International J. of Ext. Educ. Vol. XVIII: 111-123, 2022 ISSN : 2319-7188

Determinants for Diffusion of Mechanical Soil and Water Conservation Technologies: A Study of Watersheds in India

Bagdi G. L.[1], S. L. Arya[2], P. Sundarambal[2], Om Prakash[2,3], Bankey Bihari[2]

[1]Principal Scientist, ICAR-Central Arid Zone Research Institute, Regional Research Station, Bikaner – 334004, Rajasthan, India.

[2]ICAR-Indian Institute of Soil and Water Conservation, Dehradun, Uttrakhand, India

[3]ICAR-Indian Agricultural Research Institute, New Delhi, India

Corresponding author's e-mail: glbagdi@yahoo.com

ABSTRACT

The Indian Institute of Soil and Water Conservation (IISWC) and its Research Centres have developed many watersheds in the country and implementeda large number of mechanical soil and water conservation (SWC) technologies for sustainable management of soil and water. Althoughmany evaluation studies were conducted on these watershed projects in the past, assessment of diffusion of the SWC technologies wasnot carried out. This research study was conducted during 2012-15, with the specific objective to measure the extent of diffusion of mechanical SWC technologies and also ascertain the factors responsible for their diffusion. Indices of diffusion of SWC technologies from 37 watersheds revealed that more than one-fourth (27.82%) of SWC technologies were diffused from farmers' fields in watersheds. Technology-wise data revealed that 37.72 per cent farmers disseminated bunding, land leveling disseminated from 24.73 per cent farmers' fields, check dam technology disseminated from 12.98 per cent farmers' fields, recharge filter disseminated from 9.4 per cent farmers' fields, terracing disseminated from 9 per cent farmers' fields, gully plug disseminated from 5.33 per cent farmers' fields, and pond technology disseminated from 3.38 per cent farmers' fields of watersheds developed by IISWC and its Centres in the country. The important SWC technologies disseminated from watersheds were bunding, land leveling, check dam, recharge filter, terracing, gully plug technology and water pond due to the reasons of reduction in runoff & soil loss, moisture conservation, ground water recharge, and increase in agricultural production.

Key words: *diffusion, soil and water conservation technology, watershed management*

INTRODUCTION

Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003). 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 concerns the extent to which the new innovation is put to productive use. Early adopters are often referred to as innovators and the diffusion process as the spread of the innovation to other members of the population (Feder and Umali, 1993). According to Rogers' Theory of Diffusion of Innovation (Rogers, 1983) new ideas or technologies should be diffused to the intended user. However, adopters of innovation tend to explore the new technology, and experience how effectively it would work in their areas before accepting or rejecting those technologies.

When the farmers are satisfied with whatever new technology they have adopted, theyare 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 three types of technology discontinuance are: (1) replacement, (2) disenchantment and (3) forced discontinuance. Replacement discontinuance is a decision to reject an idea in order to adopt a better idea that supersedes it. Constant waves of innovations may occur in which each new idea replaces an existing practice that was an innovation in its day. For example, the adoption of tetracycline led to the discontinuance of two other antibiotic drugs (Coleman *et al.*, 1966). E-mail has replaced much postal mail. Many replacement discontinuances occur in everyday life. 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. Third type of discontinuance is also reported as forced discontinuance, it happens when individuals are compelled to change, farmers are forced to discontinue the existing practices because of government policies. For examples, chemicals like 2,4-dichlorophenoxyaceticacid and benzene hexachloride are banned for use in crop cultivation by governments in some countries due to their dangerous effect on human health and environment. Forced discontinuance happens when farmers are forced to change or discontinue the existing practices because of the government policies. Similarly, Government of India has also banned the burning of crop residue in view of harmful environmental effect and promoted the residue utilization through conservation agriculture. Inability discontinuance can also be the fourth type of discontinuance. Sometimes farmers discontinued an adopted technology because of his inability to maintain due to high cost or complexity of technology. For example, a poor farmer can't maintain bunding technology properly on his sloppy land and a breached concrete check dam can't be repaired by poor farmers.

