Post Adoption Behavior of Farmers towards Soil and Water Conservation Technologies in a Semi-Arid Watershed

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ABSTRACT

The behaviour of farmers towards soil and water conservation (SWC) technologies – basically under three categories viz, engineering, agronomy and forestry - tends to undergo changes over time during the post adoption phase of the watershed. They prefer continuance as such or with some technological gaps or discontinuance altogether corresponding to the nature of these respective technologies. The probable reasons behind their behavioral pattern might disclose some ideas to help redesigning these technologies or at least the approach, for an effective technology transfer and its sustainability. Hence, it was found necessary to analyze the post adoption behavior of selected watershed farmers with reference to these SWC technologies. Joladarasi, a semi-arid watershed in Bellary district, Karnataka was identified, and a study were undertaken for this purpose in 2012. A questionnaire addressing the behavioural pattern of the farmers with reference to the selected technologies was prepared and data were collected from selected 50 small farmers. The collected data were analyzed using a set of behavioural indices developed for this purpose. The results showed that rate of continuance adoption were comparatively high in the case of engineering technologies (92.96%), followed by that of agronomy (51.61%) and forestry (16.66%). The rates of technologies with technological gap were comparatively more in the field of agronomy (29.03), whereas the non adoption rate was highest among forestry technologies (83.34%). It was concluded that, in case of engineering technologies, apart from mere transfer of technology, farmers have to be trained on skills of maintenance of those structures. With reference to agronomical measures, a situational contingency plan to try different options must be a part of the package of practices. For sustainable adoption of forestry oriented technologies, sensitization on community participation must be emphasized, as they have high potential in common lands.

***Key words:** Soil and Water Conservation; Post adoption behavior; Technology adoption; Technological gap;*

Adoption is an individual process detailing the series of stages one undergoes from first hearing about a product to finally adopting it. *Rogers (1983)* termed adoption process as 'Innovation Decision Process' through which an individual passes from first knowledge of an innovation, to forming an attitude towards the innovation, to a decision to adopt or reject, to implementation of the new technology or idea, and to confirmation of this decision. Further, once adopted, there is every chance that the particular technology is being continued with the same specifications or with some technological gaps or discontinued completely. There are some barriers to continue adoption of a technology over the time due to improvement or modification in the technology. Thus, adoption of improved technologies will neither improve food security nor reduce poverty if barriers to their continued use are not overcome *(Oladele, 2005)* or not widely diffused *(Uaiene, 2009). Rogers (2003)* reported two types of reasons for discontinuing a technology use on the part of farmers; that is, replacement discontinuance, where farmers discontinue using the existing technology in order to adopt a superior one, and disenchantment discontinuance, where a decision to discontinue a technology, with or without replacement, is due to dissatisfaction with its performance. A particular 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. Technology complexity (*Singha and*

Baruah 2011), uncertain costs and benefits (*Uaiene, 2009*) associated with new technologies affect adoption and diffusion process. Sometime, there is a gap in technology developed at experimental farms and technology adopted by farmers in their fields. The reason may be that those farmers are not adopting the technologies as per the recommended parameters or components. This is called technological gap. Similarly, if a technology is well adopted by farmers and resulted in success, it might attract many surrounding farmers. They in turn would try to emulate the same. In this fashion, the process by which an innovation spreads within a social system is called technology diffusion.

In general, adoption behaviour of farmers hold true for Soil and Water Conservation (SWC) technologies as well. The base spectrum from which SWC technologies generally originates is vast that comprise mainly engineering, agronomy and forestry/horticulture streams. Though all are important as far as the conservation point of view, there are always differences in case of adoption and continue adoption at the field level. Literature and experience of experts say that engineering measures are found to be tough to be adopted by the farmers on their own. But, they would certainly continue, at least with some technological gaps (*Adhikari et al., 2010*). In case of agronomic measures, they are quickly to be adopted, but their continuance depends on existence of other factors like change of cropping system/crop/varieties or hybrids and their profitability and suitability. As far as forestry oriented technologies are concerned, though farmers adopt, their discontinuance rate is comparatively higher owing to the risk involved in their maintenance.

