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Determinants of Technological Gap in Soil and Water Conservation Technologies Implemented in Watershed Management Programmes in India

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ABSTRACT

The Indian Institute of Soil and Water Conservation (IISWC) and its research Centres have implemented large number of Soil and Water Conservation (SWC) technologies for watersheds development in the country. In this article, we measured the extent of technological gap in adopted SWC technologies and also ascertained the factors responsible for technological gap. The results show that about one-fifth (18.96%) of SWC technologies were adopted with technological gap by farmers in different watersheds. Technology-wise data revealed that 9.04 per cent farmers adopted check dams with technological gap, 4.22 per cent farmers adopted pond with technological gap, 18.82 per cent farmers adopted land leveling with technological gap and 34.52 per cent farmers adopted bunding with technological gap. Important reasons for technological gap in check dam technology were lack of money, siltation and labour problem. Siltation, lack of money & resources and bund damaged were the reasons for technological gap in pond technology. Important reasons for technological gap in adoption of land leveling were lack of money, lack of labour and costly technology. Bunding technology was adopted by farmers with technological gap due to lack of money to repair, breached by rain water and lack of labour for maintenance of bunding. Results imply that financial support or provision should be made after withdrawal of watershed project for poor farmers to repair and maintenance of adopted SWC technologies to remove technological gap in adopted technologies. Farm equipments should also be made available to farmers for common use on custom hiring basis could help in repair and maintenance of SWC structures to overcome the non-availability of labour.

Key words: Soil and water conservation, technology, watershed management.

INTRODUCTION

A particular SWC technology comprises a set of components, parameters of a design or package of practices, which are taken into consideration while adoption 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 research farm. It means there is gap or difference in technology developed at experimental research farm and technology adopted by farmers in their fields which is known as technological gap. The farmers have not continued adopted the technologies as per the recommended parameters or components for a particular technology due to reasons like lack of money, lack of resources with them, non-availability of inputs, lack of knowledge *etc.*

Rogers and Shoemaker (1971), considered the adoption process as a learning process, often influenced

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by group dynamics and involving four stages: the awareness, evaluation, trial and the adoption stages. 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, 1995). But, in the present times, there are so many other factors, apart from meeting of needs that push a farmer to discard a technology. 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. 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 andreplication rates were higher (De Graaff *et al.,* 2008).

IISWC and its Centres have developed many watersheds and implemented SWC technologies. Some of the adopted SWC technologies might have discontinued adopted by the beneficiary farmers with technological gap. Therefore, it was realized that the extent of technological gap in continued adopted SWC technologies for watershed management should be studied in detail and ascertain the factors responsible. Hence the study was framed with the main objective to assess the extent of technological gap in important SWC technologies adopted during watershed development programmes by IISWC & its centres in India.

METHODOLOGY

Study area: The 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 (Karnataka), 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 were considered for the study, out of which 4 or 5 watersheds were selected at each Centre. A total of 36 watersheds were selected from eight research Centres of IISWC in India as given in Table 1.

Selection of Respondents: Soil and water conservation technology-wise inventory of adopter farmers, was prepared with the help of Detail Project Report (DPR) or by organizing meetings with farmers. The inventory contained the names of farmers, the size of land holding and the adopted technology. The inventory served as the basis to prepare list of farmers for all technologies adopted during the watershed development programmes. A stratified proportionate random sampling plan was adopted to select respondents from different inventories of farmers. At least 50 respondents were selected from each watershed, representing all the existing categories of farmers in the watershed. Thus, total 1802 respondent farmers were selected in the study as sample size (Table 1). A detailed structured interview schedule was developed by the investigators. Data regarding personal, psychological and technological gap variables were recorded on the schedule through personal interviewing of the respondents.

