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ARTICLE

Adoption of conservation farming practices for sustainable rice production among small-scale paddy farmers in northern Iran

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Abstract The availability of natural resources often becomes a limiting factor for increasing per capita food production, particularly among small-scale farmers in developing countries. The adoption of conservation farming practices, as a way to tackle this challenge, has become a major issue in the development policy agenda, but data on the sustainable production of lowland rice are limited. A survey of small-scale paddy farmers was conducted to analyze factors determining adoption of conservation farming practices in Fumanat plain in northern Iran. The majority of the farmers showed high levels of adoption, corresponding to 8–10 conservation practices. Removing weeds from irrigation canals, dredging irrigation canals (i.e., cleaning bottom sediments), using a plastic cover on field borders, draining land, using organic fertilization, leveling land, and practicing conservation tillage were popular farming practices. Well-educated farmers, who were using canals as the main source of irrigation, and farmers with a large land area under cultivation, high income, access to machinery and farming inputs, and high social participation were more likely to adopt conservation practices. On the contrary, farmers' age (farmers of advanced age), household distance from the main road (remote areas), and number of family members available for farming (large families) limited the possibility of adoption. Up to 42.6 % of the variance regarding the adoption of conservation practices could be predicted by a stepwise multiple regression model. Access to machinery, access to farming inputs, the use of canals as the main source of irrigation, and farm income had the greatest share in predicting adoption. Tailored extension programs can be highly effective instruments, not only for increasing conservation of natural resources but also for reducing poverty, especially in small farms in remote and isolated areas.

Keywords Extension programs · Guilan · Natural resources · Policy · Survey

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Introduction

Economic growth in developing countries depends to a great extent on the performance of the agricultural sector and its level of contribution to the management of basic natural resources. Unfortunately, extreme weather events, such as droughts and floods, as well as human factors often reduce the availability and the quality of the main natural resources (Lal 2013). Precipitation is of crucial importance in agriculture since it is the basis for the efficiency of 82 % of the arable lands (Schultz et al. 2005). Despite the important role of water in the efficiency of agriculture and food security, irrigation water is increasingly becoming a scarce resource (Bruinsma 2009). In addition, a great proportion of the agricultural land of the world is subjected to moderate or severe soil degradation, although estimates of the intensity and extent of degradation give divergent views due to different methodologies, definitions applied, and lack of on-the-ground validation (Bindraban et al.

2012). Soil degradation is not a new problem, but failing to acknowledge, mitigate, and remediate the multiple factors causing it is no longer a viable option for humankind (Karlen and Rice 2015). Consequences of soil degradation are loss of soil production potential which directly reflects into poor production at the farmers' level and total lack of investment on soil conservation (Mengstie 2009).

Iran has a highly negative water balance, given that almost a third of the total annual precipitation is recovered (Madani 2014). Also, the temporal and spatial distribution of precipitation often does not match water demands of the agricultural sector (Rafiee and Bakhshodeh 2008). Iran ranks first in the region and second in the world in terms of soil erosion rate (Mahdian 2005). Erosion not only degrades soil, but also the deposition of soil blocks irrigation canals and waterways and fills dam reservoirs. Important problems of the irrigation and drainage network of Sefid-Rud river in Guilan province include changes in agronomic and planting patterns, increase in rice acreage supported by the network, soil deposition in drainage channels, and the loss of their transfer capacity (Pandam Consulting Engineers 2004). Also, rising of water surface and the resultant problems of drainage in the lowlands and deltas around the network, a deficiency of the available water resources due to some loss of capacity of Sefid-Rud dam reservoir, and poor water distribution in the farms due to limited water resources often occur as serious obstacles in the area (Pandam Consulting Engineers 2004). Other major problems include destruction of water entrance hatches and adjustment of water level in the canals, inappropriateness of water entrances in the canals due to changes in the farming and planting patterns, and limitations of physical and managerial structures regarding the exploitation and maintenance of the network (Pandam Consulting Engineers 2004).