Given the production risks posed by diminishing soil and water resources in semi-arid plains, information on behaviour of farmers towards continue adoption, adoption with technological gaps and discontinuance of SWC technologies in a watershed could be used by technology generators, decision makers and dissemination agencies to identify lacunas and redesign appropriate practices for future resource conservation (*Kato et al., 2009; Alufah et al., 2012*). To explore post adoption behaviour of farmers towards SWC technologies after adoption at Joladrasi watershed (1983-88) of Bellary district, Karnataka, a study was undertaken in 2012.

METHODOLOGY

This study was conducted in Joladarasi watershed (15? 18’ 22.07 N and 77?06’38.06 E) located in Hagari river (tributary of Krishna river) catchments under northern dry zone of Karnataka. Central Soil and Water Conservation Research and Training Institute (CSWCRTI) Research Centre, Belary, implemented a watershed development programme in Joladarasi village during 1983-88 as an operational research project. General climate of watershed is semi-arid, receives 60% rainfall from June to September. Farmers’ demographic profile of the watershed comprises mainly of small and marginal farmers (86%).

First of all, a list of technologies implemented in the watershed during 1983-88 was prepared. Those technologies were divided into the three major categories– engineering, agronomy and forestry. In total, 14 technologies (Seven Engineering, four agronomy and three forestry) were recommended and introduced to the farmers by CSWCRTI, Bellary in the watershed. A questionnaire comprising the questions with an intention to address different bevavioral pattern of the farmers was prepared. They covered the different post adoption scenario – continue adoption, continue adoption with technological gap, discontinuance and diffusion – of those implemented technologies. From the population of 102 farmers in the Joladarai watershed, 50 were selected for the study and data were collected from them using the questionnaire. Though the technologies were promoted during 1983-88 and the data were collected in 2012, the problem of recalling the adoption related information was well addressed. This was possible due to the proper maintenance of those old records at the office and involvement of same field staff who engaged in the watershed programme in Joladarasi village in 80’s. For analyzing the collected data, a set of behavioural indices was prepared. The behavioral computation, comprising given below indices, was used for the purpose of analysis:

Technology Continue-Adoption Index (TCAI)

This is the percentage of farmers continuously adopting a technology from the total number of farmers initially adopted that particular technology. This is explained by the given below formula:

$$TCAI = \frac{\text{No. of farmers continues to adopt a tech.}}{\text{Total no. of farmers initially adopted a tech}} \times 100$$

Discontinuance Index of Technology (DIT): This is the percentage of farmers discontinued a technology from the total number of farmers initially adopted that particular technology. This is explained by the given below formula:

$$DIT = \frac{\text{No. of farmers continues to adopt a tech.}}{\text{Total no. of farmers initially adopted a tech.}} \times 100$$

Technological Gap Index (TGI): This is with reference to the score that a farmer obtains on continuing a technology with a gap in relation to the total number of farmers adopted that particular technology with technological gap. The scores were given by the experts of respective fields by examining the technologies and the magnitude of those technological gaps.

$$TGI = \frac{\sum_{i=1}^{n}\left|\frac{R-A}{R}\right|}{N} \times 100$$

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

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

N = Total number of farmers adopted that particular technology with gap

Technology Diffusion Index (TDI): Diffusion signifies a group phenomena, which suggests how an innovation (technology in this case) spreads outside. So, here this index can be interpreted as the percentage of farmers who are involved in diffusing a technology that they adopted, from the total number of farmers who initially adopted that particular technology. This is explained by the given below formula:

$$TDI = \frac{\text{No. of farmers who diffused a tech. outside}}{\text{Total no. of farmers initially adopted a tech.}} \times 100$$

While collecting data through questionnaire, farmers were asked about their role in spreading a particular technology. In the sense, whether they pass or share any inputs or management practices with other farmers outside the study area. So, among the total number of selected farmers, number of farmers who spread the technology outside was noted down (technology wise) and the TDI was calculated accordingly.

