Anais da Academia Brasileira de Ciências (2016) 88(2): 959-971
(Annals of the Brazilian Academy of Sciences)
Printed version ISSN 0001-3765 / Online version ISSN 1678-2690
http://dx.doi.org/10.1590/0001-3765201620140613
www.scielo.br/aabc

# An examination of soil and water conservation practices in the paddy fields of Guilan province, Iran

DARYOUSH ASHOORI[1], ASGHAR BAGHERI[2], MOHAMMAD S. ALLAHYARI[3*] and AHMAD S. AL-RIMAWI[4]

[1]Young Researchers and Elite Club, Rasht Branch, Islamic Azad University, Rasht, Iran
[2]Department of Agricultural Management, Mohaghegh Ardabili University, Iran
[3]Department of Agricultural Management, Rasht Branch, Islamic Azad University, Rasht, Iran
[4]Department of Agricultural Economics and Agribusiness Management
Faculty of Agriculture, University of Jordan, Amman, Jordan

*Manuscript received on December 2, 2014; accepted for publication on March 2, 2015*

**ABSTRACT**

This study examined the use of soil and water conservation (SWC) practices among rice farmers in Iran. A random sample of 400 rice paddy farmers in the Foumanat plain of Guilan province, who use SWC measures, was drawn from a population of 52 thousand farmers. A two-part questionnaire was used to examine the level of utilization of SWC practices and to profile paddy farmers. Internal consistency was demonstrated with a coefficient alpha of 0.76, and the content and face validity of the instrument was confirmed by a panel of soil and water experts. Descriptive and analytical statistics were used to analyze the data. Results of ANOVA indicated that the mean levels of SWC practices vary considerably at the 0.01 level of significance by groups of age, education, non-agricultural income, production costs, yield, cultivated paddies and distance from home to the farm or to the main road. Similarly, significant differences were observed by groups of family size, rice production, ownership of livestock and profits from rice production at 0.05 level. The levels of experience in agriculture and ownership of poultry were found to have no significant effects on SWC practices.

**Key words**: conservation practices, soil and water, rice paddy, Foumanat plain, Iran.

## INTRODUCTION

The conservation of soil and water resources is the most important feature of sustainable development. Soil erosion may cause severe loss of topsoil where organic matter and vital nutrients needed by crops, in order to survive, usually reside. This loss harms the farmland's suitability for farming and reduces its ability to retain water (Wall et al. 2003). This leads to impoverishment of the soil and reduces soil productivity and yield potential (Somda et al. 2002). Therefore, soil erosion is an obstacle for agricultural development as it decreases soil fertility, farm productive capacity and yield, leading to a decrease in income of farmer´s households (Semgalawe and Folmer 2000). Adoption of soil and water conservation (SWC) practices reduce erosion to acceptable levels where soil loss can be offset by natural soil development, improve the physical structure of the soil, increase or maintain

Correspondence to: Mohammad Sadegh Allahyari
E-mail: allahyari@iaurasht.ac.ir

the level or organic matter, make the best use of available water and maintain the soil fertility level by reducing nutrient loss (Hudson 2004).

The process of restoring depleted land and soil resources is quite slower than erosion and deterioration. Years are required for restoration and soil reconstruction to a productive state. Residents of a community need to learn how to use maintain and lessen the effects of damage to this vital resource (Hasanzadeh 2001). The development of governmental and non-governmental SWC practices are needed for the conservation of soil and water (Nasiri et al. 2001, Tenge et al. 2005). In order to move towards the goal of sustainability and efficient use of water and land resources fundamental changes in human attitudes and behavior are needed (UNESCO 1997).

Water has long been the most important component of development. The FAO estimates that, over the next 30 years, 60% of the global food supply will require irrigation (FAO 2003). Competition for water resources is a major challenge for humans and the optimization of the use of water in agriculture to produce food is crucial (Mohammadi et al. 2010, Alavi 2010). Innovative approaches toward agriculture and distribution of water are critical for attaining of supplying food to the increasing world population (Karani and Sori 2009).

Limited water supply for agriculture in Iran is accentuated by the excessive and improper application of water for agriculture. The major reasons for low productivity and inefficient irrigation methods are the lack of technical knowledge, passive farmer's attitudes toward conservation and improper practices of water management (Shahroudi et al. 2009). Sustainable irrigation in Iran requires a general water management system that will assist farmers in promoting productivity and efficiency in the use of water (Shahroudi and Chizari 2006).

Many studies have investigated SWC practices and the appropriate management of these vital agricultural resources. A variety of practical methods of SWC measures are used and they are broadly grouped into physical (mechanical or technical), biological (vegetative) and agronomic measures (so called best management practices) (Krüger et al. 1997). Assefa-Mengstie (2009) found that Ethiopian farmers used both traditional and improved practices for soil and water conservation. These technologies included: physical measures such the use of stone bunds, contour farming and drainage, biological measures such as planting trees; and agronomic measures such as spreading manure, leaving crop residues in the field and allowing land to remain fallow. Faltermeier (2007) studied water conservation and new technologies applied to the production systems of rice in northern Ghana. Water conservation by farmers of the region consisted of physical measures such as earthen bunds, contour bunds and agronomic measures such as dibbling for transplanting rice seedlings. Jara-Rojas et al. (2013) studied the adoption of SWC practices in central Chile. The soil conservation practices adopted in the study area were developed to minimize soil erosion, to conserve soil and water and to protect the soil long-term productivity. These include agronomic measures such as fallow pastures, cover crops, crop rotation, ridge planting, stubble retention on the soil surface and mulching, incorporation of stubble residues into moist soil, composting and fertilizing with manure.