Categorization of respondents: The respondents were separated into three categories in relation to the data regarding technological gap behaviour of farmers towards SWC technologies for watershed management with help of the following criteria:

Range of score	Category
<Minimum score + CI	Low
> Minimum score + CI to < Maximum score - CI	Moderate
> Maximum score - CI	High

Where,

CI = Class Interval

Class Interval (CI) was computed using the following formula:

$$CI = \frac{Maximum\ Score - Minimum\ Score}{Number\ of\ classes}$$

Technological Gap Index (TGI): for a technology

To measure the extent of technological gap in SWC technologies implemented during watershed development programmes, a detailed methodology was developed such as data collection schedule, scoring procedure and data analysis with the following developed indices by the authors:

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

Where,

R = Maximum possible score on complete adoption of a technology by a farmer as per the design suitable in the watershed (*i.e.* 10).

A = Score obtained by a beneficiary farmers on his incomplete adoption of a technology

N = Total number of farmers in a watershed adopted that particular technology

Overall Technological Gap Index: for all technologies adopted at watershed level

$$Overall\ Techno\log ical\ Gap\ Index = \frac{\sum_{i=1}^{K} TGI_i}{K} \qquad -----(2)$$

Where, $\sum_{i=1}^{K} TGI_i$ = Sum total of Technological Gap Indices of k^{th} technologies

K = Total number of technologies

Table 1: Selection of watersheds developed by IISWC & its Centres and number of respondents

Name of Centre (No.)	Name of selected watersheds and number of respondents	Total respondents (No)
Vasad	Navamota (50), Rebari (50), Sarnal (50), Antisar (50), Vejalpur-Rampura (50)	250
Agra	Boman (50), Raghupur (50), Jalalpur (50)	150
Bellary	Joladarasi (50), Chinnatekur (50), PC Pyapli (54), Mallapuram (54), hilakanahatti (58)	266
Chandigarh	Aganpur-Bhagwasi (50), Mandhala (49), Johranpur (26), Sabeelpur (50), Kajiana (50)	225
Datia	Bajni (50), Jigna (50), Kalipahari (50), Agora (50), Durgapur (50)	250
IISWC, Dehradun	Fakot (50), Raipur (50), Sabhawala (51), Langha (60)	211
Kota	Badakhera (50), Haripura (50), Hanotiya (50), Semli Gokul (50)	200
Ooty	Salaiyur (50), Chikkahalli (50), Eramanaikkanpatti (50), Putthuvampalli (50), Thulukkamuthur (50)	250

RESULTS AND DISCUSSION

Levels of technological gap in SWC technologies adopted by farmers

The data in Table 2 showed the levels of technological gap in soil and water conservation technologies adopted by farmers in the watersheds developed by IISWC and its different research Centres in the country. Majority (more than fifty per cent) of farmers had low-level technological gap in adopted SWC technologies at Bellary (66.8%), Vasad (60.4%), Ooty (58.4%), Kota (58%) & Agra (53.3%) Centres. Majority of farmers had moderate level of technological gap in continued adopted SWC technologies only at Chandigarh (53.3%) Centre. One-fourth farmers also had high level of technological gap in adopted SWC technologies in their fields due to various reasons at Datia (29.6%), Chandigarh (25.3%) and Dehradun (24.2%) Centres. The overall pooled data revealed that maximum (47.7%) of farmers had technological gap in SWC technologies at low level, 34.3 per cent of farmers had technological gap at moderate level and only 18 per cent of farmers had high level technological gap in the SWC technologies, which were adopted during watershed development programmes implemented by IISWC and its different research Centres in India. V.G Patil (1990), Ashok K. Gupta *et al.,* (1993), B.N Kalasariya *et al.,* (1998), Bhagwan Singh (2007), G.N. Maraddi *et al.,* (2008) were reported that overall majority of the farmers were belonged to medium technological gap category in agricultural production technology.

