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Analysis of Factors Affecting Adoption of Sustainable Soil Conservation Practices among Wheat Growers

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Abstract: This study discusses factors affecting adoption of sustainable soil conservation practices among wheat growers and presents findings from a case study conducted in Varamin County. By proportional random sampling, 72 wheat growers were selected. Data collection was done through a questionnaire that was administered in 2008. Validity of the questionnaire was confirmed by a panel of experts. To assess the reliability of the questionnaire, Cronbach's alpha was used. This coefficient for adoption level of sustainable soil conservation practices was 0.73. The data were analyzed using descriptive and inferential statistics such as extent of mean, standard deviation, coefficient of variation, correlation analysis and regression analysis. The results of regression analysis shows that level of knowledge could explain 83.5% of the variation in the adoption level of sustainable soil conservation practices.

Key words: Adoption · Sustainable practices · Soil conservation

INTRODUCTION

Recent years have witnessed a rise of serious concern about the environmental risks associated with modern agricultural practices. Accelerated soil erosion is one of the major constraints to agricultural production in many areas. Therefore, sustainable and renewed resource management practices need to address the widespread land degradation, declining soil fertility, unreliable rainfall and even desertification, in a context of global climate change [1].

Similarly, such biological and mechanical soil conservation practices are currently applied by farmers in Iran, including: terracing, mulching, cover crops cultivation, integrated cropping and timely use of fertilizers, to name only a few [2, 3].

Although several soil conservation technologies had been developed and promoted through past decades, the adoption of many recommended measures was still minimal. So studies needed to be conducted in search of factors influencing adoption of soil conservation practices. Since the 1950s, a lot of attention has been paid to the factors that determine the adoption of soil conservation practices by farmers [4]. Generally, Rogers [17] summarized the results of many adoption and diffusion studies and conclusions were provided as a means of analyzing environmental innovations.

Conservation practice adoption is a multidimensional process. Numerous factors determine farmers' willingness to use a conservation practice. The multiplicity of factors combined with the potential interactions between them contributes to the complication in identifying features that contribute to adopting conservation practices.

Theoretical Approach: While there are many factors that influence adoption, it remains important to establish a theoretical base to model the relationships between independent variables and adoption of sustainable soil conservation practices. The model chosen will dictate the form of the data that need to be obtained and its usefulness for further research in this area.

Some factors commonly found in the literature to be related with the adoption of soil conservation practices fall into two categories: (1) individual level characteristics of the farmers including age, education, years of farming, knowledge level, awareness, attitude toward conservation practices, motivation, etc. (2) farm structural factors related to the adoption of conservation

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practices including farm size, income, farm profitability, tenure, etc.

Individual Level Characteristics of the Farmers: It is hypothesized that age is likely to have an impact upon the adoption of best practice in agriculture. Some studies have shown positive correlation [5, 6] while others have shown negative correlation [7-9]. However, there appears to be no clear correlation between age and best practice adoption [10]. Assessments of the role of years of farming in adoption reveal both positive correlations [9, 11] and insignificant ones [12]. There is mixed evidence regarding the relationship between farmers' educational levels and their adoption of sustainable land management practices. Indeed, education, be it specific or general, commonly correlates positively with the adoption of conservation agriculture practices [5, 8]; however, some studies have found education to be an insignificant factor [9], or even to negatively correlate with adoption [6, 12].

Social participation such as membership in local organizations has a positive relationship with the use of conservation practices [7, 13]. Linkages between landholders and others may affect the adoption as well. In other words, a history of respectful relationships between landholders and advocates for the innovation, including scientists, extension agents, other landholders and private companies may influence adoption of innovation [14, 15]. Characteristics of change agents such as competency, credibility, communication ability and confidence identified as factors which influence adoption [16, 17].

In the case of soil conservation technology adoption, some studies [18, 19] emphasize awareness on the part of farm operators as an obvious prerequisite to adoption. On the other hand, according to Rogers [15] knowledge/awareness of a technology leads to its adoption. Furthermore, Roosta [20] understood that there is a positive and significant relation between technical knowledge and sustainable agriculture. Without knowledge of the practices associated with conservation agriculture via some information or communication channels, adoption is improbable. Indeed, studies of innovation adoption and diffusion have long recognized information as a key variable and its availability is typically found to correlate with adoption [21]. Information becomes especially important as the degree of complexity of the conservation technology increases [22].

Some studies identify farmer training through workshops and seminars as the major approaches to enhance the adoption of the technology [18, 23]. Moreover, the presence of conservation attitudes among farmers has been assessed in relation to conservation agriculture adoption and studies have revealed both positive [6] and insignificant correlations [4, 5].