Several studies describe the factors affecting the adoption of SWC measures. Jara-Rojas et al. (2012) indicated that the dimensions of farms and the ownership of land are important variables associated with the adoption of conservation measures. Teng et al. (2004) examined social and economic factors affecting adoption of SWC practices in the western Uzambara Mountains in Tanzania. Results indicated that the age, sex, educational status of the heads of families and ownership of land had positive significant effects on SWC practices. Non-farm income and distance from farm land to home had significant negative effects on SWC practices. The dimensions of the farm, the availability of manpower, and the number of domestic animals had no significant affect over SWC practices. Rezvanfar et al. (2009) found that the education level and adoption of sustainable soil conservation techniques are positively and significantly correlated. The variables of age, education level, family size, experience in agriculture, and annual farm income, annual non-farm income, and farm size, availability of farm labor and profitability of the farm were found to have no significant effect on sustainable soil conservation practices. In addition, Amsalu and de Graaff (2007) stated that factors having positive and significant effects on SWC practices were age of head of household, farm size and knowledge about profitability of conservation technology. Factors with significant negative effects on SWC were the number of domestic animals and high productivity of the soil. Resistance to adopting soil and water conservation measures were likely to be attributed to the lack of farmers' awareness of soil loss caused by erosion and lack of immediate apparent financial benefit from SWC measures (Tenge et al. 2004).

Guilan province is a unique agricultural region in northern Iran with a moderate climate, suitable land for agriculture and rich soil. Agriculture in this province is important to Iran because it is the center of rice production (Keshavarz et al. 2011). Irregular rainfalls, pollution of water resources caused by expansion of civilization and, more importantly, depletion of water from underground aquifers, which is the major source of water for the rice fields, are major factors contributing to the water shortage (Alizadeh et al. 2011).

It is no longer possible to ignore the impact of depletion of soil and water resources that lead to the deterioration and loss of resources. Although, the issues of soil and water conservation have been subject to extensive research worldwide, few have examined the factors and practices of water and soil conservation in Iran, particularly in Guilan. The present study examined paddy farms, farmers' characteristics, the use of SWC practices in Foumanat plain in Guilan by farmers and the factors affecting the use of SWC measures.

## MATERIALS AND METHODS

The study area is the Foumanat plain, which is located in central Guilan province in Iran. It includes the Anzali wetland catchment area. The total area is 84310 ha, of which 56774 $ha^2$ are rice paddies. Foumanat plain is located between 48°45' and 49°41' E longitude and 37°00' and 37°34' N latitude. Developmental units F1 to F5 of the Sefidrood irrigation and drainage system in Foumanat plain in Guilan were used in this study. The study population comprised paddy land farmers resident in the counties of Shaft, Fouman, Soamesara and Rezvanshahr who use SWC measures. More than 56900 households live in the target area, of which 5206 families are rice producers. The study was quantitative and descriptive (non-experimental) and employed a survey technique. Using the table for determining minimum sample size for a given population size for continuous and categorical data, with alpha of 5%, as developed by Bartlett et al. (2001) and others, produced a required sample size of 362. A 10% was added to the sample to further reduce the margin of error, thus making a total sample of 400 farmers.

A literature review was used to prepare a two-part questionnaire. Part 1 measured the usage of SWC practices by rice producers. Five-points Likert-type items were used for ratings, with 1 representing very low and 5 very high. A 10-items scale was used as for rating the farmers' tendency to adopt SWC measures. Thus, the scale (hereafter labeled as SWC scale) ranged between 10 and 50. These practices include physical measures such as use of bunds, dikes and dams, removal of weeds and sediment from canals, leveling and terracing of farms and farm drainage. Agronomic measures include ratoon cropping, crop rotation, use of compost or manure and tillage conservation.

Part two measured demographic and economic characteristics of farmers such as age, sex, marital status, average size of a family education level, farm income level, main occupation, farm size and land tenure. The questionnaire was validated by a panel of SWC experts to have sufficient content and face validity. The questionnaire was field-tested using a sample of 30 farmers, and was then revised and adapted to ensure proper layout, usability and content validity. Internal consistency reliability of survey instrument (the scale) was demonstrated with the alpha coefficient of 0.763, which is acceptable and indicated the internal integrity of the questions.

Descriptive statistics of frequency, mean, standard deviation were used to describe paddy farms and farmers' socio-economic characteristics. The ANOVA procedure was used to detect significant differences among the means of the SWC scale by the groups of the independent variables/ factors, while LSD test was used for mean separation to investigate where the differences occurred among these factors. The independent variables in the F-test included the categorized socioeconomic variables (age, experience in agriculture, etc.) and the dependent variable was the overall score of the SWC scale which rate the paddy rice farmers' tendency to adopt SWC practices.