Table 2: Levels of technological gap in SWC technologies adopted by farmers in different watershed programmes implemented by IISWC and its research Centres in India
n = 1802

Levels of technological gap	Number of farmers								Pool (1802)
	Vasad	Dehradun	Chandigarh	Bellary	Kota	Agra	Ooty	Datia	
	Navamota, Rebari, Sarnal, Antisar& VejalpurRampura (N=250) %	Fakot, Raipur, Sabhawala&Langha (N=211) %	Aganpur-Bhagwasi, Mandhala, Johranpur, Sabeelpur & Kajiyana (N=225) %	Joladarasi, Chinnatekur, PC Pyapli, Mallapuram &Chilakana-hatti (N=266) %	Badakheda, Haripura, Hanotiya &SemliGokul (N=200) %	Boman, Raghupur, Jalalpur (N=150) %	Salaiyur, Chikkahali, Eramanaikkanpatti, Patthuvampalli, Thulukkamuth- ur (N=250) %	Bajni, Jigna, Kalipahari, Agora, Durgapur (N=250) %	
Low	151 (60.4)	76 (36.02)	55 (24.44)	139 (66.83)	116 (58)	80 (53.33)	146 (58.4)	69 (27.6)	832 (47.71)

Moderate	83 (33.2)	84 (39.81)	113 (50.22)	45 (21.63)	63 (31.5)	36 (24)	67 (26.8)	107 (42.8)	598 (34.29)
High	16 (6.4)	51 (24.17)	57 (25.33)	24 (11.54)	21 (10.5)	34 (22.67)	37 (14.8)	74 (29.6)	314 (18)
Total	250 (100)	211 (100)	225 (100)	208 (100)	200 (100)	150 (100)	250 (100)	250 (100)	1744 (100)

Extent of technological gapin SWC technologies in different watersheds

The extent of technological gap in SWC technologies was measured with the help of Technological Gap Index (TGI) and Overall Technological Gap Index (OTGI) within watershed region. Table 3 shows the data regarding extent of continue adopted SWC technologies with technological gap behaviour of farmers towards SWC technologies in different watersheds developed by eight research Centres of IISWC in the country. It was found out that the same position in Sarnal and Rebari watershed where farmers continue adopted SWC technologies with technological gap as perceived by 46.49 per cent and 46.29 per cent. Around one-third (30.19%) of SWC technologies were still continue adopted with technological gap by farmers in Vejalpur Rampura watershed, followed by below twenty five per cent (24.65%) of watershed management technologies were continue adopted with technological gap by farmers in Novamota watershed and above twenty per cent (20.84%) of SWC practices were still continue adopted with technological gap by farmers in Antisar watershed developed by Research Centre Vasad. The OTGI value revealed that more than thirty per cent (33.69%)of SWC practices were continued adopted with technological gap by farmers in these five watersheds developed by Research Centre Vasad in Gujarat state.

At IISWC Dehradun, it was revealed that little less one-third (31.48%) of SWC technologies were continue adopted with technological gap by farmers in Fakot watershed, followed by about two per cent (2.17%) of SWC technologies were still continue adopted with technological gap by farmers in Langha watershed and only one per cent (1.12%) of SWC practices were continue adopted with technological gap by farmers in Sabhawala watershed developed by Research Centre Dehradun. The average little bit above ten percent (11.59%)of SWC practices were continue adopted with technological gap by farmers in these three watersheds developed by IISWC, Dehradun in Uttrakhand state.

The Table 3 also showed that maximum more than thirty percent (30.53%) of SWC technologies were still continue adopted with technological gap by farmers in Sabeelpur watershed, followed by around one-fourth (25.42%) of watershed management technologies were continue adopted with technological gap by farmers in Mandhala watershed and below one-fourth (23.41%) of SWC practices were still continue adopted with technological gap by farmers in Johranpur watershed developed by Research Centre Chandigarh in Haryana state. Followed by little below one-fifth (18.69%) of watershed management technologies were continue adopted with technological gap by farmers in Kajiyana watershed and 16.05 per cent of SWC practices were still continue adopted with technological gap by farmers in Aganpur Bhagwasi watershed developed by Research Centre Chandigarh. The average little above one-fourth (22.82%) of SWC practices were continue adopted with technological gap by farmers for natural resource conservation in these five watersheds developed by research Centre Chandigarh in Haryana state.