Few soil and water conservation technologies introduced on community land, waste land and drainage line for which there were no direct individual beneficiaries, the immediate nearby farmers who get indirect benefits were selected as respondents.

For arriving at Overall indices of technologies under different measures at watershed level, given below formulae were used for the calculation:

Overall Technology Continue-Adoption Index (OTCAI)

$$OTCAI = \frac{\text{Total no. of farmers continued the adopted tech.}}{\text{Total no. of farmers adopted the tech.}} \times 100$$

Overall Discontinuance Index (ODI)

$$OTCAI = \frac{\text{Total no. of farmers discontinued the tech.}}{\text{Total no. of farmers adopted the tech.}} \times 100$$

Overall Technological Gap Index (OTGI)

$$OTGI = \frac{\text{Total no. of farmers continued the tech. with techl. gap}}{\text{Total no. of farmers adopted the tech.}} \times 100$$

Overall Technology Diffusion Index (OTDI)

$$OTGI = \frac{\text{Total no. of farmers involved in diffusing the tech.}}{\text{Total no. of farmers adopted the tech.}} \times 100$$

RESULTS AND DISCUSSION

For better understanding, the results are shown under the three above mentioned categories viz, engineering, agronomical and forestry.

Among the 50 respondents, 48 were introduced with graded bunding. In which, one has discontinued and other one is continuing with technological gap. Waste weirs introduced in 48 farmers' fields were being adopted continuously in all the 48 fields. Among the 11 watershed farmers, who were introduced with farm ponds, nine were continuing with technological gap whereas two farmers closed the pond with soil and leveled them for cultivation. Land smoothening was done on 28 farmers' fields and is being continued in all the farmers' fields for *in situ* rainwater conservation to augment crop productivity. Both diversion drain and grassed water ways, introduced in three famers' fields, were discontinued and zing terrace introduced in one farmer's field was discontinued.

In case of agronomical technologies, the technology - coriander-safflower (4:2) intercropping - was initially adopted by almost all the selected 50 respondents. But, only 24 among them continued it, in which 18 continued with some technological gaps. *Kessler (2006)* also felt in similar line that SWC measures fully adopted only when their execution is sustained and fully integrated in the household's farming

Table 1. Technology matrix of SWC technologies implemented at Joladarasi watershed (N=210)

Name of Technologies	1	2	3	4	5	6
Engineering						
Graded Bund	48	47	1	46	1	0
Waste weir	48	48	0	48	0	0
Farm Pond	11	9	2	0	9	0
Land smoothening	28	28	0	28	0	0
Diversion drain	3	0	3	0	0	0
Water ways / Grassed waterways	3	0	3	0	0	0
Zingg terrace	1	0	1	0	0	0
Sub Total	142	132	10	122	10	0
Agronomical						
Coriander-Safflower (4:2) intercropping	50	24	26	6	18	10
Border strip	2	0	2	0	0	0
Sorghum	8	8	0	8	0	0
Redgram	2	0	2	0	0	0
Sub Total	62	32	30	14	18	10
Forestry						
Community plantation	2	0	2	0	0	0
Vegetative barrier	1	0	1	0	0	0
Bund/Border plantation	3	1	2	1	0	0
Sub Total	6	1	5	1	0	0
Over all Total	210	165	45	137	28	10

1-Total no. of farmers adopted technology; 2-No. of farmers continue to adopte technology; 3- No. of farmers discontinued technology; 4-No. of farmers completely adopted technology; 5-No. of farmers adopted technology with technological gap; 6-No. of farmers diffused a technology;

system. In case of border strip, both the farmers who adopted have discontinued the technology. Cultivation of sorghum is being continued by all the eight adopted farmers, whereas red gram was discontinued by the adopted two farmers.