## RESULTS AND DISCUSSION

### USE OF SOIL AND WATER CONSERVATION (SWC) PRACTICES

Table I shows the relative frequency and ranking of use of SWC practices by paddy farmer. The SWC scale was used as to rate the farmers' tendency to use of SWC measures. These practices include:
(1) Agronomic measures such as ratoon cropping (36%), crop rotation (28%), use of compost or manure (18%), and conservation tillage (12%). Ratooning is a method which leaves the lower parts of the plant along with the root uncut at the time of harvesting to give a crop (which is called the ratoon crop) that grows from the stubble of the crop already harvested. Ratooning reduces the need for irrigation, it can decrease the cost of preparing the field and planting, and the crop matures earlier in the season. Crop rotation is also a popular practice when growing a series of dissimilar types of crops in the same area in sequential seasons. Rotation helps avoid the build-up of pests and excessive depletion of soil nutrients, and it can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants. Manure application and tillage management are part of management practices in traditional indigenous farming methods. Conservation tillage conserves soil by reducing erosion and conserves water and maintains water-holding capacity by reducing runoff and evaporation and by retention of plant residues.
(2) Physical measures such as the use of plastic mulch on soil surface on the borders of rice fields (17%), leveling and terracing of farms (7%), bunds, dikes and dams (14%), removal of weeds (10%) and sediment from canals (6%), and farm drainage (2%). Plastic mulching can reduce soil erosion, reduce evaporation and retain moisture and suppress weed growth. This conservation of water makes the use of plastic mulch quite helpful in dry and arid climates where water is a limited resource in Iran. Physical SWC measures require funding and know-how which have to be addressed by a government policy in order to provide a source of financial and technical assistance to help paddy farmers to adopt SWC measures.

Table II shows that only 4% were considerably implementing SWC measures, and less than one quarter (24%) used moderately SWC measures. This indicates that 72% of farmers practiced very few conservation activities (Table II). Although a

**TABLE I**
**Frequency and ranking of use of soil and water conservation practices by paddy farmer.**

| Rank | Variable | Number of responses | Percentage of responses | Percentage of cases |
|---|---|---|---|---|
| | **Agronomic measures** | | | |
| 1 | Ratoon harvest | 144 | 36.00 | 58.8 |
| 2 | Crop rotation | 111 | 27.75 | 45.3 |
| 3 | Compost or manure | 72 | 18.00 | 29.4 |
| 6 | Conservation tillage | 48 | 12.00 | 19.6 |
| | **Physical measures** | | | |
| 4 | Use a plastic mulch on the borders of rice fields | 67 | 16.75 | 27.3 |
| 5 | Use of bunds, flood walls and dams | 58 | 14.50 | 23.7 |
| 7 | Removal of weeds in canals | 42 | 10.50 | 17.1 |
| 8 | Leveling and terracing farms | 27 | 6.75 | 11.0 |
| 9 | Cleaning of sediments in canals | 25 | 6.25 | 10.2 |
| 10 | Farms drainage | 9 | 2.25 | 3.70 |

good percentage of farmers implement agronomic SWC measures, a considerably lower amount of farmers implement physical SWC measures as shown in Table I. Farmers do not appear to perceive soil erosion as a problem. A possible explanation for this behavior is the degree to which the results of an innovation (improved SWC practices) are visible to others. Rogers (1995) stated that the observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption. Besides, farmers lack funding and the know-how needed to implement soil conservation measures.

**TABLE II**
**Distribution of farmers according to their use of SWC practices (n=400).**

| Levels of use of SWC measures | Frequency | Percent | Cumulative percentage |
|---|---|---|---|
| Very low (less than 15) | 133 | 33.2 | 33.2 |
| Low (25-15) | 154 | 38.5 | 71.7 |
| Medium (35-25) | 98 | 24.5 | 96.2 |
| High (45-35) | 15 | 3.80 | 100 |

## CHARACTERISTICS OF PADDY FARMS AND FARMERS

Socio-economic factors are important in understanding and shaping attitudes, behavior and decisions of individuals. Table III shows paddy farms characteristics. The most common cultivar used (85%) was the native cultivar and 15% of paddy farms used both native and genetically-engineered cultivars. Most of the farmers (93%) owned their land, either individually or jointly. Canals were a source of irrigation for 69% of farms, 44% used water from a river, 3.8% from a spring, 8.8% from a well and 5.2% from water reservoirs. Tillers are the most widely type of owned farm machines, reported by 80% of farmers (Table III). Tractors, combines and planting machines were reported by 19%, 16% and 6% of farmers respectively.

Table IV shows additional characteristics of paddy. Paddy farm sizes ranged between 0.03 to 7 ha, 83% were 2 ha or less and the overall mean of a paddy farm was 1.5 ha (Table IV). Three fifths (59%) had 1-2 paddies, and the mean number of paddy plots was 2.74. About one third of farmers had no domestic animals (31%), and about one third had more than three animals (32%), and the mean number of owned animals was 4.2. One third of farmers had no poultry (33%), and the mean

**TABLE III**
**Frequency distribution of characteristics of selected agronomic variables (n = 400).**

| Variables | Groups | Frequency | % |
|---|---|---|---|
| The cultivar used | Local | 173 | 43.2 |
| | Modified | 168 | 42.0 |
| | Both | 59 | 14.8 |
| Land tenure | Rent | 29 | 7.2 |
| | Barry shares | 371 | 92.8 |
| Source of irrigation | River | 370 | 92.5 |
| | Spring | 15 | 3.8 |
| | Well | 35 | 8.8 |
| | Bund | 21 | 5.2 |
| | Canal | 263 | 65.8 |
| Machines available | Tiller | 320 | 80.0 |
| | Tractor | 76 | 19.0 |
| | Combine | 63 | 15.8 |
| | Trans planter | 24 | 6.0 |

units of poultry were 35. The mean distance from home to the farm was 1.01 km and the mean rage distance from the farmer's home to the main road was 0.72 km.