It was measured that little above one-fourth (26.27%) of SWC technologies were still continue adopted with technological gap by farmers in Chinnatekur, followed by there is no big difference in two watersheds where farmers have continue adopted SWC practices with technological gap above ten per cent as perceived by (12.92%) in Mallapuram watershed and (12.78%) in PC Pyapli watersheds developed by Research Center Bellary. Only (10.96%) percent of SWC technologies were continue adopted with technological gap by farmers in Joladarasi water shed. The average little bit above fifteen percent (15.73%) of SWC practices were continue adopted with technological gap by farmers for sustainable management of these five watersheds developed by research Centre Bellary in Karnataka state.

It was assessed that about one-fifth (21.4%) of SWC technologies were still continue adopted with technological gap by farmers in Semli Gokul watershed, followed by only 8 per cent SWC practices were continue adopted with technological gap by farmers in Hanotiya water shed and farmers have continue adopted below ten per cent SWC practices with technological gap in Badakheda (7.70%) and in Haripura (7.40%) watersheds developed by Research Center Kota. The OTGI shows that average 8.9 per cent of SWC technologies were continue adopted with technological gap by farmers for sustainable management of these five watersheds developed by research Centre Kota in Rajasthan state.

At research Centre Agra, it was found out that maximum below thirty percent (28.9%) of SWC technologies were continue adopted with technological gap by farmers in Jalalpur water shed, followed by more than ten percent (11.3%) of SWC technologies were continue adopted with technological gap by farmers for Boman watershed and only 6.94 per cent of SWC practices were continue adopted with technological gap by farmers in Raghupur watershed. The OTGI value shows that average 15.71 per cent of SWC practices were continue adopted with technological gap by farmers in these four watersheds developed by research Centre Agra in Uttar Pradesh state.

The OTGI values in Table 3 also indicated that little bit below one-fourth (24.34%) of SWC technologies were still continue adopted with technological gap by farmers in Chikkahali watershed, followed by 12.02 per cent of SWC technologies were continue adopted with technological gap by farmers in Salaiyur watershed and 10.47 per cent of SWC practices were continue adopted with technological gap by farmers in Eramanaikkanpatti waters hed at Research Centre Ooty. SWC practices were continued adopted with technological gap in Thulukkamuthur (9.4%) and Patthuvampalli (8.6%) watersheds. The average 12.97 per cent of SWC practices were continue adopted with technological gap by farmers of these five watersheds developed by research Centre Ooty in Tamil Nadu state of country.

Above one-fourth of SWC technologies were continued adopted with technological gap in Bajani (30.77%), Kalipahari (30.67%), Jigna (30.51%),Agora (30.26%), and Durgapur (29.16%) watersheds developed by research Centre Datia. The average OTGI value shows that 30.27 per cent of SWC practices were continued adopted with technological gap by farmers in these five watersheds developed by research Centre Datia in Madhya Pradesh state.The study further revealed that the overall average value of OTGI showed that 18.96 per cent of SWC technologies were continued adopted with technological in different watersheds developed by IISWC and its research Centres in India.

Table 3 : Overall extent of technological gap in SWC technologies adopted by farmers in different watershed programmes implemented by IISWC and its research Centresin India