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 (De Graaff *et al.*, 2008).

Bryce Ryan and Neal C. Gross's (1943) investigation of the diffusion of hybrid seed corn in Iowa found that the typical Iowa farmer first heard of hybrid seed from a commercial salesman, but that neighbors were the most influential channel in persuading a farmer to adopt the innovation. One of the most serious shortcomings of diffusion research is its pro-innovation bias. This problem was one of the first biases to be recognized (Rogers with Shoemaker, 1971). The pro-innovation bias is the implication in diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected.

IISWC and its Centres have developed many watersheds and implemented SWC technologies. Some of the adopted SWC technologies might have diffused from beneficiary farmers' fields to other farmers' fields within or outside of watersheds. Therefore, it was realized that the diffusion behaviour of beneficiary farmers who have adopted different SWC technologies for watershed management should be studied in detail regarding their present status of diffusion and factors responsible. Hence the study was framed with the main objective to assess the extent of diffusion of different SWC technologies from watersheds implemented by IISWC and 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), Datia (Madhya Pradesh), Kota (Rajasthan) and Ooty (Tamil Nadu). The earlier developed watersheds by IISWC and its Centres that were at least three years old were considered for the study and 4 or 5 developed watersheds were selected at each Centre for the study. A total of 37 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) of developed watersheds 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 1852 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 discontinued adoption behaviour variables were recorded on the schedule through personal interviewing of the respondents.

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

Name of Centre	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	Etmatpur (50), Boman (50), Raghupur (50), Jalalpur (50)	200
Bellary	Joladarasi (50), Chinnatekur (50), PC Pyapli (54), Mallapuram (54),Chilakanahatti (58)	266
Chandigarh	Aganpur-Bhagwasi (50), Mandhala (49), Johranpur (26), Kajiana (50)	175
Datia	Bajni (50), Jigna (50), Kalipahari (50), Agora (50), Durgapur (50)	250
IISWC, Dehradun	Fakot (50), Raipur (50), Sabhawala (51), Langha (60)	211
Kota	Chhajawa (50), Badakhera (50), Haripura (50), Hanotiya (50), SemliGokul(50)	250
Ooty	Salaiyur (50), Chikkahalli (50), Eramanaikkanpatti (50), Putthuvampalli (50), Thulukkamuthur (50)	250

Categorization of respondents: The respondents were classified into three categories in relation to the data regarding diffusion of SWC technologies from watersheds developed by IISWC and its Centres in the country with help of the following criteria:

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 = Class Interval

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

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

Measurement of diffusion of SWC technologies from watersheds: To measure the extent of diffusion of SWC technologies to other farmers' fields within watershed or nearby villages from the farmers' fields of watersheds developed by IISWC and its Centres, a detailed methodology was developed such as data collection schedule, scoring procedure and data analysis with the help of indicesas follows: (I) **Technologies Diffusion Index (TsDI):** Number of SWC technologies diffused out of total initially adopted technologies by a farmer from his field in watershed area and it could be worked out as given below.

$$TsDI = \frac{Number\ of\ SWC\ TechnoLogies\ Diffused\ by\ a\ Farmer}{Number\ of\ SWC\ TechnoLogies\ Initially\ Adopted\ by\ a\ Farmers} X\,100 \quad ---(1)$$

Overall Technologies Diffusion Index (OTsDI):

$$OTsDI = \frac{\sum_{i=1}^{N} TDI_i}{N} \quad ----------(2)$$

Where, $\sum_{i=1}^{N} TDI_i$ = Sum Total of Technology Diffusion Indices of i^{th} farmers

N = Total Number of farmers

(ii) **Technology Diffusion Index (TDI):** Number of farmersdiffused a particular SWC technology out of total initially adopted farmers of a watershed area and it could be worked out technology wise for each SWC technology as given below

$$TDI = \frac{number\ of\ farmers\ diffused\ a\ particular\ SWC\ technoLogy}{number\ of\ farmers\ initially\ adopted\ a\ partcular\ SWC\ technoLogy} X\,100 \ ---(3)$$