Overall post-adoption scenario of forestry related technologies were not much encouraging as interventions like community plantation, vegetative barrier and bund/border plantation were almost discontinued by the adopted farmers.

Table 2 shows the figures obtained using the indices described below.

The results show that the TCAIs are comparatively more in technologies of engineering, followed by agronomical and forestry oriented technologies in general. In specific, the continue adoption rate of technologies like graded bund, waste weir and farm pond

Table 2. Indices of technology continue-adoption, discontinuance, technological gap and diffusion

Technologies	TCAI (%)	DIT (%)	TGI (%)	TDI (%)
Engineering				
Graded Bund	97.92	2.08	90	—
Waste weir	100.00	0.00	—	—
Farm Pond	81.82	18.18	50	—
Land smoothening	100.00	0.00	—	—
Diversion drain	0.00	100.00	—	—
Water ways / Grassed waterways	0.00	100.00	—	—
Zingg terrace	0.00	100.00	—	—
Agronomical				
Coriander-Safflower (4:2) intercropping	48.00	52.00	50	20.00
Border strip	0.00	100.00	—	—
Sorghum	100.00	0.00	—	—
Red gram	0.00	100.00	—	—
Forestry				
Community plantation	0.00	100.00	—	—
Vegetative barrier	0.00	100.00	—	—
Bund/Border plantation	33.33	66.67	—	—

were more than 80 per cent. The reasons behind high rate of continue adoption of technologies like graded bund, waste weir and land smoothening may be attributed to the fact that there was little effort from the farmers' side for their maintenance. However, barring the technology - land smoothening, farmers did involve in minor repairs of graded bund and waste weir, which made them intact all these years. Though the TGI of graded bund was at 90 per cent, it is worth to mention here that only one farmer continued this technology with technological gap. Hence, it is negligible. But, in case of the technology – farm pond, though TCAI is 81.82 per cent, all the farmers who continued this technology, continued with some technological gaps, as shown in the Table 1. The TGI of this technology is found to be at 50 per cent as per Table 2, which means that average technological gap of those 9 adopted farmers was at 50 per cent. These ponds were found with some minor or major problems like siltation, breakages in in-let or out-let etc, which only were reflected in gap index. The negligence among farmers was the key reason behind these gaps. However, though many of them could not repair the damages, they could have performed desiltation work. This also means that the main purpose of construction of these ponds - supplementary irrigation during *rabi* season, was not fulfilled in complete sense. However, they were successful to some extend as they are acting as storage structure of excess run-off water to be collected during monsoon showers, drinking water source for animals, usage for mixing with pesticides, drinking purpose etc. So, in this context, this technology was considered as a continued one with TGI at 50 per cent. The two farmers who discontinued the farm pond cited the reasons like – to utilize the land for cultivation purpose, animal menace when they come for drinking purpose. In case of technologies like diversion drain, water ways / grassed waterways and zingg terrace, there was 100% discontinuance. This may be due to the reasons like – lack of technical competence at the farmers' level to maintain these structures which ended in siltation, unawareness among the farmers about the indirect benefits of these technologies and disruption from other sources like gravel quarry, railway lines extension etc, especially in case of diversion drain. As reported by *Wubneh (2007)*, some subsistence farmers in the Koga watershed of Ethiopia were hesitant to accept different measures such as terracing, check dam construction and gully planting, and cut-off drains, as they might not believe that these measures were effective, or they might have socio-economic challenges that restrict use of the specific promoted SWC technologies.