n = 1802

Name of Research Centre(RC)	Name of watersheds	Overall Technological Gap Index (OTGI)	Average
RC, Vasad, Gujarat	Navamota (n=50)	24.65	33.69
	Rebari (n=50)	46.29	
	Saranal (n=50)	46.49	
	Antisar (n=50)	20.84	
	Vejalpur (n=50)	30.19	
IISWC, Dehradun, Uttrakhand	Fakot (n=50)	31.48	11.59
	Raipur (n=50)	-	
	Sabhawala (n=51)	1.12	
	Langha (n=60)	2.17	
RC, Chandigarh, Haryana	AganpurBhagwasi (n=50)	16.05	22.82
	Mandhala (n=49)	25.42	
	Johranpur (n=26)	23.41	
	Sabeelpur (n=50)	30.53	
	Kajiyana (n=50)	18.69	
RC, Bellary, Karnataka	Joladarasi(n=50)	10.96	15.73
	Chinnatekur (n=50)	26.27	
	PC Pyapli (n=54)	12.78	
	Mallapuram (n=54)	12.92	
	Chilakanahatti (n=58)	-	
RC, Kota, Rajasthan	Badakheda (n=50)	7.70	8.90
	Haripura (n=50)	7.40	
	Hanotiya (n=50)	8	
	SemliGokul (n=50)	21.4	
RC, Agra, Uttar Pradesh	Boman (n=50)	11.3	15.71
	Raghupur (n=50)	6.94	
	Jalalpur (n=50)	28.9	
RC, Ooty, Tamil Nadu	Salaiyur(n=50)	12.02	12.97
	Chikkahali (n=50)	24.34	
	Eramanaikkanpatti (n=50)	10.47	
	Patthuvampalli (n=50)	8.6	
	Thulukkamuthur (n=50)	9.4	
RC, Datia, Madhya Pradesh	Bajni(n=50)	30.77	30.27
	Jigna (n=50)	30.51	
	Kalipahari (n=50)	30.67	
	Agora (n=50)	30.26	
	Durgapur (n=50)	29.16	
Overall Average			18.96

Extent of technological gap in important SWC technologies of water shed management

The Overall Technological Gap Index (OTGI) data presented in Table 4 revealed that Check dam technology was continued adopted with technological gap by 20 per cent farmers in watersheds developed by Agra Centre, 13.6 per cent farmers were continued adopted Check dam with technological gap in watersheds developed by Vasad Centreand 10 per cent farmers continued adopted Check dam with technological gap in watersheds developed by Kota Centre. 7.2, 6.48, 4 and 2.04 per cent farmers were continued adopted Check dam with technological gap in watersheds developed by Datia, Bellary, Ooty and Chandigarh Centres respectively. The average OTGI value revealed that Check dam technology was still continued adopted with technological gap by 9.04per cent farmers whereas, 20.6 per cent farmers were adopted it initially during development of watershed programmes implemented by seven research Centres of IISWC in India.

Pond technology was continued adopted with technological gap by 7.08 per cent farmers in watersheds developed by Bellary Centre, 5 per cent farmers were continued adopted pond with technological gap in watersheds developed by Vasad Centre and 4 per cent farmers continued adopted pond with technological gap in watersheds developed by Ooty Centre. Only 3.06 and 2 per cent farmers were continued adopted pond with technological gap in watersheds developed by Datia and Agra Centres respectively. The average OTGI value revealed that pond technology was continued adopted with technological gap by 4.22 per cent farmers whereas, 6.31 per cent farmers were adopted it initially during development of watersheds implemented by five research Centres of IISWC in India.

Land levelling technology was continued adopted with technological gap by 26.8 per cent farmers in watersheds developed by Datia Centre, 18 per cent farmers were continued adopted land levelling with technological gap in watersheds developed by Vasad Centre, 16.5 per cent farmers continued adopted land levelling with technological gap in watersheds developed by Agra Centre and 14 per cent farmers were continued adopted land levelling with technological gap in watersheds developed by Kota Centre. The average OTGI value revealed that land levelling technology was still continued adopted with technological gap by 18.82 per cent farmers whereas, 35.85 per cent farmers were adopted it initially during development of watersheds implemented by four research Centres of IISWC in India.

Bunding technology was continued adopted with technological gap by majority 55.5 per cent farmers in watersheds developed by Vasad Centre, 37 per cent farmers continued adopted bunding with technological gap in watersheds developed by Ooty Centre, 36.4 per cent farmers continued adopted bunding with technological gap in watersheds developed by Datia Centre. About one-fourth of farmers were continued adopted bunding with technological gap in watersheds developed by Kota (29.2 per cent), Chandigarh (24.57 per cent) and Agra (24.5 per cent) Centresrespectively. The average OTGI value revealed that bundingtechnology was still continued adopted with technological gap by 34.52 per cent farmers whereas, 62.71 per cent farmers were adopted it initially during development of watersheds implemented by six research Centres of IISWC in India.