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

$$OTDI = \frac{\sum_{i=1}^{N} TDI_i}{N} \quad --------------------(4)$$

where,

$\sum_{i=1}^{N} TDI_i$ = sum total of particular technology diffusionindices of i^{th}watersheds for a SWC technology

N = Total number of watersheds in an area or region

RESULTS AND DISCUSSION

Levels of Diffusion of SWC Technologies from Farmers' Fields of Watersheds Developed by IISWC and its Centres

The data in Table 2 shows that the majority of farmers were disseminated mechanical SWC technologies at low level from the watersheds developed by Bellary (81.20%),Vasad (75.2%), Ooty (73.6%), Datia (58%), Chandigarh (52.57%) and Kota (52%) Centres in the country. The majority of farmers were diffused at moderate level from the watersheds developed by Agra Centre (50%) and IISWC, Dehradun (44.07%). A few farmers have also disseminated SWC technologies at high level from their fields for natural resource conservation. The overall pooled data revealed that majority (60.53%) of farmers were disseminated mechanical SWC technologies from their fields at low level, followed by about thirty per cent (29.10%) of farmers disseminated at moderate level and only ten percent (10.37%) of farmers were disseminated SWC technologies at high level. The low level of diffusion of mechanical SWC technologies might be due to the high cost incurred in initial construction and adoption of mechanical SWC measures for natural resource conservation by poor farmers having mostly small or medium size land holdings.

Table 2
Levels of diffusion of mechanical SWC technologies from watersheds developed by IISWC and its Centres in India

Levels of diffusion of SWC technologies from watersheds	Number of farmers selected from watersheds								Pool
	Vasad	Dehradun	Chandigarh	Bellary	Kota	Agra	Ooty	Datia	
	Navamota, Rebari, Sarnal, Antisar & Vejalpur (n=250)	Fakot, Raipur, Sabhawala & Langha (n=211)	Aganpur Bhagwasi, Mandhala, Johranpur & Kajiyana (n=175)	Joladarasi, Chinnat-ekur, PC Pyapli, Mallapur-am &Chilakan a-hatti (n=266)	Chhajawa, Badakheda, Haripura, Hanotiya& Semli Gokul (n=250)	Etmatpur, Boman, Raghupur, & Jalalpur (n=200)	Salaiyur, Chikka-hali, Ermanai-kkanpatti ,Putthuva -mpalli & Thulukk-amuthur (n=250)	Bajni, Jigna, Kalip-ahari, Agora & Durg-apur (n=250)	(1852)
Low	188 (75.2)	96 (45.50)	92 (52.57)	216 (81.20)	130 (52)	70 (35)	184 (73.6)	145 (58)	1121 (60.53)
Moderate	42 (16.8)	93 (44.07)	67 (38.29)	35 (13.16)	95 (38)	100 (50)	43 (17.2)	64 (25.6)	539 (29.10)
High	20 (8)	22 (10.43)	16 (9.14)	15 (5.64)	25 (10)	30 (15)	23 (9.2)	41 (16.4)	191 (10.37)

Note: The data in parentheses are in percentage.

Extent of Diffusion of SWC Technologies

Table 3 shows the OTsDI data regarding extent of diffusion of SWC technologies from watersheds developed by eight research Centres of IISWC in the country. It was found out that majority more than two-third (68.63%) SWC technologies were diffused from Navamota, followed by sixty per cent (60.61%) from Rebari, forty per cent (41.50%) from Vejalpur Rampura, more than one-third (38.56%) from Sarnal and more than one-fourth (30.45%) SWC technologies were diffused from Antisar watersheds developed by Research Centre Vasad. The pooled OTsDI value shows that overall 47.95 per cent of SWC practices were diffused from these five watersheds developed by Vasad Centre ofIISWC in Gujarat state.