Table IV shows paddy farmers socioeconomic characteristics. Forty three percent of paddy farmers were over 50 years of age, with a mean age of 49 years (CV 95%: 49± 11). Almost all respondents were males, and married (98%). Two thirds of farm households consisted of 3 to 6 members, with a mean of 4. Table IV indicates that 20% were illiterate and less than 7% had a university degree, indicating a general low level of education among respondents. The primary occupation of most respondents was agriculture (77%), and the rest had off farm employment. About half of the paddy farmers (49%) had 20 to 40 years of experience in farming, largely in rice cultivation, with a mean of about 30 years (Table IV).

Mean accounting profit (total return minus cash costs) from agriculture for respondents was 15.9 million Tomans (3100 Tomans equal one USD) with most of the respondents in the range of 18 to 24 million Tomans. A large proportion of respondents were found to derive no profit from agriculture (34%). Mean rice yield for respondents was 2900 kg and mean agricultural cost was 2.9 million Tomans (Table IV).

### Factors Affecting the Use of SWC Measures

Table IV presents the results of the ANOVA test to identify significant differences among the means of the SWC scale by the groups of the independent variables (factors) tested, and the results of LSD test for mean separation to investigate where the differences occurred among these groups. The independent variables in the F-test are listed in Table IV and include factors such as age, family size and education.

The results suggest that there were statistically significant difference between the mean scores of the SWC scale for the groups of age, educational status, non-agricultural income, costs of production, yield, product performance, number of paddy plots, distance from home to farm, and distance from home to main road at the $p<0.01$ level. Similar significant results were observed at the $p<0.05$ level for the groups of family size, experience in rice production, number of domestic animals, and level of profit from rice production. Mean scores of the SWC scale for the groups of experience in agriculture and the number of poultry were not significantly different (Table IV).

Post hoc analysis using the least significant differences (LSD) test was used to compare the mean scores of the SWC scale for the groups of the independent variables with statically significant effect. The results of the post-hoc LSD test indicated that age had a significant effect on the use of SWC measures at the p<0.001 level. The mean score of the SWC scale for the group under-30 age group was higher than other groups, which suggests that younger farmers are more likely to adopt SWC measures. As age increased, the probability of adopting SWC decreased. Amsalu and de Graaff (2007), Assefa-Mengstie (2009), Nkegbe et al. (2011), Illukpitiya and Gopalakrishnan (2004), and Ghomba (2004) all found that farmer age had a significant and positive effect on adoption of SWC practices. However the results of Bakhsh et al. (2012), Nasiri et al. (2011), and Anley et al. (2007) indicated that age had a significant negative effect on adoption of SWC practices, while the results of Bekele (2003), Jara-Rojas et al. (2012), and Kessler (2006) indicated that farmer age had no significant effect on use of SWC measures.

Similarly, family size had a significant effect on the mean score of the SWC scale at the p<0.01 level. Table IV shows that the highest mean scores

**TABLE IV**
**Frequency distribution of socioeconomic characteristics of paddy farmers and Analysis of Variance of the SWC scores by groups of the independent variables (n = 400).**

| Variable | Groups | Descriptive Statistics | | ANOVA Test | | |
|---|---|---|---|---|---|---|
| | | Frequency | % | Group means of the SWC scale scores | F | p-value |
| Age (Years) ($\bar{x}$ = 49.6, SD=11.0 ) | < 30 | 17 | 4.2 | $26.76^{b}$ | 5.495 | $0.001^{**}$ |
| | 30 to 40 | 82 | 20.5 | $20.95^{a}$ | | |
| | 40 to 50 | 130 | 32.5 | $18.26^{a}$ | | |
| | > 50 | 171 | 42.8 | $19.84^{a}$ | | |
| Family size (No.) ($\bar{x}$ = 4.82, SD= 1.62 ) | < 3 | 81 | 20.2 | $21.48^{ab}$ | 4.694 | $0.010^{*}$ |
| | 3 to 6 | 272 | 68.0 | $18.94^{a}$ | | |
| | > 6 | 47 | 11.8 | $22.28^{b}$ | | |
| Level of education | Illiterate | 81 | 20.2 | $17.80^{a}$ | 9.196 | $0.000^{**}$ |
| | Basic | 195 | 48.8 | $18.95^{ab}$ | | |
| | Secondary | 97 | 24.2 | $21.43^{b}$ | | |
| | University | 27 | 6.8 | $26.74^{c}$ | | |
| Rice farming experience ($\bar{x}$ =30.80 , SD=13.61 ) | < 20 | 128 | 32.0 | $20.16^{b}$ | 4.513 | 0.012* |
| | 20 to 40 | 196 | 49.0 | $20.69^{b}$ | | |
| | > 40 | 76 | 19.0 | $17.18^{a}$ | | |
| Livestock: Number of domestic animals ($\bar{x}$ = 4.18 , SD= 11.41 ) | None | 125 | 31.2 | $19.20^{a}$ | 2.821 | 0.039* |
| | 1 to 3 | 145 | 36.2 | $18.95^{a}$ | | |
| | 3 to 6 | 62 | 15.5 | $20.39^{ab}$ | | |
| | > 6 | 68 | 17.0 | $22.46^{b}$ | | |
| Poultry : Number of birds ($\bar{x}$ = 35.46, SD=144.15) | None | 131 | 32.8 | $18.68^{a}$ | 1.898 | $0.129^{ns}$ |
| | 1 to 25 | 113 | 28.2 | $20.47^{ab}$ | | |
| | 25 to 50 | 117 | 29.2 | $19.77^{ab}$ | | |
| | > 50 | 39 | 9.8 | $22.21^{b}$ | | |
| Farm size (ha) ($\bar{x}$ =1.59 , SD= 1.10 ) | < 1 | 193 | 48.2 | $17.61^{a}$ | 19.313 | $0.000^{**}$ |
| | 1 to 2 | 139 | 34.8 | $20.50^{b}$ | | |
| | > 2 | 68 | 17.0 | $24.88^{c}$ | | |