Several studies dealt with farmers' adoption of water and soil conservation practices in various crops or cropping systems around the world (Sidibé 2005; Amsalu and De Graaff 2007; Rezvanfar et al. 2009; Wauters et al. 2010; Mariano et al. 2012; Jara-Rojas et al. 2013; Arslan et al. 2014). Personal, economic, social, institutional, and biophysical factors were found to play some role in farmers' decision-making with respect to adoption. Taking these factors into account, while planning soil conservation measures, enables policy makers to come up with projects that win acceptance by the local people (Asrat et al. 2004). A basic motivation of farmers for adopting practices and technology for the conservation of basic resources (water and soil) is often the expected profitability of such practices (Cary and Wilkinson 1997; Amsalu and De Graaff 2007; De Graaff et al. 2008). Apart from profitability, however, several other factors, such as training and perception of soil erosion (Sidibé 2005; Haghjou et al. 2014; Tesfaye et al. 2014), farming experience, education, and land tenure (Illukpitiya and Gopalakrishnan 2004), level of knowledge (Rezvanfar et al. 2009), access to information and support programs for initial investment (Bekele 2003), household's progressiveness (Kessler 2006), and soil slope (Amsalu and De Graaff 2007), also affect the adoption decision. On the other hand, various factors, such as farm distance from farmer's household (Fentie et al. 2013), the number of livestock, and high soil fertility (Amsalu and De Graaff 2007), were found to adversely impact adoption. Evidently, the factors affecting the adoption of conservation practices are context specific and the relative importance of each factor differs across sites; hence, generalization is not possible (Lapar and Pandey 1999; De Graaff et al. 2008).

Understanding farmer-specific characteristics as well as the environment where farmers operate is an essential requirement before the dissemination of any rice technologies at the farm level (Ghimire et al. 2015). To this end, surveys are useful to characterize farmers so that the proper matching of prospective technologies with farmers' characteristics and agroeconomic conditions on farms will reduce the cost of technology diffusion and alleviate any flaws of technology adoption. A unique feature of lowland rice culture is the crop growth under flooded soil. In transplanted rice, fields are puddled to reduce percolation and are flooded before planting, with frequent irrigations treating potential water losses. In any case, water control is the most important management practice that largely determines the efficiency of other production inputs in rice farming (Bouman et al. 2007). However, unsustainable practices of land and water management that violate the system's carrying capacity can impose significant costs on regional communities (Khan and Hanjra 2008). Therefore, while technological change was necessary to meet the growing population demand for food, its negative impacts on land and soil quality should be minimized by adopting sustainable techno-managerial methods (Ali 2004). In this context, rice farmers face everyday decisions on how to optimize their land use. Such decisions include choices intended to increase farm productivity and profit. In most developing countries, however, the adoption rate of technologies aiming at the conservation of natural resources has been low, despite the desirable impacts of new rice technologies and considerable effort put into persuading farmers to adopt them (Jones 2002; Tenge et al. 2004). The application of such practices usually has two main aspects: (i) consistency with the local biophysical conditions, which are natural and relatively stable factors in a region and (ii) suitability in terms of social and economic conditions of the local population (Liu et al. 2013).

The adoption of conservation farming practices, as a way to tackle the challenge of long-term sustainability of natural resources, has become a major issue in the development policy agenda in many rural areas worldwide, but data on the sustainable production of lowland rice are highly limited. The objective of the present study was to explore the level of adoption of water and soil conservation practices by small-scale paddy farmers in Fumanat plain of Guilan province, Iran and point out significant factors that affect the decision for adoption. The results could provide a benchmark for future comparisons in the area or other areas with similar farmers' profile and assist a better understanding of farmers' management behavior for targeted agricultural extension.

Materials and methods

Study area

The study area composed of the irrigation and drainage network of the Sefid-Rud river in Fumanat plain of Guilan province, northern Iran (Fig. 1). Sefid-Rud is the largest river in Guilan, originating in the interior plateau of Iran, and flowing into the Guilan plain and then to the Caspian Sea. Fumanat plain is located in the central part of Guilan province fed by the watershed of Anzali lagoon. Its total area is over 84,310 ha out of which an area of 56,774 ha is under rice cultivation. The study area has over 56,908 households, out of which 52,086 are affiliated to rice farming (Pandam Consulting Engineers 2004).

Selection of sample

The participants of the study comprised rice farmers living in Fumanat plain, including farmers who were using water and soil conservation practices in rice farming and farmers who had not adopted them at the time of study. From the population of rice farmers in the area (52,086), the number for the survey sample was calculated to 382 farmers using the following equation (Bartlett et al. 2001):

$$n = \frac{\frac{z_{\frac{\alpha}{2}}^2 pq}{d^2}}{1 + \frac{1}{N}\left[\frac{z_{\frac{\alpha}{2}}^2 pq}{d^2} - 1\right]},$$

where n is the sample size, N is the population size (in this case $N = 52{,}086$ farmers), p is the estimated proportion of the population ($p = 0.5$), q is the $(1 - p)$ (i.e., $q = 0.5$), d is the one half of the desired interval width ($d = 0.05$), and z is the value from the standard normal distribution for the selected confidence level of 95 % ($z = 1.96$). From the above equation, the sample size was calculated to be 382 farmers. This value was increased to 400 farmers to further enhance external validity.