At IISWC Dehradun, it was revealed that fifteen percent (15.72%) SWC technologies were diffused from Raipur, followed by ten percent (10.71%) from Sabhawala, 7.97% from Langha and 7.04% of SWC practices were diffused from Fakot watersheds. The pooled OTsDI value shows that ten percent (10.36%) SWC technologies were diffused from the watersheds developed by IISWC, Dehradun in Uttrakhand state. The low diffusion of technologies in this region might be due to that these watersheds were lies in foothills of Himalaya where the movement and communication within farmers is very less due to hilly tract and lack of transportation facilities.

Table 3 also shows that one-fourth (26.2%) SWC technologies were diffused from Aganpur Bhagwasi, followed by one-fifth (21.47%) SWC technologies were diffused from Johranpur, 13.25 per cent of SWC practices were diffused from Mandhala, 1.72 per cent technologies diffused from Kajiyana and no SWC technology was diffused from Sabeelpur watersheds developed by research Centre Chandigarh in Haryana state. The pooled OTsDI value shows that 15.66 per cent SWC technologies were diffused for natural resource conservation from watersheds developed by research Centre Chandigarh in Haryana State.

One-fourth(25.06%) of SWC technologies were diffused from Mallapuram, followed by more than one-fifth (22.56%) technologies diffused from Chilakanahatti,16.12per cent technologies diffused from PC Pyapli, about ten per cent (9.56%) technologies diffused from Chinnatekur and only 4.80 per cent SWC technologies were diffused from Joladarasi watersheds. The pooled OTsDI value shows that fifteen per cent (15.62%) SWC technologies were diffused from watersheds developed by research Centre Bellary in Karnataka state.

Table 3

Overall extent of diffusion of mechanical SWC technologies from watersheds developed by IISWC and its Centres in India

Name of Research Centre (RC)	Name of watersheds	OTsDI values	Pooled OTsDI values
RC, Vasad, Gujarat	Navamota (n=50)	68.63	47.95
	Rebari (n=50)	60.61	
	Saranal (n=50)	38.56	
	Antisar (n=50)	30.45	
	Vejalpur (n=50)	41.50	
IISWC, Dehradun, Uttrakhand	Fakot (n=50)	7.04	10.36
	Raipur (n=50)	15.72	
	Sabhawala (n=51)	10.71	
	Langha (n=60)	7.97	
RC, Chandigarh, Haryana	AganpurBhagwasi(n=50)	26.2	15.66
	Mandhala (n=49)	13.25	
	Johranpur (n=26)	21.47	
	Sabeelpur (n=50)	0	
	Kajiyana (n=50)	1.72	
RC, Bellary, Karnataka	Joladarasi(n=50)	4.80	15.62
	Chinnatekur (n=50)	9.56	
	PC Pyapli (n=54)	16.12	
	Mallapuram (n=54)	25.06	
	Chilakanahatti (n=58)	22.56	

RC, Kota, Rajasthan	Chhajawa(n=50)	45.90	41.83
	Badakheda (n=50)	82.58	
	Haripura (n=50)	62.67	
	Hanotiya (n=50)	11	
	Semli Gokul (n=50)	7	
RC, Agra, Uttar Pradesh	Etmatpur(n=50)	31.96	39.46
	Boman (n=50)	41.68	
	Raghupur (n=50)	44.14	
	Jalalpur (n=50)	40.07	
RC, Ooty, Tamil Nadu	Salaiyur(n=50)	12.10	18.24
	Chikkahali (n=50)	39	
	Eramanaikkanpatti (n=50)	18.39	
	Patthuvampalli (n=50)	12.83	
	Thulukkamuthur (n=50)	8.9	
RC, Datia, Madhya Pradesh	Bajni(n=50)	32.28	33.45
	Jigna (n=50)	36.48	
	Kalipahari (n=50)	45.97	
	Agora (n=50)	27.66	
	Durgapur (n=50)	24.75	
Average			**27.82**

The OTsDI values in Table 3 further revealed that eighty per cent (82.58%) SWC technologies were diffused from Badakheda, followed by about sixty per cent (62.67%) technologies diffused from Haripura, forty five per cent (45.90%) technologies diffused from Chhajawa, above ten per cent (11%) technologies diffused from Hanotiya and only 7per cent SWC technologies were diffused from Semli Gokul watersheds. The pooled OTsDI value shows that forty per cent (41.83%) of SWC technologies were diffused from watersheds developed by research Centre Kota in Rajasthan state.