**TABLE IV (continuation)**

| Variable | Groups | Descriptive Statistics | | ANOVA Test | | |
|---|---|---|---|---|---|---|
| | | Frequency | % | Group means of the SWC scale scores | F | p-value |
| Number of Plots ($\bar{x}$ =2.74 , SD= 2.18 ) | 1 | 108 | 27.0 | 16.39[a] | 9.679 | 0.000** |
| | 2 | 123 | 30.8 | 20.00[b] | | |
| | 3 | 86 | 21.5 | 21.27[bc] | | |
| | > 3 | 83 | 20.8 | 22.65[c] | | |
| Distance from home to the farm (km) ($\bar{x}$=1.02 , SD=1.35 ) | < 0.1 | 83 | 20.8 | 16.55[a] | 7.933 | 0.000** |
| | 0.1 to 1 | 222 | 55.5 | 20.99[b] | | |
| | > 1 | 95 | 23.8 | 20.06[b] | | |
| Rice cultivation profit (MM Toman*) ($\bar{x}$=15.93 , SD=10.07 ) | > 6 | 70 | 17.5 | 20.46[b] | 3.146 | 0.014* |
| | 6 to 12 | 97 | 24.2 | 18.59[ab] | | |
| | 12 to 18 | 69 | 17.2 | 21.16[b] | | |
| | 18 to 24 | 102 | 25.5 | 21.34[b] | | |
| | > 24 | 62 | 15.5 | 17.21[a] | | |
| Non-farm income (MM Toman*) | No income | 136 | 34.0 | 16.32[a] | 12.458 | 0.000** |
| | < 3 | 102 | 25.5 | 21.96[b] | | |
| | 3 to 6 | 81 | 20.2 | 22.27[b] | | |
| | > 6 | 81 | 20.2 | 20.68[b] | | |
| Product performance (MT) ($\bar{x}$ =2.91 , SD= 1.60 ) | < 1.5 | 118 | 29.5 | 18.12[a] | 5.731 | 0.000** |
| | 1.50 to 3.0 | 110 | 27.5 | 21.35[b] | | |
| | 3.0 to 4.0 | 115 | 28.8 | 18.67[a] | | |
| | > 4.0 | 57 | 14.2 | 22.89[b] | | |
| Total costs of production (In MM Toman*) ($\bar{x}$ =2.98 , SD= 2.45 ) | < 1 | 53 | 13.2 | 15.38[a] | 32.334 | 0.000** |
| | 1 to 3 | 218 | 54.2 | 17.69[a] | | |
| | 3-6 | 96 | 24.0 | 24.50[b] | | |
| | > 6 | 34 | 8.5 | 27.44[c] | | |

Exchange rate: One USD = 3100 Toman.

In each variable, means with the similar letters are not significantly different at 5% level of probability using LSD test.

were found to be for families with more than six family members. A large family may be more dependent on farm income and have more active farm workers. This may provide incentive to promote productivity and reduce the need to hire labor to undertake or maintain SWC measures. Jara-Rojas et al. (2012) and NKegbe et al. (2011) found a positive correlation between family size and adoption of water conservation practices and assumed that this was related to the increased manpower in a large family. In contrast, Bakhsh et al. (2012) and Assefa-Mengstie (2009) stated that family size had a significant negative effect on adoption of water conservation practices; they assumed that the increase in family size decreased the probability of adopting soil and water conservation of soil conservation and were more inclined to adopt SWC measures. This is consistent with the results of Asafu-Adjaye (2008) and Bayard et al. (2006). Assefa-Mengstie (2009), Nasiri et al. (2011), Anley et al. (2007) and Tenge et al. (2004) indicated that the level of education had a significant effect on adoption of SWC practices. However, Foltz (2003), Posthumus (2005) and Jara-Rojas et al. (2012), found that education level had no significant effect on water conservation practices.

They stated that the increase in family size put pressure on financial resources available to hire employees for SWC practices. In a larger household, competition arises for labor between on-farm food production and off farm activities, and hence, less time will be allocated for undertaking SWC measures. Rezvanfar et al. (2009), Amsalu and de Graff (2006), Amsalu (2006), Kessler (2006), and Posthumus (2005) found that family size had no significant effect on adoption of soil and water conservation.

Results show that the mean score of the SWC scale increased as education level increased ($p<0.01$). Paddy farmers with higher education levels were more aware of the benefits of SWC measures. Table IV indicated that experience in rice farming had a significant effect on mean score of the SWC scale at the 95% confidence level ($p<0.01$). This is consistent with the findings of Illukpitiya and Gopalakrishnan (2004). However, Rezvanfar et al. (2009) claim that experience in agriculture in general, had no significant effect on adoption of soil sustainable conservation practices.

Table IV shows that as the number of domestic animals owned by rice producers increased, the mean score of the SWC scale also increased ($p<0.05$). This is in line with the findings of Jara-Rojas et al. (2012) and Assefa-Mengstie (2009). They assumed that the amount livestock was an indicator of wealth and that wealthy farmers are more able to invest and are more inclined to adopt SWC measures. Faltermeier (2007) and Amsalu and de Graaff (2007) found that the number of domestic animals had a significant negative effect on adoption of SWC practices. The large number of domestic animals prevents investment on conservation of resources. This may be a result of family inclination to focus on animal husbandry rather than agricultural production. Anley et al. (2007) and Tenge et al. (2004) found that the number of domestic animals had no significant effect on adoption of SWC practices.