Data collection: process and instruments

Following review of the literature, previous experience in the area, and numerous meetings with experts, a questionnaire was designed as the main tool for the study. The dependent variable was related to the prevailing water and soil conservation practices in the region, including the following practices: (1) removal of weeds from irrigation canals, (2) dredging irrigation canals (i.e., cleaning bottom sediments of both common and individual canals), (3) practicing crop rotation or second planting with canola, cereals, and various cucurbits, (4) performing ratoon harvest, (5) using organic fertilization (i.e., compost or rotten manure), (6) practicing conservation tillage, (7) using a plastic cover on farm borders, (8) creating floodgates and dikes, (9) leveling land, and (10) draining land. The above practices are the most common conservation practices for rice cultivation in the area, dealing with the conservation of soil and water. However, the level of contribution of each farming practice to the conservation of natural resources was not a part of the objective of this study and was not assessed. Data were collected via personal interviews with the farmers. For this reason, farmers' lists were taken from the local authorities and prospective farmers were

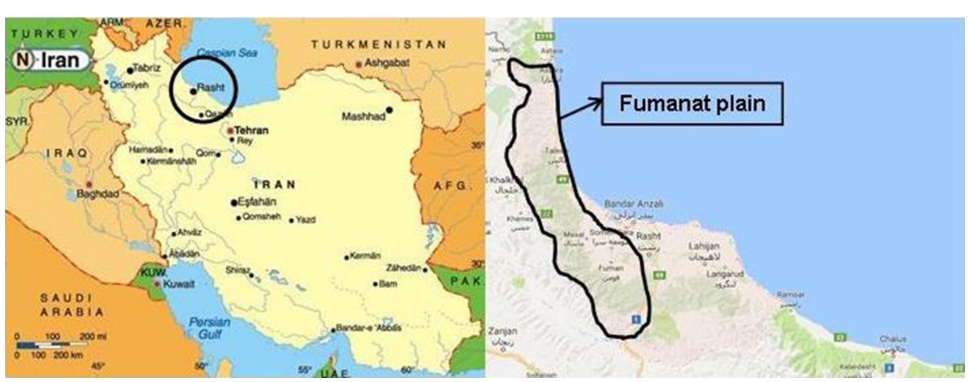

Fig. 1 Map of the study area

randomly selected. The rice farmers were asked if they were using these practices or not (1 = yes, 0 = no). Eventually, a total score of adoption was calculated for each farmer and a total score of implementation determined the popularity of each practice. The number of reported practices was used to define the level of adoption among farmers; the importance of each farming practice to the conservation of natural resources was not assessed. Thus, farmers were grouped into adoption levels in terms of the extent of adoption of water and soil conservation practices as follows: farmers who reported to use 1–3 conservation practices were classified in the group of low adopters, those who reported to use 4–7 practices were classified in the group of moderate adopters, and finally those who using 8–10 practices were classified in the group of high adopters. Independent variables of this study included demographic variables (i.e., gender, age, marital status, household members, education, occupation in agriculture or in other activities, farming experience, and rice farming experience), economic variables (i.e., livestock number, poultry number, farm income, off-farm income, total rice production, and total farming costs), social characteristics (i.e., cooperation with other farmers, village authorities, village institutions, local extension agents, participation in governmental programs, and attendance of extension courses), and technical characteristics (i.e., land size, number of plots, farm distance to village, village distance to the main road, cultivars grown, land ownership, irrigation water resources, access to machinery, and institutional characteristics). Social and institutional characteristics of farmers were assessed on a five-point Likert-type scale as follows: very low, low, moderate (fair), high, and very high. The validity of the research tool was assessed and confirmed by a panel of experts, including academic teachers and rice field experts of Guilan province. To estimate its reliability, a pilot study was carried out with 30 farmers out of the study area and the questionnaire was adjusted accordingly; ambiguous meanings were clarified or removed using the feedback from the pilot study. The reliability was estimated for the required sections to 0.84.

Data analysis

Basic descriptive statistics (frequency percentages, means, and standard deviations) of the sample were calculated. Inferential statistics, including Pearson, Spearman, and point-biserial coefficients of correlation, were used to determine the relationships between measured variables. For grouping farmers according to their levels of social and institutional characteristics, a five-point Likert-type scale was used as follows: very low, low, moderate (fair), high, and very high. For better understanding the basic trends, the 'very low' category was merged with the 'low' category and the 'very high' category was merged with the 'high' category in the presentation of the data.