Adoption, typically, is a continuous process that involves evaluation of rewards from early adopters, which may trigger bandwagon effect in adoption [24], as such the positive relationship that existed between profit as a result of innovation and adoption index is thus, a motivating factor for innovation spread. Based on statistical analysis of actual farmer behavior, Sinden and King [25] concluded that while the stewardship motivation and personal factors encourage perception and recognition of a problem, economic factors promote actual adoption. Since there is no action without motivation hence the factors of motivation are strong enough to trigger adoption [26].

Farm Structural Factors: Some studies associating farm tenure (owning or renting) to use of conservation practices show that ownership is significantly related to use of profitable practices but not to use of unprofitable practices [27, 28] still even when practices are not controlled for profitability, the relationship of farm ownership and use of conservation practices has been found to be in a positive direction [7, 29]. Property size is often, but not always, related to innovation adoption-larger areas tend to increase the overall benefits of adoption of beneficial innovations and so increase the likelihood of adoption [13, 30]. Other studies have shown no significant relationship between farm size and adoption [31], or even a negative correlation [12]. Hence, the overall impact of farm size on adoption is inconclusive.

Calatrava Leyva *et al*. [32] believe that farm profitability is positively related with the adoption of soil conservation practices. Access to and reliance on off-property income may increase financial security but also may decrease the tendency to adopt some practices that would involve greater management demands [33]. Although Chomba [28] has indicated that available household labor was not a significant factor in adoption of soil and water conservation practices, Carlson and Dillman [29] found operating the farm with a son was related to adopting erosion control measures. Furthermore, proximity of the property to information sources, town and main road is also important [28, 34].

MATERIALS AND METHODS

To collect data, a questionnaire was administered on the basis of literature review, hypotheses and interviews in 2008. The questionnaire was validated by a panel of experts after necessary corrections and was pre-tested against a sample of 30 wheat growers. The calculated Cronbach's alpha for sustainable soil conservation practices was 0.73. Proportional random sampling method was employed to select 72 wheat growers from villages located in three agricultural districts of Varamin County, namely Javadabad, Pishva and Markazi (Table 1) and Gharchak was excluded from the study because of its industrial condition.

In order to measure the adoption level of sustainable soil conservation practices sixteen dichotomous statements (i.e., not implementing a practice=0, implementing a practice=1) were applied in the questionnaire. Each statement was given an importance value by a weighting system that assigned values to each conservation practice based on its importance relative to all other conservation practices used. The assigned values were developed in consultation with research specialists. The weighted "importance" score for each practice was multiplied by the reported answers of implementation. Finally, wheat growers were categorized as "low", "fairly low", "fairly high" and "high" adopters based on the collective 'adoption score'. Score ranges for low, fairly low, fairly high and high adoption categories have been determined by mean and standard deviation, as follows:

Min<A<Mean-St.d: A= Low
Mean-St.d <B<Mean: B = Fairly Low
Mean <C<Mean+St.d: C= Fairly High
Mean+St.d <D<Max: D = High

To measure independent variables including using level of information sources and communication channels, social motivation, stewardship motivation, economic motivation, level of awareness about the effects of sustainable environmental practices at farm level, attitudes toward sustainable environmental practices, viewpoint on change agent and level of knowledge, six point scales with score range of 0 to 5 were developed, while the score was reversed for unfavorable statements.

Data were analyzed using descriptive and inferential statistics such as extent of mean, standard deviation, coefficient of variation, correlation analysis and stepwise regression analysis. Although the dependent variable was parametric, mean comparison was done through a nonparametric test (Man-Whitney Test) because the distribution of groups wasn't normal.

Table 1: Statistical population and sample size of the study

County	District	No. of wheat growers per district	Sample size
Varamin	Javadabad	1280	37
	Pishva	430	13
	Markazi	760	22
	Total	2470	72

RESULTS AND DISCUSSION

On average, respondents were 47 years of age. Each household had an average of 5 members and farm size of 10.7 Hectares grown to wheat. It was found out that a high proportion of wheat growers (83.3 percent) had completed one form of schooling. Among respondents, 66.6 percent cropped on owned farmlands. Average yield was 4.076 t/ha annually. The overall average of 29 years of farming indicates that wheat growers were highly experienced in farming practices therefore they may apply conservation practices effectively. Farming operations were carried out by 2 household members and 3 employed labors on average. Total on-farm and off-farm incomes were 40125000 (1000Rials)/yr and 20634330 (1000Rials)/yr respectively. Approximately 64 percent of farmers were members of rural cooperatives. While participation in training courses accelerates the adoption of sustainable conservation practices, 65.2 percent of wheat growers have never participated in farmer training course on sustainable environmental practices. Taking no part in so-called courses is likely to constrain sustainable soil use.