Table 4: Overall Technological Gap Index (OTGI) of important SWC technologies in different watersheds implemented by IISWC and its research Centres in India

Name of technologies implemented in watersheds	Overall Technological Gap Index (OTGI) of important SWC technologies							Pool
	Vasad	Chandigarh	Bellary	Kota	Agra	Ooty	Datia	
Check dam	13.6 (18.8)	2.04 (2.04)	6.48 (33.80)	10 (46)	20 (22)	4 (12)	7.2 (9.6)	9.04 (20.60)
Pond	5 (5)	-	7.08 (8.02)	-	2 (4)	4 (11.5)	3.06 (3.06)	4.22 (6.31)
Land Levelling	18 (33.5)	-	-	14 (37)	16.5 (40.50)	-	26.8 (32.4)	18.82 (35.85)
Bunding	55.50 (60)	24.57 (46.29)	-	29.2 (65.20)	24.50 (85)	37 (75)	36.4 (44.8)	34.52 (62.71)

Note: Figures presented in parentheses are also percentage of farmers adopted the technologies initially at the time of implementation of watershed programme.

Reasons for technological gap in check dam-technology

The pooled data in Table 5 showed that lack of money with farmers were the most important reasons for continued adoption of check dam technology with technological gap as perceived 3.4 per cent farmers. Check dams were silted up due to rain water in the fields of 1.5 per cent farmers of watersheds developed by Bellary, Ooty and Vasad Centres. Check dams were breached out due to rain water in the fields of 1.4 per cent farmers of watersheds developed by Vasad, Ootyand Bellary Centres. No financial help after project withdrawal was another reason for continue adoption of check dam technology with technological gap by 1.4 per cent farmers of Agra and Kota Centres of IISWC in the country. Labour availability and lack of knowledge were also considered important reasons for continue adoption of check dam with technological gap by the 0.8 and 0.6 per cent farmers respectively of watersheds developed by Agra Centre. Therefore, the check dam technology should be adopted in medium and large land holdings and financial provisions must be made for repair and maintenance of check dams.

Table 5: Reasons for continue adoption of check dam technology with technological gap as perceived by farmers of selected watersheds at different Centres.

Reasons for continue adoption of Check dam with technological gap	Number of farmers					Pool
	Vasad Navamota, Sarnal, Antisar, VejalpurRampura (N=200)	Bellary PC Pyapli, Mallapuram, Chilakana hatti (N=166)	Kota Badakheda, Haripura (N=100)	Agra Boman (N=50)	Ooty Salaiyur, Ermanaikkanpatti, Patthuvampalli Thulukkamuthur (N=200)	
Lack of money	11 (5.5)	2 (1.2)	2 (2.0)	9 (18.0)	-	24 (3.4)
Soil silting with rain water	3 (1.5)	5 (3.0)	-	-	3 (1.5)	11 (1.5)
Bund broken by rain water	6 (3.0)	1 (0.6)	-	-	3 (1.5)	10 (1.4)
No financial help after project withdrawal	-	-	4 (4.0)	6 (12.0)	-	10 (1.4)
Labour problem	-	-	-	6 (12.0)	-	6 (0.8)
Lack of knowledge	-	-	-	4 (8.0)	-	4 (0.6)

Note: The data in parentheses are in percentage.

Reasons for technological gap inpond technology

The overall pool data in Table 6 showed that the siltation was most important reason to continue adoption of pond technology with technological gap in their fields as perceived by highest 3.6 per cent farmers of various watersheds developed by Ooty and Bellary Centres. Lack of money & resources was another reason for continued adopted pond technology with technological gap as perceived by 2.3 per cent of farmers from watersheds developed by Bellary, Vasad and Agra Centres of IISWC in the country. Pond was continued adopted with technological gap as bund damaged & broken by rain water perceived by 1.7 per cent of farmers of watersheds developed by Ooty and Vasad Centres in the country. Infestation of prosopisjuli flora (Vilayatibabul) was also reason for continued adoption of pond with technological gap by 1.5percent of farmers of watersheds developed by Ooty &Vasad Centres. Seepage problem was also reason for adoption of pond with technological gap as considered by 1.1 per cent farmers of watersheds developed by Bellary Centre. M.N. Popat *et al.,* (2006) have reported that percolation tank-cum-farm pond technology obtained first rank in adoption gap.