To determine quantitative relationships between the dependent and the independent variables, stepwise multiple regression analysis was used (the respondents can choose more than one item). The construction of a multiple linear regression (MLR) model helps investigate the impact of several independent variables (X1, X2, …, Xk) on one dependent variable (Y). The essence of MLR models is based on the scientific information contained in the obtained equation. The applied stepwise regression was designed to leave a minimum set of independent variables in the regression model, while maximizing the adjusted determination coefficient and minimizing the mean squared deviation from the regression model. This method involves, in its first step, construction of a model that contains all potential dependent variables and then gradually eliminates them to maintain the model with the highest determination coefficient, while maintaining the significance of the parameters (Kolasa-Wiecek 2015). All data were analyzed using $SPSS_{22}$ and MS-Excel software packages.

Results

Farmers' characteristics

The majority of the farmers (97.5 %) were male (Table 1). The mean age of the farmers surveyed was 49.6 years. Most farmers belonged to the age groups of 41–50 years and more than 50 years, showing that local rice farmers were mainly elderly. This is also supported by the high experience of farmers in farming (mean = 31.6 years) and particularly in rice farming (mean = 30.8 years). In terms of educational level, most farmers (69 %) had up to intermediate education, whereas only 6.8 % had an academic education (Table 1). Most farmers were occupied mainly in agriculture, whereas some farmers were involved also in other activities. Total rice production was, on average, 2908 kg and the average farming costs were 29.8 million Iranian rials (IRR) (Table 2). The labor of farmers and of their family members is not included in the farming costs. Farmers' average income from rice growing was 82.7 million IRR with most farmers having income in the group of less than 60 million IRR. Farmers' average off-farm income was 39.7 million IRR, while the main job of most farmers was farming with no off-farm income (Table 2). Concerning some social characteristics of farmers (Table 3), cooperation with other farmers (mean = 3.52) and cooperation with village authorities (mean = 2.84) had the highest ranks among indicators of rice farmers' social participation. With reference to

Table 1 Basic demographic profile of rice farmers

Variable	Frequency	Percentage
Gender		
Male	390	97.5
Female	10	2.5
Age (mean = 49.6)		
Less than 30 years	17	4.2
From 30 to 40 years	82	20.5
From 41 to 50 years	130	32.5
More than 50 years	171	42.8
Marital status		
Single	9	2.2
Married	391	97.8
Household members (mean = 4.8)		
Less than 3 individuals	81	20.2
From 3 to 6 individuals	272	68.0
More than 6 individuals	47	11.8
Education		
No education at all	81	20.2
Elementary or intermediate	195	48.8
High school graduate	97	24.2
Academic education	27	6.8
Occupied in agriculture		
Yes	307	76.8
No	93	23.2
Occupied in other activities		
Yes	194	48.5
No	206	51.5
Farming experience (mean = 31.6)		
Less than 20 years	116	29.0
From 20 to 40 years	195	48.8
More than 40 years	89	22.2
Rice farming experience (mean = 30.8)		
Less than 20 years	128	32.0
From 20 to 40 years	196	49.0
More than 40 years	76	19.0

Table 2 Basic economic profile of rice farmers

Variable	Frequency	Percentage
Number of livestock (mean = 4.2)		
None	125	31.3
Less than 3 heads	145	36.2
From 3 to 6 heads	62	15.5
More than 6 heads	68	17.0
Number of poultry (mean = 35.5)		
None	131	32.8
Less than 25 hens	113	28.2
From 25 to 50 hens	117	29.2
More than 50 hens	39	9.8
Farm income (mean = 82.7)		
Up to 60 million IRR	236	59.0
From 61 to 120 million IRR	94	23.5
From 121 to 180 million IRR	28	7.0
From 181 to 240 million IRR	23	5.8
More than 240 million IRR	19	4.7
Off-farm income (mean = 39.7)		
Zero	136	34.0
Up to 30 million IRR	102	25.6
From 31 to 60 million IRR	81	20.2
More than 60 million IRR	81	20.2
Total rice production (mean = 2908.3)		
Less than 1500 kg	118	29.5
From 1500 to 3000 kg	110	27.5
From 3001 to 4000 kg	115	28.8
More than 4000 kg	57	14.2
Total farming costs (mean = 29.8)		
Less than 10 million IRR	53	13.3
From 10 to 30 million IRR	217	54.2
From 31 to 60 million IRR	96	24.0
More than 60 million IRR	34	8.5

