chinnatekur, Mallapuram (N=154)	Badakheda (N=50)	Boman (N=50)	Salaiyur, Chikkahali, Ermanaik-kanpatti, Patthuva-mpalli & Thulukk-amuthur (N=250)	
1.	Water harvesting for irrigation	13 (8.7)	56 (37.6)	2 (1.3)	4 (8.0)	2 (4.0)	31 (11.6)	108 (13.4)
2.	Well recharge	1 (0.7)	-	-	5 (10.0)	-	28 (11.2)	34 (7.6)
3.	Animal drinking water	8 (5.3)	6 (4.0)	9 (5.8)	-	1 (2.0)	17 (6.8)	41 (5.4)
4.	Ground water recharge	3 (2.0)	45 (30.2)	2 (1.3)	-	3 (6.0)	75 (30.0)	128 (16.9)

5.	Water used for Pisciculture	-	-	-	-	-	7 (2.8)	7 (2.8)

***Note:** The data in parentheses are in percentage*

Reasons for continued adoption of gully plug technology : The data presented in Table 9 are different reasons for continued adoption of gully plug technology by farmers of watersheds developed by IISWC and its centres in the country. The first most important reason was reduction in soil loss as perceived by highest 19.2 per cent of farmers of watersheds developed by three centres. The control of gullies for its widening was second important reason for continued adoption of gully plug technology by 16 per cent of farmers in their fields. Reduction in speed of flowing water was the third important reason for continued adoption of gully plug as considered by 9.8 per cent of farmers of watersheds developed by two centres. The other reasons for continued adoption of gully plug technology by farmers were moisture conservation, ground water recharge and land leveled more as perceived by 9.3, 3.3 and 1.3 per cent farmers respectively of three watersheds developed by Vasad research centre of IISWC.

Table 9
Reasons for continue adoption of gully plug as perceived by farmers of selected watersheds at different centres of IISWC

Sr. No.	Reasons for continue adoption of gully glug	Number of farmers in watersheds developed by Centres of IISWC				Pool
		Vasad	Dehradun	Chandigarh	Kota	
		Navamota, Rebari, Sarnal (N=150)	Fakot, Raipur (N=100)	Aganpur Bhagwasi, Mandhala, Johranpur (N=125)	Chhajawa, Badakheda (N=100)	
1.	Control of gullies for its widening	2 (1.3)	3 (3)	55 (44)	-	60 (16.0)
2.	To reduce soil loss	12 (8.0)	-	50 (40)	10 (10)	72 (19.2)
3.	Moisture conservation	14 (9.3)	-	-	-	14 (9.3)
4.	Ground water recharge	5 (3.3)	-	-	-	6 (3.3)
5.	Land leveled more	2 (1.3)	-	-	-	2 (1.3)
6.	Reduction in speed of flowing water	2 (1.3)	-	25 (20)	-	27 (9.8)

***Note :** The data in parentheses are in percentage.*

CONCLUSIONS

The study showed that three-fourth of SWC technologies continued adopted by farmers, out of the initially adopted total technologies, for natural resources conservation and sustainable management of watersheds developed by IISWC and its centres in the country. The study further revealed that bunding, land leveling, terracing, check dam, gully plug and pond were important SWC technologies continued adopted by farmers for sustainable management of different watersheds developed by IISWC and its centres in the country. It came to light that reduction in soil loss & runoff, moisture conservation and more yield were the important reasons for continued adoption of bunding by farmers for their watersheds management. Land leveling technology was continued adopted for increase in crop production, reduction in runoff and uniform application of water as considered by farmers. Reduction in soil erosion, increase in crop yield and moisture conservation were the important reasons for continued adoption of terracing by farmers. Check dam technology continued adopted by farmers in the watersheds developed by IISWC and its centres for water harvesting, runoff control and ground water recharge as considered by farmers. The three important reasons for continued adoption of gully plug technology were reduction in soil loss, control of gullies for its widening and reduction in speed of flowing water as perceived by farmers. Ground water recharge, water harvesting for irrigation and well recharge were the three important reasons for continued adoption of pond by farmers in the watersheds developed by IISWC and its centres in India.

Thus, it is obvious from the results that before adopting any SWC technology in the catchment area of watershed, the farmer should consider the information about technology, benefits from technology, need of farmer for what reason to adopt the technology such as for reduction in soil loss & runoff, for increase in crop production, for water harvesting, for ground water recharge etc. as per the need of farmland for sustainable watershed management. Therefore, the SWC technologies should be adopted according to topographic condition, water availability, slope of land, erodibility of land, in catchment area of watershed. Based on the study findings, the following implications were drawn. There is need for sensitization of farmers and watershed development agencies that the more emphasis should be given in adoption of SWC technologies according to suitability to catchment area of watershed. Bunding, terracing and gully plug SWC technologies should be given more emphasis for adoption in watersheds under sloppy or hilly areas. Water harvesting technologies like pond, check dam and land leveling should be given more emphasis for adoption in watersheds under arid or semi-arid areas with less sloppy land for sustainable watershed management. This finding is in conformity with Simon Alufah et al. (2012) who studied that before adopting any SWC technology in the catchment, farmers consider information about the technology, topography of the farmland and social interaction.

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