Table 6 : Reasons for continue adoption of pond SWC technology with technological gap as perceived by farmers of selected watersheds at different Centres.

Reasons for continue adoption of Pond technology with technological gap	Number of farmers				Pool
	Vasad Navamota, Rebari, Vejalpur Rampura (N=150)	Bellary Joladarasi, Chinnatekur, Mallapuram, Chilakanahatti (N=212)	Agra Boman (N=50)	Ooty Salaiyur, Chikkahali, Ermanaikkanpatti, Patthuvampalli & Thulukkamuthur (N=250)	
Lack of money and resources	4 (2.7)	10 (4.7)	1 (2)	-	15 (2.3)
Bund damaged & broken by rain water	1 (0.7)	-	-	10 (4)	11 (1.7)
Seepage	-	7 (3.3)	-	-	7 (1.1)
Siltation	-	5 (2.4)	-	19 (7.6)	24 (3.6)
Infested with prosopisjuliflora	3 (2)	-	-	7 (2.8)	10 (1.5)

Note: The data in parentheses are in percentage.

Reasons for technological gap inland levelling technology

The Table 7 showed that highest 11.6 per cent of farmers considered the lack of money as most important reason to continue adoption of land levelling technology with technological gap in their watersheds developed by Vasad, Agra and Kota Centres in the country. Lack of labour was considered a reason to adopt land levelling with technological gap by 3.8 per cent of farmers of watersheds developed by Agra and Vasad Centres developed by IISWC. Lack of knowledge was also considered a reason to adopt land levelling with technological gap by 3.6 per cent of farmers of watersheds developed by Agra Centre. Land levelling is a costly technology and due to that 3.4 per cent farmers were adopting it with technological gap in watersheds developed by Vasad and Agra Centres of IISWC in the country.

Table 7 : Reasons for continue adoption of land leveling technology with technological gap as perceived by farmers of selected watersheds at different Centres.

Reasons for continue adoption of land leveling with technological gap	Number of farmers			Pool
	Vasad Navamota, Rebari, Sarnal, Antisar & Vejalpur Rampura (N=250)	Kota Haripura & Semli Gokul (N=100)	Agra Boman, Raghupur, & Jalalpur (N=150)	
Lack of money	33 (13.2)	8 (8.0)	17 (11.3)	58 (11.6)
Lack of farm equipment	11 (4.4)	1 (1.0)	-	12 (2.4)
Lack of labour	5 (2.0)	-	14 (9.3)	19 (3.8)
Costly	9 (3.6)	-	8 (5.3)	17 (3.4)
Lack of knowledge	-	-	18 (12.0)	18 (3.6)

Note: The data in parentheses are in percentage.

Reasons for technological gap in bunding technology

The overall pool data in Table 8 showed that the maximum18 per cent of farmers were continued adopted bunding with technological gap because of the lack of money. Bund breached due to rain water as perceived by 8.5 per cent of farmers of different watersheds in the country. Lack of maintenance was the reason to continued adoption of bunding with technological gap technology as perceived by 7.1 per cent of farmers in all the selected watersheds developed by Bellary and Vasad Centres in the country. Lack of labourconsidered as reason by 5.3 per cent of farmers of various watersheds developed by Chandigarh, Ooty and Kota Centres of IISWC in the country. Lack of knowledgeamong farmers was also reason as perceived by3.2 per cent of farmers of various watersheds developed by Chandigarh and Kota Centres of IISWC. Rameshwar Das *et al.,* (1998) has reported that education, farm power, material possession, social participation, socio-economic status, extension contact, and mass media exposure has significant and negative association with the technological gap.

Table 8 : Reasons for continue adoption of bunding technology with technological gap as perceived by farmers of selected watersheds at different Centres.