IRR Iranian rials (1.00 US dollar = 30,175.02 IRR)

technical characteristics of farmers (Table 4), mean land area was 1.59 ha and the highest frequency of land plots was in the groups of up to two plots. Most farmland was owned (92.8 %); fields were prepared by tractors and sown with seeds of local varieties. Most farmers irrigated their farms using canals. Also, the mean distance of farms from the village was 1.02 km and the mean distance of the village from the main road was 0.72 km (Table 4). Table 5 presents the distribution frequency of some institutional characteristics of rice farmers. The majority of the farmers (67.5 %) showed moderate or high levels of access to information sources (i.e., radio, magazines, extensionists, etc.), but low levels of satisfaction by the pricing policy (66 %). Few farmers were highly aware of the agricultural regulations; the majority (60.3 %) had low levels of knowledge. Extension courses were evaluated as not so useful by most farmers (80.8 %), whereas some farmers (10.7 %) felt that they were highly useful (Table 5).

Adoption of water and soil conservation practices

The majority of the farmers (49.2 %) showed high levels of adoption, corresponding to 8–10 conservation practices (Table 6). Also, a great proportion (30.8 %) reported moderate levels of adoption, corresponding to 4–7

Table 3 Social characteristics of rice farmers

Attribute	Frequency (%)			Mean	SD
	Low	Fair	High		
Cooperation with other farmers	21.5	19.8	58.7	3.52	1.189
Cooperation with village authorities	37.0	35.7	27.3	2.84	1.038
Cooperation with village institutions	56.8	31.0	12.2	2.42	0.967
Cooperation with local extension agents	69.5	18.5	12.0	2.21	0.992
Participation in governmental programs	66.0	23.8	10.2	2.17	1.022
Attendance of extension courses	81.5	14.3	4.2	1.90	0.833

SD standard deviation

Table 4 Technical characteristics of rice farmers

Characteristic	Frequency	Percentage
Land size (mean = 1.59)		
Less than 1 ha	193	48.2
From 1 to 2 ha	139	34.8
More than 2 ha	68	17.0
Number of plots (mean = 2.74)		
1 plot	108	27.0
Up to 2 plots	123	30.8
Up to 3 plots	86	21.5
More than 3 plots	83	20.7
Farm distance to village (mean = 1.02)		
Less than 0.1 km	83	20.7
From 0.1 to 1 km	222	55.5
More than 1 km	95	23.8
Village distance to the main road (mean = 0.72)		
Less than 0.1 km	173	43.2
From 0.1 to 1 km	168	42.0
More than 1 km	59	14.8
Cultivars grown		
Local	368	92.8
Bred	0	0.0
Both	32	7.2
Land ownership		
Owned land	371	92.8
Rented land (or shareholders)	29	7.2
Irrigation water resource		
Canals	263	65.8
Spring, well, dike	137	34.2
Access to machinery		
Tractor	76	19.0
Tractor plus other machines (tiller, transplanter, combine)	324	81.0

conservation practices. By contrast, a sizeable proportion (20 %) reported low levels of adoption. Among water and soil conservation practices (Table 7), removing weeds from irrigation canals, dredging irrigation canals (i.e., cleaning bottom sediments), using a plastic cover on field borders, draining land, using organic fertilization, leveling land, and practicing conservation tillage were quite popular practices among farmers. On the other hand, the practices 'creation of floodgates and dikes' and 'performing ratoon harvest' were the least popular among farmers (Table 7).

Table 5 Institutional characteristics of rice farmers

Attribute	Frequency (%)			Mean	SD
	Low	Moderate	High		
Access to information sources	32.5	42.8	24.7	2.84	1.055
Satisfaction by pricing policy	66.0	17.3	16.7	2.23	1.126
Knowledge of regulations	60.3	33.0	6.7	2.20	0.913
Extension courses usefulness	80.8	8.5	10.7	1.83	1.082

SD standard deviation

Table 6 Overall adoption level of water and soil conservation practices among rice farmers

Adoption level	Frequency	Percentage
Low (1–3 practices)	80	20.0
Moderate (4–7 practices)	123	30.8
High (8–10 practices)	197	49.2

Relationship between adoption level and studied variables

The adoption level of water and soil conservation practices among rice farmers was positively correlated with access to machinery ($r = 0.390$), access to farming inputs ($r = 0.348$), canals as the main source of irrigation ($r = 0.347$), farm income ($r = 0.257$), availability of loans ($r = 0.247$), education background ($r = 0.230$), social participation ($r = 0.210$), and land size ($r = 0.169$) (Table 8). By contrast, there was a negative correlation of adoption with household distance from the main road ($r = -0.294$), household members available for farming ($r = -0.256$), and age of farmers ($r = -0.156$). These results definitely indicate a link between adoption and the above variables, but they need to be interpreted discreetly since the coefficients of correlation are low, but significant because of the large sample size.