In case of agronomical technologies, red gram and border strip were completely discontinued. This may be due to less preference by the farmers for red gram and unawareness about the indirect benefit of border strip. Whereas, sorghum has been continued with the TCAI at 100 per cent. Here the role of sorghum as fodder crop for animals had played a major role. In case of coriander-safflower intercropping, almost 50 per cent of the farmers continued with this technology, as the TCAI is at 48 per cent. The reasons cited were that of high yield of coriander, insurance against climate risk, market rate etc. But, among those who continued, almost 75 per cent of them continued with technological gaps, with TGI at 50 per cent. This means, they discontinued the cultivation of safflower. The reasons were – fewer yields, labor problem for harvesting, less market rate etc. Ironically, this was the only technology which got diffused as well, outside the watershed from 20 per cent of the total adopted farmers. The reasons mentioned for continue adoption could similarly be applied to this diffusion.

In case of Forestry oriented technologies, only bund/border plantation is in continuance adoption with TCAI at 33.33 per cent for the reason being used for fodder purpose. Other two technologies – vegetative barrier and community plantation - scored DIT at 100 per cent. Failure of community plantation may be attributed to lack of community participation in checking the animal menace, whereas reasons like obstacle of roots were cited for discontinuance for vegetative barrier. In case of bund/border plantation also, shade effect was quoted by those who discontinued it.

The results of overall technological indices obtained with reference to different measures are given below:

Table 3. Overall technological indices of technologies at watershed level

Measures / Indices	OTCAI	ODI	OTGI	OTDI
Engineering	92.96	7.04	7.04	0
Agronomical	51.61	48.39	29.03	16.13
Forestry	16.66	83.34	0	0

This shows that, in overall, the technological reach of engineering measures and their continuance was at 92.96 per cent. In which, OTGI was at mere 7.04 per cent. This is found to be better, considering factors like nature of the structures, less maintenance etc. In case of agronomical measures, the OTCAI was at 51.61%. But OTGI index indicates that 29.03 per cent of farmers who adopted agronomical technologies, continued with technological gaps (only coriander-safflower intercropping, in this case). Further, this is the only technology that got diffused to adjacent watersheds as well, with OTDI at 16.13 per cent. The reasons could be attributed to less complexity in this technology to emulate, easy availability of inputs, market preference etc in addition to what was described previously for continue-adoption of this technology. In case of forestry, the acceptance was very low as the OTCAI was at 16.66 per cent only. In spite of huge benefits of tree crops, preference among farmers was very low, as they have to wait for long and due to other misconception like shade effects.

CONCLUSION

In this study explained the post adoption behavior of farmers with respect to SWC technologies. The results obtained may be concluded that engineering measures were found to be accepted and continued by the farmers to a greater extend with minimum technological gaps. In case of agronomical measures, the technological gaps were at considerable level, but continue adoption percentage and diffusion rate were also found to be at significant level. But in case of forestry measures, the discontinuance rate was much higher than the other two measures. Based on these results, some implications may be derived as given below.

Engineering measures are long lasting with much less efforts required from the farmers' side for their maintenance. This attribute may be well utilized to strengthen the skill of farmers for further better usage. This means, apart from mere transfer of technology, farmers have to be trained on skills of maintaining these technologies. Especially in case of farm pond, skills pertaining to desiltation, repair of in-lets / out-lets, waterways etc, shall be imparted to the needy farmers at appropriate intervals.

In case of agronomical measures, the technologies are found to be very fluid in nature, in the sense, they tend to get adapted easily as per the situation arises, at that specific period of time. Further, there is an ample scope for farmers to try different combinations intentionally or due to other external factors like availability of inputs, labor, market preference etc. Hence, here the approach for betterment should focus on providing some options to them. Similar to the contingency plan developed by Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, considering the climate related parameters, a contingency plan considering other above mentioned parameters needs to be developed and brought to their notice.

With reference to forestry related technologies, there is a much need to sensitize the clients about the long term benefits of forest trees. Further, in case of establishing these trees in the degraded lands, which are predominantly found in common or community land, community participation is very much essential. Hence, the approach should be individual oriented, in case of fruit trees or border plantations, but community oriented in case multi-purpose trees preferred to be planted in common lands.

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