Reasons for continue adoption of bunding with technological gap	Number of farmers						Pool (991)
	Vasad Navamota, Rebari, Sarnal, Antisar (N=200)	Chandigarh Mandhala, Johranpur, (N=75)	Bellary Joladarasi, Chinnatek-ur,PC Pyapli, Mallapura m,Chilaka-nahatti (N=266)	Kota Badakheda Haripura, Hanotiya, SemliGok ul (N=200)	Agra Boman, Raghupur, Jalalpur (N=150)	Ooty Chikka-hali, Ermana-ikkanpa-tti (N=100)	
Lack of money	52 (26.0)	17 (22.7)	34 (12.8)	36 (18.0)	39 (26.0)	-	178 (18.0)
Breached due to rain water	26 (13.0)	-	7 (2.6)	7 (3.5)	26 (17.3)	18 (18.0)	84 (8.5)
Lack of maintenance	16 (8.0)	-	54 (20.3)	-	-	-	70 (7.1)
Gradual height reduction	5 (2.5)	-	6 (2.3)	-	-	15 (15.0)	26 (2.6)
Lack of labour	-	22 (29.3)	-	13 (6.5)	-	18 (18.0)	53 (5.3)
Lack of knowledge	-	16 (21.3)	-	16 (8.0)	-	-	32 (3.2)

Note: The data in parentheses are in percentage.

CONCLUSION

It was found out that 47.71 per cent farmers were continued adopted SWC technologies with technological gap at low level, 34.29 per cent farmers continued adopted SWC technologies with technological gap at moderate level and only 18 per cent farmers continued adopted SWC technologies with technological gap at high level in the watersheds implemented by IISWC and its research Centres in India. The study further revealed that the average value of OTGI shows that 18.96 per cent of SWC technologies were continued adopted with technological in different watersheds developed by IISWC and its research Centres in India.

The Overall Technological Gap Index (OTDI) values revealed that 34.52 per cent farmers continued adopted bunding technology with technological gap, 18.82 per cent farmers continued adopted land leveling with technological gap, 9.04 per cent farmers continued adopted check dam with technological gap and 4.22 per cent farmers continued adopted pond with technological gap in the watersheds developed by IISWC and its research Centres in India.

Bunding technology was continued adopted with technological gap due to lack of money, bund breached out due to rain water and lack of maintenance as perceived by 18.0 per cent, 8.5 per cent and 7.1 per cent farmers respectively. The important reasons for continued adoption of bunding with technological gap were lack of labour and knowledge as perceived by5.3 per cent and 3.2 per cent farmers respectively. Lack of money, labour constraints, high cost of maintenance and lack of farm equipments were the reasons for continued adoption of land levelling with technological gap by 11.6 per cent, 3.8 per cent, 3.4 per cent and 2.4 per cent farmers respectively.

Check dam technology was continued adopted by farmers with technological gap due to lack of money, soil silting with rain water and breached away due to heavy rain as considered by 3.4 per cent, 1.5 per cent and 1.4 per cent farmers respectively. No financial help after project withdrawal, labour problem andlack of knowledge with farmers were the reasons for adoption of check dam with technological gap by 1.4 per cent, 0.8 per cent and 0.6 per cent of farmers in the watersheds developed by IISWC and its Centres in India. Pond was continued adopted by farmers with technological gap due to siltation, lack of money& resources, bund damaged by rain water as perceived by 3.6 per cent, 2.3 per cent and 1.7 per cent farmers respectively. Infestation of pond with Prosopis juliflora (Vilayatibabul) and seepage were the reasons for adoption of pond with technological gap by 1.5 per cent and 1.1 per cent of farmers in the watersheds developed by IISWC and its Centres in India.

It can be inferred from the findings that the poor farmers are not taking proper care and maintenance of SWC structures after project withdrawal by PIA due to lack of money and resources. Therefore, financial provisions at the time of completion of watershed projects should be made for future repair and maintenance of adopted SWC technologies in proper complete technology package without any technological gap. Farm equipments should be provided to poor farmers from watershed development projects money on custom hiring basis at watershed level so that the SWC structures could be repaired and maintained by poor farmers in case of non-availability of labours for long-term sustainable benefits to farmers from SWC structures.

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