Stepwise multiple linear regression

In this analysis, seven models were tested to examine the variation among respondents in the adoption level of water and soil conservation practices. Model 7 explained up to 42.6 % of the variation in the adoption level of water and soil conservation practices using the predictors: access to machinery, access to inputs, canals as the main source of irrigation, farm income, age, household distance from the main road, and household members available for farming (Table 9). The value of ΔR square was used to interpret the most important predictors among the above variables. ΔR square is the incremental increase in the model R square resulting from the addition of a predictor or a set of predictors to the regression equation. For this purpose, predictors which could make change more than 5 % in the dependent variable got the first priority. Therefore, the variables—access to machinery, access to inputs, canals as the main source of irrigation, and farm income—had significant influence in determining the adoption level of water and soil conservation practices (Table 9). However, β values (a measure of how strongly each predictor variable affects the dependent variable) should be used to estimate the relative importance of independent variables in the prediction of the regression equation. β values of this model showed that the variable 'access to machinery' ($\beta = 0.340$) was more effective at the adoption level of water and soil conservation practices than other variables

Table 7 Common conservation practices adopted by rice farmers

Conservation practice	No. of responses	% of responses	% of cases
Weeds removal from irrigation canals	340	12.2	85.0
Dredging irrigation canals regularly	333	11.9	83.2
Using a plastic cover on field borders	300	10.7	75.0
Draining land of rice field plots	295	10.6	73.8
Application of organic fertilizers	295	10.6	73.8
Leveling land of rice field plots	281	10.1	70.2
Conservation tillage application	263	9.4	65.8
Crop rotation implementation	248	8.9	62.0
Floodgates and dikes creation	227	8.1	56.8
Performing ratoon harvest	209	7.5	52.2

Table 8 Correlation test for the adoption level of conservation practices and the studied variables

Variable	Statistic	Correlation coefficient	P value
Access to machinery	Point-biserial	0.390**	0.000
Access to farming inputs	Spearman	0.348**	0.000
Canals as the main source of irrigation	Point-biserial	0.347**	0.000
Household distance from the main road	Spearman	−0.294**	0.000
Farm income	Spearman	0.257**	0.000
Household members available for farming	Pearson	−0.256**	0.000
Availability of loans	Pearson	0.247**	0.000
Educational background	Pearson	0.230**	0.000
Social participation	Spearman	0.210**	0.000
Land size	Spearman	0.169**	0.001
Age	Spearman	−0.156**	0.002
Attitude	Spearman	0.128*	0.010

** Significant at $P < 0.01$, * Significant at $P < 0.05$

Table 9 Regression coefficients for predicting the adoption level of conservation practices

Variable	Nonstandardized coefficients		Standardized coefficients	t	P value	ΔR^2	Tolerance	VIF
	B	SE	β					
Constant	5.588	0.848		6.591	0.000	–		
Access to machinery	2.627	0.301	0.340	8.719	0.000	0.152	0.965	1.037
Access to farming inputs	0.267	0.053	0.223	5.001	0.000	0.115	0.736	1.359
Canals as the main source of irrigation	1.347	0.255	0.211	5.284	0.000	0.059	0.921	1.086
Farm income	0.070	0.000	0.229	5.880	0.000	0.052	0.970	1.031
Age	−0.042	0.011	−0.152	−3.880	0.000	0.023	0.950	1.052
Household distance from the main road	−0.359	0.109	−0.145	−3.286	0.001	0.017	0.750	1.333
Household members available for farming	−0.222	0.110	−0.079	−2.011	0.045	0.006	0.946	1.057

$F = 24.84$ ($P < 0.01$); Durbin-Watson = 1.381; $R = 0.652$, $R^2 = 0.426$; $R^2_{ad} = 0.415$

VIF variance inflation factor

in the studied region. The next most important variables were 'access to inputs' ($\beta = 0.223$), 'canals as the main source of irrigation' ($\beta = 0.211$), and 'farm income' ($\beta = 0.229$) (Table 9).