ANOVA results indicated that as farm size increases, mean score of the SWC scale increases ($p<0.01$). This is similar to the findings of Jara-Rojas et al. (2013), Bakhsh et al. (2012), Nkegbe et al. (2011), Assefa-Mengstie (2009), Asafu-Adjave (2008), and Anley et al. (2007). Farmers with larger farms were more likely to adopt SWC measures because they had the financial resources to invest. Better off farmers are more likely to take risk with their investments, and thus, are more inclined to adopt SWC practices. Tenge et al. (2004), Foltz (2003), Rezvanfar et al. (2009) and Faltermeier (2007) found that farm size had no significant effect on the adoption of sustainable SWC practices. The number of paddy plots had a significant effect on adoption of SWC practices ($p<0.001$). This is in contrast to the results of Bakhsh et al. (2012), who suggested that the number of paddies had a significant negative effect on adoption of water conservation practices. The significant negative coefficient indicates that an increase in the number of paddies decreases the likelihood of adopting SWC practices because farmers must cope with resource transfer and time limitations.

Table IV indicated that the increase in product performance increased the use of SWC practices among paddy farmers ($p<0.001$). Liu et al. (2013) and Noorivandi et al. (2011) found that agricultural performance had a significant effect on adoption of SWC practices, and farmers using more conservation practices achieved better product performance. The amount of accounting profit from rice cultivation had a significant effect on mean score of the SWC scale ($p<0.01$). Those who make 12-24 million Tomans as profit have higher mean scores on the SWC scale, and thus they were the most likely to adopt and to invest in SWC measures. Asafu-Adjaye (2008); Bayard et al. (2006), and Nasiri et al. (2011) stated that net income from rice production had a significant effect on adoption of SWC practices. Similarly, Rezvanfar et al. (2009) found that farm profitability was correlated with the score of adoption of SWC measures ($p<0.10$).

ANOVA test results indicated that production costs increased, the mean score of the SWC scale increased ($p<0.01$). This is similar to results found by Jara-Rojas et al. (2012), but in contrast to Pannell (1999) who reported that the adoption of SWC measures had been lower and slower than would be socially optimal due to factors such as high implementation costs. Chomba (2004) stated that decreasing cost of production and increasing access to services and resources to farmers had a positive effect on the use of conservation practices. Foltz (2003) indicated that water cost had no significant effect on adoption of conservation practices. The net present value of an investment in SWC measures is what really counts and not the amount of input costs.

The off farm income had a significant effect on mean score of the SWC score at the 99% confidence level ($p<0.001$). Farmers with off farm income were more likely to adopt SWC measures than full time farmers. This supports the results found by Lapar and Pandey (1999) who reported that off farm income had a significant positive effect on adoption of SWC measures as they have more financial resources to invest in using these measures. Amsalu and de Graaff (2007) stated that off farm income decreased the manpower available for conservation on the farm. However, off farm income allowed investment in conservation of resources and employment of labor for conservation practices. In contrast, Faltermeier (2007), Bravo-Uureta et al. (2006) and Tenge et al. (2004) found that off farm income had a significant negative effect on adoption of SWC practices. They stated that earning off farm income decreased the time available for agriculture and such farmers were less concerned with improving the quality of natural resources. Assefa-Mengstie (2009), Anley et al. (2007), Jara-Rojas et al. (2013) and Rezvanfar et al. (2009) found that off farm income had no significant effect on adoption of SWC practices. This suggest that the effect of off farm income on the adoption of SWC measures is interrelated with other factors such as the quality and quantity of farm resources, the off farm employment opportunities and the probable on-farm and off-farm income.

Table IV shows that as the distance from home to paddy farms increases, the mean score of the SWC scale increases up to one kilometer, but it decreases thereafter ($p<0.01$). This is in contrast with the findings of Nkegbe et al. (2011), Bekele (2003), Tenge et al. (2004), Kessler (2006), and Anley et al. (2007) who found that the increase in distance from home to farm had a significant negative effect on adoption of SWC practices. Amsalu and de Graaff (2006) and Amsalu and de Graaff (2007) found that distance from home to farm had no significant effect on adoption of SWC practices. Similarly, as distance from home to the main road increases, the mean score of the SWC scale increases up to one kilometer, but it decreases thereafter ($p<0.01$). This is partly consistent with the findings of Chomba (2004). However, this is in contrast to the findings of Assefa-Mengstie (2009) who found that the greater the distance from home to road, the lower the tendency to undertake SWC measures, and to Lapar and Pandey (1999) who found a negative relationship between the rate of adoption of SWC measures and the distance from home to a main road.

## CONCLUSIONS

The results of ANOVA testing indicated statistically significant differences at the 99% confidence level between the mean scores of SWC scale of the groups of age, educational status, and non-agricultural income, costs of production, yield, product performance, and number of paddy plots, distance from home to farm and distance from home to main road. Similar significant results were observed at the 95% confidence level by the family size, experience in rice production, number of domestic animals, and level of profit from rice production. The variables of experience in agriculture and the number of poultry had no significant effect on conservation. Younger paddy farmers who are more production efficient, who make larger profits and have off farm income and those with larger family members, higher education, longer rice farming experience, larger number of animals and larger farms, were more likely to adopt and use SWC measures.