At research Centre Agra, it was found out that more than forty per cent (44.14%) of SWC technologies were diffused from Raghupur watershed, forty per cent (41.68%) SWC technologies diffused from Bomanas well as from Jalalpur (40.07%), and above thirty per cent (31.96%) SWC practices diffused from Etmatpur watersheds. The OTsDI shows that overall about forty per cent (39.46%) of SWC technologies were diffused from the watersheds developed by research Centre Agra in Uttar Pradesh state.

The OTsDI values in Table 3 revealed that 39 per cent of SWC technologies were diffused from Chikkahali watershed, followed by about one-fifth (18.39%) technologies diffused from Eramanaikkanpatti, about twelve per cent technologies diffused from Patthuvampalli (12.83%) as well as Sailyur (12.10%) and 8.9 per cent SWC practices were diffused from Thulukkamuthur watersheds. The pooled OTsDI value shows that overall about one-fifth (18.24%) of SWC technologies were diffused from watersheds developed by research Centre Ooty in Tamil Nadu state of country.

Forty five per cent (45.97%) of SWC technologies were diffused from Kalipahari watershed, followed by about one-third technologies diffused from Jigna (36.48%) as well as Bajni (32.38%) and about one-fourthof SWC technologies were diffused from Agora (27.66%) and Durgapur (24.75%) watersheds. The pooled

OTsDI value shows that one-third (33.45%) of SWC technologies were diffused from watersheds developed by Datia Centre in Madhya Pradesh state.

The overall average extent of diffusion of SWC technologies in the watersheds developed by IISWC and its research Centres was studied with help of average of OTsDI values and it was measured that more than one-fourth (27.82%) SWC technologies were diffused from watersheds developed by IISWC and its Centres in the country.

Diffusion of mechanical SWC technologies from watersheds

Table 4
Diffusion of particular mechanical SWC technology from watersheds developed by IISWC and its Centres in India

Name of technologies diffused from watersheds	**Overall Technology Diffusion Index (OTDI)**							**Pool**
	Vasad	**Dehra dun**	**Bellary**	**Kota**	**Agra**	**Ooty**	**Datia**	
	Navamota, Rebari, Sarnal, Antisar & Vejalpur Rampura (n=250) %	Fakot, Raipur, Sabha-wala & Langha (n=211) (%)	Joladarasi, Chinnate-kur, PC Pyapli, Mallapur-am & Chilakan-ahatti (n=266) %	Chhajawa, Badakheda, Haripura, Hanotiya&Semli Gokul (n=250) %	Etmatpur, Boman, Raghupur, Jalalpur (n=200) %	Salaiyur, Chikkahali, Ermanaikk-anpatti, Patthuva-mpalli&Thulukka-muthur (n=250) %	Bajni, Jigna, Kalipah-ari, Agora & Durgapur (n=250) %	
Check dam	17.2	-	7.41	35.33	2	-	3	12.98
Pond	5	-	4.32	3	2	4	2	3.38
Recharge filter	8	-	-	-	-	-	10.8	9.4
Land Levelling	14.15	-	-	36.67	39	10.67	23.2	24.73
Terracing	3	14	-	-	10	-	-	9
Gully Plug	8	2	-	6	-	-	-	5.33
Bunding	46	-	28.24	61.63	34.50	24	32	37.72