Discussion

Most farmers in the study area showed satisfactory levels of adoption regarding various conservation practices in rice farming. Most used canals for irrigation and therefore the practices 'removal of weeds from irrigation canals' and 'dredging irrigation canals' were the most adopted practices by the farmers as expected. On the other hand, the practice 'performing ratoon harvest' had a low adoption rate. Ratoon harvest in rice is a method of harvesting, which leaves the roots and the lower plant parts uncut to give the ratoon or the stubble crop, with main benefits for the farmers (i) the early crop maturation in the season (i.e., the benefit of harvesting early) and (ii) the high resource use efficiency per unit time and per unit land area (i.e., the benefit of high productivity) (Santos et al. 2003). For these reasons, ratoon harvest is considered a sustainable cropping practice in rice production (Faruq et al. 2014). The low adoption rate of this practice might be attributed to the lack of rice cultivars with good ratooning ability, lack of information about management practices, or even due to building up of insect, weed, or disease problems in rice fields. In practice, after the harvesting season in the study area, many farmers use their farms as a pasture and release their animals to the farms. However, because there is no fence around most farms, farmers who want to perform ratoon harvesting cannot retain animals away from their farms. Overall, the satisfactory level of adoption of several conservation practices by rice farmers of the study area could be related to the fact that conservation of basic resources is a high priority for most small-scale farmers to maximize production. Also, farmers who consume some of their own produce for household survival are expected to be highly dependent on farming, which also means that probably they will implement conservation practices of farming extensively to retain the basic resources. Different trends, however, exist in the literature (Jara-Rojas et al. 2013). Another reason for the satisfactory level of adoption could be the fact that the majority of the farmers of the current study had farming as a main job and high farming experience. It is likely that these features created positive perceptions of the importance of soil conservation, and thus, most farmers were quite aware of the value of conservation operations and willing to implement them. The findings imply that if farmers are informed about the value of the soil, the conservation practices, and their advantages, they probably will try to implement conservation operations. This is in line with the results of previous studies (Nasiri et al. 2011). The low involvement of farmers in off-farm activities (zero or low off-farm income) also may have contributed to the high levels of adoption, given that involvement in off-farm activities has been reported as a limiting factor in the adoption of conservation practices by reducing labor and time availability (Tenge et al. 2004).

Well-educated farmers, who were using canals as the main source of irrigation, and farmers with a large land area under cultivation, high income, access to machinery and farming inputs, and high social participation were associated with increased adoption levels of conservation practices. On the contrary, age, household distance from the main road, and the number of family members available for farming seemed to be negatively associated with adoption. However, according to the regression model used, access to machinery and farming inputs, the use of canals as the main source of irrigation, and farm income had the greatest share in predicting adoption. Access to machinery was the most effective factor in the adoption of conservation practices, implying that rice farmers with easy access to a tractor were inclined to adopt conservation practices. This attitude can be associated with the fact that soil conservation practices, e.g., conservation tillage and land leveling, are labor-consuming, and they can be readily adopted by rice farmers if they have access to a tractor. Machinery ownership had a positive impact on the adoption of certified seed technology and integrated crop management practices in rice production in the Philippines, mitigating seasonal bottlenecks in labor supply during planting and harvesting (Mariano et al. 2012). Limited access to machinery has been reported as a limiting factor of conservation tillage adoption (Speratti et al. 2015). A recent study (Thierfelder et al. 2013) reported that conservation agriculture in maize can be practiced in highly diverse environments as long as adequate inputs (fertilizer, herbicides, and labor) are available, especially in the early years of adoption. With the positive and significant impact of mechanization on the adoption of technology, the government should create a scheme that enables farmers to obtain labor-saving machinery or have timely access to the machinery required the periods of land preparation, planting, and harvesting at an affordable rental.

The use of canals as the main source of irrigation had a positive influence on adoption. This could be attributed to the safe environment for rice production that is created by the existence of canals in terms of water availability. Local conditions, such as rainfall and its distribution, may vary considerably, and this impacts cropping patterns and practices in the area. Thus, uncertainty in water supply plays a major role in water management and the subsequent adoption of water-saving measures (Mushtaq et al. 2006). Canals, therefore, not only store surplus and capture rainwater effectively but also provide a reliable source of water, which is a prerequisite for the adoption of conservation practices. Despite these facts, however, farmers who were more reliant on pond irrigation had additional water, a fact which resulted in continuous flooding and less adoption of alternate wetting and drying irrigation (Mushtaq et al. 2006). Farm monthly income was an important variable for the adoption. This could be attributed to the fact that high income is required for land development operations (e.g., land leveling) which are costly. Therefore, higher income households are expected to be more willing to adopt conservation practices than lower income households, because income may be used to hire labor for land development operations. Economic considerations are often found to play a major role in the adoption of innovations, particularly for small-scale farmers in developing countries, where the main objective is to increase production, generate income, and improve livelihood. Nonrice income and farm assets such as land and machinery are proxies for wealth. It is expected that rich farmers are more financially capable to invest in technologies than poor farmers (Mariano et al. 2012). Hence, institutional and policy reforms, as well as technologies that aim at not only reducing soil erosion but also directly increasing farmers' income, are needed. In this context, land use management planning should consider rehabilitating land with regard to raising its agricultural productivity (Assefa and Hans-Rudolf 2016).