Findings and recommendations on adoption of SWC practices include:

1. Younger farmers are more likely to engage in SWC practices.
2. Education level increased farmer's awareness of the benefits of SWC practices. Farmers with higher education should be a focus of the promotion of SWC practices because they are more likely adopts SWC measures.
3. Income has a direct effect on adoption of conservation practices. Since initiation of conservation practices is costly and time-consuming, it is recommended to grant long-term loans to low income groups of farmers.
4. Physical SWC measure requires funding and know-how which have to be addressed by a government policy in order to provide a source of financial and technical assistance to help paddy farmers to adopt and use SWC measures.
5. The developments of SWC practices on larger farms are more workable and sustainable than small farms. Farmers with large holdings or groups of farmers at catchment or microcatchment bases should be addressed in extension campaigns to promote SWC practices.

## ACKNOWLEDGMENTS

Financial support by Rasht Branch, Islamic Azad University Grant No. 4.5830 is acknowledged.

## RESUMO

Este estudo analisou o uso de práticas de conservação de solo e água entre produtores de arroz no Irã. Uma amostra aleatória de 400 produtores de arroz da planície Foumanat, da província de Guilan, que adotam medidas de conservação de solo e água, foi extraída de uma população de 52 mil agricultores. Um questionário com duas partes foi usado para examinar o nível de utilização de práticas de conservação de solo e água e o perfil dos agricultores de arroz. A consistência interna foi demonstrada com um coeficiente alfa de 0,76 e o conteúdo e validade do instrumento foi confirmada por um painel de especialistas em solo e água. Estatísticas descritivas e analíticas foram utilizadas para analisar os dados. Os resultados de ANOVA indicaram que os níveis médios de práticas de conservação de solo e água variam consideravelmente, ao nível 0,01 de significância por grupos de idade, escolaridade, renda não-agrícola, custos de produção, rendimento produtivo, arrozais cultivados e distância de casa para a fazenda ou para a estrada principal. Da mesma forma, a um nível de significância de 0,05 foi observado variações determinada por grupos de tamanho da família, produção de arroz, propriedade de gado e lucros com produção de arroz. Os níveis de experiência na agricultura e posse de aves não apresentaram efeitos significativos sobre as práticas de conservação.

**Palavras-chave:** práticas de conservação, solo e água, arrozais, planície Foumanat, Irã.

## REFERENCES

ALAVI SR. 2010. Feasibility Study of Participatory Land and Water Resources Utilization System in Shahid Madani Dam in Tabriz. J Agric Extension Edu Res 3(1): 99-115.

ALIZADEH M, MIRZAEI F AND SOHRABI T. 2011. Laboratory Study the Effects of Zeolite on Guilan Province's Paddy's Soils Behaviors in the Occurrence of Difference Stages of the During Cracks Intermittent Irrigation. J Water Soil 25(5): 1138-1146.

AMSALU A. 2006. Caring for the land: Best practices in soil and water conservation in Beressa watershed, highlands of Ethiopia. Ph.D. dissertation. Wageningen University, Wageningen.

AMSALU A AND DE GRAAFF J. 2006. Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. Ecol Econ 61: 294–302.

AMSALU A AND DE GRAAFF J. 2007. Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. Ecol Econ 61: 294-302.

ANLEY Y, BOGALE A AND HAILE-GABRIEL A. 2007. Adoption decision and use intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo district, Western Ethiopia. Land Degrad Dev 18: 289-302.

ASAFU-ADJAYE J. 2008. Factors affecting the adoption of soil conservation measures: A case study of Fijian cane farmers. J Agr Resour Econ 33: 99-117.

ASSEFA-MENGSTIE FA. 2009. Assessment of Adoption Behavior of Soil and Water Conservation Practices in the Koga Watershed, Highlands of Ethiopia (Doctoral dissertation, Cornell University).

BAKHSH K, HASSAN I, KHURSHID W AND HASSAN S. 2012. Econometric Analysis of Adoption of Water Conservation Practices: A Case of Cotton Crop. J Agric Res 50: 445-455

BARTLETT JE, KOTRLIK JW AND HIGGINS CHC. 2001. Organizational research: Determining appropriate sample size in survey research appropriate sample size in survey research. Inform Technol Learning Perform J 19(1): 43.

BAYARD B, JOLLY CM AND SHANNON DA. 2006. The adoption and management of soil conservation practices in Haiti: The case of rock walls. Agric Econo Rev 7: 28-39.

BEKELE E. 2003. Causes and consequences of environmental degradation in Ethiopia. In: Gedion A (Ed), Environment and environmental change in Ethiopia. Consultation Papers on Environment No. 1. Forum for Social Studies, Addis Ababa, p. 24-31.

BRAVO-URETA BE, SOLIS D, COCCHI H AND QUIROGA RE. 2006. The impact of soil conservation and output diversification on farm income in Central American hillside farming. Agric Econo 35: 267-276.

CHOMBA GN. 2004. Factors Affecting Smallholder Farmers' adoption of Soil and Water Conservation Practices in Zambia. Doctoral Dissertation, Michigan State University.

FALTERMEIER L. 2007. Adoption of water conservation and intensification technologies in the lowland rice production systems of Northern Ghana. In MEIDE Conference, Maastricht, Netherlands.

FAO. 2003. Unlocking the Water Potential of Agriculture. Rome, Italy.

FOLTZ JD. 2003. The Economics of Water-Conserving Technology Adoption in Tunisia: An Empirical Estimation of Farmer Technology Choice. Econo Dev Cult Chang 5: 359-373.