OTDI values regarding extent of diffusion of important SWC technologies from watersheds developed by IISWC and its Centres in the country are presented in Table 4. It was revealed that maximum 37.72 per cent farmers responded that bunding technology was diffused from their fields in watersheds developed by IISWC and its Centres in the country. Followed by land leveling technology was diffused from 24.73 per cent farmers' fields of watersheds developed by IISWC and its Centres in the country. Check dam technology was disseminated only from 12.98 per cent farmers' fields to other farmers' fields for natural resource conservation. It might be due to that the Check dam is an expensive technology, it cannot be adopted easily because high cost is incurred in construction of check dam. Recharge filter technology was diffused from 9.4 per cent farmers' fields from the watersheds developed by Vasad and Datia Centres. Terracing technology was diffused by 9 per cent farmers' fields of watersheds developed by Vasad, Dehradun and Agra Centres. Gully plug technology was diffused from 5.33 per cent farmers' fields and Pond technology was also diffused from 3.38 per cent farmers' fields of watersheds developed by IISWC and its Centres for soil and water conservation and sustainable agricultural production in the country. The findings revealed that most important mechanical SWC technologies diffused from farmers' fields were bunding, land leveling and check dam.

Reasons for Diffusion of Bunding SWC Technology

The data in Table 5 represents important reasons for diffusion of bunding technology and overall pool data show that bunding technology was diffused from 222 farmers' fields and adopted by other farmers due tothe reason that bunding reduces soil loss and runoff. Moisture conservation was another second most reason for diffusion of bunding technology from 139 farmers' fields of watersheds developed by IISWC & its Centres. More yield was third reason for diffusion of bunding technology from 133 farmers' fields of watersheds. Ground water recharge was considered a fourth important reason by 69 farmers for diffusion of bunding technology. The other reasons to diffusion of bunding technology were land leveling, grass production and prevention of nutrient losses as considered by 23, 8 and 6 farmers, respectively.

Table 5

Reasons for diffusion of bunding SWC technology as perceived by farmers of watersheds developed by IISWC and its Centres

Reasons for diffusion of bunding technology	**Number of farmers**					**Pool**
	Vasad	**Bellary**	**Kota**	**Agra**	**Ooty**	
	Navamota, Rebari, Sarnal, Antisar (n=200)	Chinnatekur, PC Pyapli, Mallapuram & Chilakanahatti (n=208)	Chhajawa, Badakheda &Haripura (n=150)	Etmatpur, Boman, Raghupur, Jalalpur (n=200)	Chikkahali&Erma naikkanpatti (n=100)	
Moisture conservation	22	7	11	67	32	139
To reduce soil loss & runoff	65	52	58	17	30	222
Ground water recharge	21	-	21	15	12	69
Land leveling	17	5	1			23
More yield	63	11	-	42	17	133
Grass production	8	-	-	-		8
Prevention of nutrient loss	-	-	-	-	6	6

Reasons for Diffusion of Land Leveling Technology

Table 6 shows data regarding important reasons for diffusion of land leveling technology from watersheds developed by IISWC and its centers in the country. It was found out that highest 199 farmers perceived the moisture conservation was important reason for diffusion of land levelling technology from their fields. More production was another reason for diffusion of land leveling technology as perceived by 182 farmers. Soil and water conservation due to land levelling technology was considered by 120 farmers. Uniform application of water was considered another reason by 105 farmers of watersheds developed by IISWC and its Centres. The other important reasons for diffusion of land leveling were reduction in runoff and easy agricultural operations as perceived by 60 and 3 farmers, respectively.

Table 6
Reasons for diffusion of land leveling SWC technology as perceived by farmers of watersheds developed by IISWC and its Centres

Reasons for diffusion of land leveling technology	**Number of farmers**					**Pool**
	Vasad	**Kota**	**Agra**	**Ooty**	**Datia**	
	Navamota, Rebari, Sarnal, Antisar & Vejalpur (n=250)	Chhajawa, Badakheda, Haripura, (n=150)	Etmatpur, Boman, Raghupur, Jalalpur (n=200)	Chikkahali, Ermanaikkanpatti, Patthuvampalli & Thulukkamuthur (n=200)	Bajni, Jigna, Kalipahari, Agora & Durgapur (n=250)	
Moisture conservation	4	12	72	16	95	199
More production	15	-	63	9	95	182
Reduction in runoff	-	3	-	8	49	60
Uniform application of water	2	24	-	14	65	105
To conserve soil & water	13	35	20	-	52	120
Easy in agricultural operations	1	2	-	-	-	3

Reasons for diffusion of Check dam technology

The overall pooled data in Table 7 show that majority 72 farmers considered that Check dam technology was diffused from their fields due to the reason that it reduces soil loss and runoff. Rainwater harvesting was another reason for diffusion of check dam technology from their fields as perceived by 19 farmers. Ground water recharge and increase in crop production were other reasons for diffusion of check dam technology as perceived by 5 and 2 farmers respectively from their fields' lies in watersheds developed by IISWC and its Centres.