The distance of 72.2 percent of wheat growers' properties from extension services centers was on average 10 kilometers. Extension services are a major source of technical information for farmers therefore contact or proximity to extension agents increases adoption. While wheat growers have highly potential access to extension services and extension agents, they are more likely to adopt sustainable soil conservation practices. About 20.8 and 15.3 percent declared fairly low and low opinion on characteristics of change agent. While 58.3 percent held fairly high opinion, only 5.8 percent of wheat growers expressed high opinion on the characteristics of change agent.

Priority Setting of Indicators of Sustainable Soil Conservation Practices: Sustainable soil conservation practices are listed in order of priority on the basis of the

results of the study (Table 2). Chemical fertilizer use due to crop need (CV=0.209), timely use of fertilizer (CV=0.210) and crop rotation (CV=0.450) are at the top of the list. While planned leaching events application to control soil salinity remained the lowest priority on account of its highest coefficient variation.

Adoption Level of Sustainable Soil Conservation Practices: Table 3 shows the percentage of wheat growers scoring in the low, fairly low, fairly high and high levels of adoption of sustainable soil conservation practices. It could be inferred from the table that majority of respondents fell into fairly low or high ranking in terms of soil conservation measures adoption.

Correlation Analysis among Adoption Level of Soil Conservation Practices and Selective Variables: Table 4 shows that there is a positive and significant correlation (P<0.01) between using level of information sources and communication channels and level of wheat growers' adoption which is in accordance with [35]. The positive correlation implies that as using level of information sources and communication channels increases the adoption of sustainable soil conservation practices increases and vice versa amongst the wheat growers in the area. Economic motivation was positively and significantly (P<0.01) correlated with wheat growers' adoption. In the same vein, stewardship motivation of adoption of conservation practices was positively and significantly (P<0.01) correlated with adoption. This is in agreement with Sinden and King [25] and Tshiunza *et al*. [26] in their studies found that the stewardship motivation and economic factors promote actual adoption. This result indicates that highly-motivated farmers are more likely to adopt sustainable soil conservation practices.

In the same manner, there is a positive and significant correlation (P<0.01) between level of awareness about the effects of conservation practices and level of adoption. This finding is in line with the findings of [17-19]. Also there is a positive and significant correlation (P<0.01) between viewpoint on extension agents and level of adoption, which indicates that the viewpoint of wheat growers on change agents in the area may affect the adoption of sustainable soil conservation measures. Hence, if they have a positive viewpoint on them it will be more probable that they accept change agents' useful advice enthusiastically and follow their instructions satisfactorily. In other words, the more change agents attempt to create and maintain positive viewpoint among farmers, the higher the adoption level of conservation practices will be. The origins of that positive viewpoint can be traced back to characteristics of the change agent such as credibility, communication ability and confidence. These results are in agreement with [17, 20]. Similarly, level of knowledge is positively and significantly (P<0.01) correlated with soil conservation practice adoption. Different studies have confirmed this result [17, 20].

Comparison of adoption level among different groups of wheat growers in terms of membership in cooperatives, participation in extension-education courses and farming system

Results of Mann-Whitney Test reveals significant difference (P<0.01) in mean rank of adoption level of soil conservation practices with regard to participation in extension-education courses. In other words, adoption level was different between participants in extension-education courses and non-participants. In addition, adoption level of soil conservation practices was different (p<0.05) between small holders and large holders (Table 5).

Table 2: Prioritized indicators of sustainable soil conservation practices

Statement	Mean	Std. Dev.	CV	Priority
Chemical fertilizer use due to crop need	0.671	0.140	0.209	1
Timely use of fertilizers	0.767	0.161	0.210	2
Crop rotation	0.667	0.300	0.450	3
Field irrigation after using fertilizers	0.500	0.225	0.450	4
Use of biofertilizers & organic manure	0.750	0.338	0.451	5
Returning crop residues to soil	0.622	0.335	0.538	6
Mulching	0.544	0.293	0.539	7
Fallowing	0.450	0.262	0.582	8
Construction of bunds and other erosion control structures	0.457	0.336	0.735	9
Use of sulphur	0.308	0.302	0.980	10
Tree planting	0.340	0.352	1.035	11
Cover crops cultivation	0.322	0.395	1.227	12
Integrated cropping	0.243	0.336	1.383	13
Reduced tillage methods application	0.256	0.376	1.469	14
Across-slope cultivation	0.287	0.422	1.470	15
Planned leaching events application to control soil salinity	0.156	0.293	1.878	16

Table 3: Distribution of the respondents according to adoption level of sustainable soil conservation practices

Dependent Variable	Group	Scale	Frequency	% of frequency
Adoption level of soil conservation practices	Group 1 (low)	≤ 5.306	13	18.1
	Group 2 (fairly low)	5.307-7.340	18	25
	Group 3 (fairly high)	7.341-8.06	13	18.1
	Group 4 (high)	≥11	28	38.8
	Total		72	100
	Max:11	Min:1.4	Mean:7.34	Std. Dev.:2.034