HASANZADEH M. 2001. The role of information in land management, soil erosion and sustainable development. National Conference on Land Management - Soil erosion and sustainable development, January 2001, Arak, p. 85-93.

HUDSON N. 2004. Soil and water conservation in semi-arid areas. Revised edition, FAO, Rome.

ILLUKPITIYA P AND GOPALAKRISHNAN C. 2004. Decision-making in soil conservation: application of a behavioral model to potato farmers in Sri Lanka. Land Use Policy 2: 321-331.

JARA-ROJAS R, BRAVO-URETA BE AND DÍAZ J. 2012. Adoption of water conservation practices: A socioeconomic analysis of small-scale farmers in Central Chile. Agric Sys 110: 54-62.

JARA-ROJAS R, BRAVO-URETA BE, ENGLER A AND DÍAZ J. 2013. An analysis of the joint adoption of water conservation and soil conservation in Central Chile. Land Use Policy 32: 292-301.

KARANI Z AND SORI N. 2009. Optimal management of water resources for agriculture, a step towards sustainable development. National second conference of drought impacts and management strategies, 30-31 May 2009, Esfahan, p. 1-7.

KESHAVARZ F, ALLAHYARI MS, AZARMI Z AND KHAYATI M. 2011. Effective Factors on Non-Adoption of High Producing Varieties among Rice Producers in Guilan Province. J Agric Extension Edu Res 3: 99-112.

KESSLER CA. 2006. Decisive key-factors influencing farm households' soil and water conservation investments. Appl Geog 26: 40-60.

KRÜGER HJ, BERHANU F, YOHANNES G AND KEFENI K. 1997. Inventory of indigenous soil and water conservation measures on selected sites in the Ethiopian Highlands. Soil Conservation Research Programme Research Report 34, Centre for Development and Environment, University of Bern Switzerland

LAPAR MLA AND PANDEY S. 1999. Adoption of soil conservation: the case of the Philippine uplands. Agric Econ 21: 241-256.

LIU G, DAI F, NAN L AND DU S. 2013. Assessing the suitability of soil and water conservation practices in Southwestern China. Land Use Policy 30: 319-327.

MOHAMMADI Y, SHABANALI FAMI H AND ASADI M. 2010. Identification and analysis of agricultural water management problems in the city of Golden Plain, Fars Province. Iranian J Agric Sci 41-2(4): 501-511.

NASIRI M, NAJAFINEJAD A, DARIJANI A AND SAADODIN A. 2001. Evaluating socio-economic influencing factors on terracing adoption: Using Logit model, Case study, Chamany Watershed, Golestan Province. J Water Soil Conserv 18: 209-223.

NKEGBE PK, SHANKAR B AND CEDDIA GM 2011. Smallholder Adoption of Soil and Water Conservation Practices in Northern Ghana. In 2011 International Congress, August 30-September 2, 2011, Zurich, Switzerland (No. 114608). European Association of Agricultural Economists.

NOORIVANDI A, AJILI A, CHIZARI A AND BIJANI M. 2011. Comparison of soil conservation technology adoption patterns in Khuzestan province. Iranian Agric Extension Edu 7: 21-33.

PANNELL DJ. 1999. Uncertainty and Adoption of Sustainable Farming Systems. J Soil Water Conserv 51: 313-321. Available at: http://dpannell.fnas.uwa.edu.au/dpap9901f.htm

POSTHUMUS H. 2005. The adoption of terraces in the Peruvian Andes. Ph.D. dissertation. Wageningen University, Wageningen.

REZVANFAR A, SAMIEE A AND FAHAM E. 2009. Analysis of factors affecting adoption of sustainable soil conservation practices among wheat growers. World Appl Sci J 6: 644-651.

ROGERS E. 1995. Diffusion of Innovations. 4th ed., New York, USA: the Free Press.

SEMGALAWE ZM AND FOLMER H. 2000. Household adoption behavior of improved soil conservation: the case of the North Pare and West Usambara Mountains of Tanzania. Land Use Policy 17: 321-336.

SHAHROUDI A and CHIZARI M. 2006. Water user's cooperatives; strategies in achieving sustainable agricultural water management efficiency. Jihad Magazine 274: 92-109.

SHAHROUDI A, CHIZARI M and PEZESHKIRAD GHR. 2009. The Influence of Water Users' Cooperative on Farmers' Attitudes toward Agricultural Water Management: A Case Study in Khorasan-Razavi Province, Iran. J Econ Agric Dev 22: 71-85.

SOMDA J, NIANOGO AJ, NASSA S AND SANOU S. 2002. Soil fertility management and socio-economic factors in crop-livestock systems in Burkina Faso: a case study of composting technology. Ecolo Econ 43: 175-183.

TENGE AJ, DE GRAAFF J AND HELLA JP. 2004. Social and economic factors affecting the adoption of soil and water conservation in West Usambara highlands, Tanzania. Land Degrad Dev 15: 99-114.

TENGE AJ, DE GRAAFF J AND HELLA JP. 2005. Financial efficiency of major soil and water conservation measures in West Usambara highlands, Tanzania. Appl Geog 25: 348-366.

UNESCO. 1997. Educating for a Sustainable Future; a Transdisciplinary Vision for Concerted Action. United Nations Educational, Scientific and Cultural Organization

WALL G, BALDWIN C AND SHELTON J. 2003. Soil Erosion - Causes and Effects. Fact Sheet, Ontario Ministry of Agriculture – Food and Rural Affairs, Canada.