The variables 'household distance from the main road' and 'age' had a negative correlation with adoption, namely as age and household distance from the main road increased, the adoption of water and soil conservation practices decreased. Practically, elderly farmers tended to adopt conservation practices less extensively than young farmers. An explanation for the low adoption of conservation practices by old farmers might be their labor shortage and the fact that old farmers usually stick to their traditional way of farming (Tenge et al. 2004). One other explanation for the negative relationship between age and conservation effort may be the long planning horizon for young farmers relative to elderly ones (Anley et al. 2007). On the other hand, Bluemling et al. (2010) stated that age may have no direct effect on the adoption of water conservation practices, but it may have an indirect effect, namely old farmers may pay more attention to what local officials say and so they are more likely to accept these practices as a response to water deficiency. The negative relationship between household distance from the main road and conservation effort can be related to limited access to inputs required for conserving water and soil. Farmers whose farms are near to their residence use soil-conserving technologies because the time and energy they spend is less for near farms than for distant farms. This finding is in line with findings of Mengstie (2009) and Lapar and Pandey (1999) who reported that the high distance of household from farms was a decreasing factor of adoption. The distance of the homestead to the nearest road, as a proxy for market access, may capture the effect of several variables (Lapar and Pandey 1999). First, there is more incentive for the farmer to ensure that farm productivity is improved or at least maintained to take advantage of market opportunities. In this case, farmers who can potentially generate good returns from the production and sale of crops that are highly demanded in the market may therefore find soil conservation economically attractive. Second, farmers who live closer to the road are more likely to be visited by extension agents than the ones who are situated far away (Lapar and Pandey 1999). There was also a negative relationship between adoption and 'family members available for farming.' The reason for this relationship is likely to be related to land fragmentation, which is often more severe in large families. It has been reported that land fragmentation makes adoption of some conservation technologies difficult or too costly (Wildemeersch et al. 2015). With reference to the correlation coefficients calculated (Table 8), they indicated a significant link between adoption and some of the above variables, but they need to be interpreted discreetly, since they were low, but significant because of the large sample size. For this reason, interpretations were mainly based on the results of the stepwise multiple regression model.

Conclusions

The present paper analyzed the adoption of water and soil conservation practices by small-scale paddy farmers in Fumanat plain of Guilan province in northern Iran using stepwise multiple linear regression analysis. The main factors influencing adoption in the study area included access to machinery, access to inputs, the use of canals as the main source of irrigation, farm income, household distance from the main road, and farmers' age. The results are reasonably consistent and in line with previous results in the literature; they could provide a benchmark for future comparisons in the area or other areas with similar farmers' profile and assist a better understanding of farmers' management behavior for targeted agricultural extension. Evidently, the absence of universally significant factors affecting conservation agriculture adoption and especially the sometimes contradictory results observed across analyses make the task of developing policies to promote the adoption of conservation agriculture particularly challenging. The results presented above could have important policy implications for promoting sustainable rice production in the study area.

Since the poorest farmers are those least likely to adopt water conservation practices, these farmers need special attention when policies are designed to promote adoption of the types of techniques and technologies analyzed in this study. An important implication is the need to create education and technical assistance programs that encourage farmers to adopt these practices regardless of their economic standing. Clearly, financial viability is a major consideration that limits interest in conservation agriculture. Yet, several techniques of conservation agriculture have at least modest advantages over conventional practices on this account. Thus, awareness creation and demonstration of the effectiveness of these measures is essential (Tesfaye et al. 2014). Increasing farmers' income in the short term will motivate them to continue practicing sustainable practices. Hence, policy reforms as well as technologies that not only reduce soil erosion but also directly increase farmers' income are needed. Nonfinancial factors, such as farmers' knowledge of conservation agriculture techniques, may be constraining further adoption. It is necessary to enhance farmers' knowledge of these practices and their advantages which will contribute to the expansion of conservation practices. Given the negative impact of farmers' age on the adoption of conservation practices, it is recommended to put young farmers in priority of fulfilling water and soil conservation practices. Shortening the effective distance between markets and rice farms providing easy access to markets through a better road network is essential. Tailored extension programs that encourage adoption of conservation practices can be highly effective instruments, not only for increasing conservation of natural resources but also for reducing poverty, especially in small farms in remote and isolated areas.

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