Table 7
Reasons for diffusion of Check dam SWC technology as perceived by farmers of watersheds developed by IISWC and its Centres

Reasons for diffusion of check dam technology	**Number of farmers**			**Pool**
	Vasad	**Bellary**	**Kota**	
	Navamota, Rebari, Sarnal, Antisar & Vejalpur (n=250)	PC Pyapli, Mallapuram&Chila kanahatti (n=166)	Chhajawa, Badakheda, Haripura (n=150)	
To reduce soil loss & runoff	10	4	58	72
Rain water harvesting	17	2	-	19
Ground water recharge	3	2	-	5
Increase in crop production	2	-	-	2

Reasons for diffusion of water pond technology

Table 8
Reasons for diffusion of water pond technology as perceived by farmers of watersheds developed by IISWC and its Centres

Reasons for diffusion of water pond technology	Number of farmers					Pool
	Vasad	Bellary	Kota	Agra	Ooty	
	Navamota, Rebari, Vejalpur (n=150)	Chinnatekur, Mallapuram&Chilakanahatti (n=162)	Badakheda (n=50)	Boman (n=50)	Patthuvampalli& Thulukkamuthur (n=100)	
Water harvesting	10	1	2	-	-	13
Well recharge	1		3	-	-	4
Animal drinking water	4	1	-	1	-	6
Ground water recharge	5	3	-	2	4	14
Water for irrigation	4	2	-	1	2	9

The overall pool data in Table 8 show that the ground water recharge was most important reason for diffusion of water pond technology from the fields of14 farmers of watersheds developed by IISWC and its Centres in the country. Water harvesting was second important reason for diffusion of pond technology from 13 farmers' fields. Availability of water for irrigation was third important reason for diffusion of pond from9 farmers' fields. The other important reasons for diffusion of pond technology were animal drinking water and well recharge as considered by 6 and 4 farmers, respectively.

Reasons for Diffusion of Terracing SWC Technologies:

The Table 9 reveals that terracing technology was mostly adopted by farmers in ravine areas of Vasad and Agra Centres as well as in hilly region of IISWC Dehradun. Further the overall pool data show that the highest 20farmers were considered increase production from ravine lands as most important reason for diffusion of terracing technology from their fields. The second most important reason was less soil erosion for diffusion of terracing from13farmers' fields. The third important reason was moisture conservation for diffusion of terracing technologyfrom10 farmers' fields of watersheds developed by IISWCand its Centres in the country.

Table 9
Reasons for diffusion of terracing technology as perceived by farmers of watersheds developed by IISWC and its Centres

Reasons for diffusion of Terracing Technology	Number of farmers			Pool
	Vasad	Dehradun	Agra	
	Navamota (n=50)	Fakot (n=50)	Boman, Jalalpur (n=100)	
Moisture conservation	1	3	6	10
Less soil erosion	1	4	8	13
Increase production	-	8	12	20

CONCLUSION

The study revealed that majority sixty per cent of farmers (60.53%) have diffused SWC technologies at low level, followed by about thirty per cent of farmers (29.10%) diffused SWC technologies at moderate level and only ten percent farmers (10.37%) were diffused SWC technologies at high level from their fields to other farmers fields for natural resource conservation. The overall extent of diffusion of SWC technologies was studied and average OTsDI value revealed that more than one-fourth (27.82%) of mechanical SWC technologies were diffused from watersheds developed by IISWC and its Centres in the country.