Table 4: Correlation analysis among adoption level of wheat growers' and selective variables

Variable	Adoption of soil conservation practices Correlation Coefficients
Age	-0.033
Level of literacy	-0.013
Household size	0.130
Years of farming	0.042
Annual on-farm income	0.226
Annual off-farm income	-0.146
Years of membership in rural cooperatives	-0.006
Farm size	0.126
Proximity of the property to agricultural extension services	0.103
Level of participation in extension-education courses	-0.353**
Number of farm labors	0.048
Farm profitability	0.101
Using level of information sources and communication channels	0.46**
Level of social motivation	0.162
Level of economic motivation	0.334**
Level of stewardship motivation	0.331**
Level of awareness about the effects of sustainable conservation practices	0.355**
Attitude toward conservation practices	0.136
Viewpoint on extension agents	0.36**
Level of knowledge	0.918**

* (P<0.05) and ** (P<0.01)

Table 5: Comparison of mean rank of adoption level among wheat growers by using Mann-Whitney Test

Test Variable	Grouping Variable	Item	Mean Rank	Mann-Whitney U	t
Adoption level of soil conservation practices	Membership in cooperatives	Member	38.16	429.5	0.129
		Non-member	30.4		
	Participation in extension-education courses	Participants	47.82	297	0.001
		Non-participants	30.69		
	Farming system	Smallholder	29.25	420.5	0.033
		Large holder	40.22		

Table 6: Regression analysis explaining variation in adoption level of soil conservation practices

Description	Label	Soil conservation practices B	t
Constant		2.158	7.084**
Level of knowledge of soil conservation practices	KSP	0.693	18.255*
F=333.237**	R^2=0.835	R^2adj=0.832	

* (P<0.05) and ** (P<0.01)

Regression Analysis Explaining Variations in Adoption Level of Soil Conservation Practices: In order to explain variations in adoption level of soil conservation practices at farm level, stepwise multiple linear regression has been used. The results of regression analysis of adoption level of soil conservation practices shows that level of knowledge could explain 83.5% of variations in adoption level of wheat growers' (Table 6).

According to the results of Table 6, following model is estimated for explaining wheat growers' adoption level of soil conservation practices

$$Y = 2.158 + 0.693\ KSP$$

Where:

Y: Dependent variable representing wheat growers' adoption level of soil conservation practices

CONCLUSION AND RECOMMENDATIONS

Accelerated soil erosion and declining soil fertility are among major constraints to agricultural production. Since adoption of many recommended soil conservation measures is still minimal in many areas, paying attention to factors which determine adoption is a top priority per se.

In looking at factors expected to influence adoption of sustainable soil conservation practices, participation in extension-education courses, using level of information sources and communication channels, economic motivation, stewardship motivations, level of awareness, viewpoint on extension agents and level of knowledge appear to be important factors due to their positive and significant correlation with the dependent variable of adoption. It is evident that not only a host of aforementioned independent variables contributes to adoption but also they interact with each other logically. Additionally, the research provides evidence showing that level of knowledge received notable support regarding sustainable soil conservation practices in the regression model. The findings provided a basis for the following recommendations:

It is generally true that access to information sources and communication channels and adequate number of extension education courses with relevant content may increase awareness about the effects and consequences of sustainable soil conservation practices among farmers while providing them with required knowledge. In particular, positive motivation towards sustainable soil use on the part of wheat growers may enhance further adoption. By understanding economic and environmental effects of soil conservation practices, the effective uptake of soil conservation practices may occur. Hence provision of required information via various information sources and communication channels, in order to raise farmers' awareness is suggested. Community awareness program on the conservation measures should be promoted through the use of television and radio broadcasts to the farmers. The "mass media," should be used in greater amounts for the dissemination of conservation information.

On the other hand, technical expertise of the extension agent; local profile of the extension agent (e.g. local residence); communication skills of the extension agent; personal relationships between the extension agent and landholders; and extension-agent empathy with the circumstances and problems of landholders probably exert influence on farmers' viewpoint. Since characteristics of the extension agents goes a long way to affect the decision of the adopters hence they must be given adequate training before and on the job to improve their characteristics e.g. communication ability and credibility.

Village extension agents should encourage proper use of sustainable soil conservation practices among the farmers through workshops, seminars and trainings. Hence, there is a need for the integration of environmental issues into messages disseminated by extension agents and also a need to empower farmers through educational/training programs on environmental conservation methods to boost sustainable food production. The solution is to better target extension and to improve the methods of information delivery. Appropriateness of training programs minimizes costs of delivering conservation-related extension services. Whereas lack of knowledge is cited as a hindrance to adoption, the farmers should be made to know these practices and how best to integrate or incorporate these practices in their agricultural activities for better living as well as protect the environment.

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