The OTDI values revealed that bunding technology was diffused from maximum 37.72 per cent farmers' fields, followed by land leveling technology diffused from 24.73 per cent farmers' fields, Check dam technology diffused from 12.98 per cent farmers' fields to other farmers' fields for the cause of soil and water conservation. Recharge filter technology was diffused from 9.4 per cent farmers' fields, terracing technology was diffused from 9 per cent farmers' fields, Gully plug technology was diffused from 5.33 per cent farmers' fields, and water pond technology was diffused from 3.38 per cent farmers' fields in watersheds developed by IISWC and its Centres for natural resource conservation and sustainable agricultural production.

Reduction in runoff and soil loss was the important reason for diffusion of bunding technology as perceived by farmers. Moisture conservation was the important reason for diffusion of land leveling technology. Reduction in soil loss and runoff was also reason for diffusion of Check dam technology. Ground water recharge was the important reason for diffusion of water pond technology and increase in agricultural production in sloppy lands was the important reason for diffusion of terracing technology from watersheds developed by IISWC and its Centres in the country.

Therefore, it could be concluded from the study that the mechanical SWC technologies were diffused at low level from majority of farmers' fields because these technologies require high level of technical input and capital investment in adoption. The overall only one-fourth of SWC technologies were diffused from farmers' fields to nearby agricultural fields within or outside villages for soil and water conservation and sustainable agricultural production. The most important SWC technologies diffused from farmers' fields were bunding, land leveling, check dam for natural resource conservation and agricultural production.

Based on the study findings, the following implications were drawn. There is need for sensitization of farmers to adopt SWC technologies through collective contribution of money and labour on watershed basis because high cost incurred in initial construction and adoption of mechanical SWC technologies and due to that poor farmers having small or medium size land holdings face difficulty in adoption of these technologies. The bunding, land levelling and earthen check dam low cost mechanical SWC technologies could be more suitable technologies for natural resource conservation on watershed basis for reduction in runoff and soil loss, moisture conservation, rain water harvesting and ground water recharge. Farmers' visits should be conducted to successful developed watersheds for more diffusion of SWC technologies.

Paper received on 14.06.2022
Accepted on 25.06.2022

REFERENCES

Bryce Ryan, and Neal C. Gross, 1943. "The Diffusion of Hybrid Seed Corn in Two Iowa Communities." *Rural Sociology,* 8:15-24 RS (E)

Coleman, James S., Elihu Katz, and Herbert Menzel, 1966.*Medical Innovation: A Diffusion Study*, New York: Bobbs-Merrill. PH(E).

De Graaff, J., A.Amsalu, F.Bodnar, A.Kessler, H.Posthumus, andA.Tenge, 2008. Factors influencing adoption and continued use of long-term soil and water conservation measures in five developing countries. *Applied Geography*, 28: 271- 280.

Feder G. and D.L. Umali, 1993. The adoption of agricultural innovations: A review. *Technol Forecast Soc*, 43: 215-219.

Leuthold, O.Frank, 1967. "Discontinuance of Improved Farm Innovations by Wisconsin Farm Operators." *Ph.D.diss.*, University of Wisconsin, Madison. RS (E).

Minten, B. and B.C. Barrett, 2008. Agricultural technology, productivity and poverty in Madagascar. *World Development*, 36(5): 797-822.

Oladele, O.I. (2005) A tobit analysis of propensity to discontinue adoption of agricultural technology among farmers in southern Nigeria. *Journal of Central European Agriculture*, 6 (3): 249-254.

Rogers E. M., (1983) Diffusion of Innovations (3rd ed.). *The Free Press,* New York.

Rogers, E.M.,(1995) Diffusion of Innovations.*The Free Press*, New York.

Rogers, E.M.,(2003) Diffusion of Innovations. *The Free Press*: 1-5, 21-38.

Rogers, E.M. and F. F. Shoemaker, 1971. Communication of Innovations. *The Free Press,*New York.

Sarkar J., 1998. Technological diffusion: alternative theories and historical evidence. *J Econ Survey,* 12: 131-176.

Van Tongeren P., 2003. Assessing Agricultural Development Interventions in the western highlands of Guatemala: A farmer centered Approach. *Unpublished master's thesis*, Michigan state university, East Lansing.

....