

Factors Affecting Sustainable Rice Farming: The Case of Rice Farmers in the Mazandaran Province, Iran

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Abstract

In recent years, the production of high-yielding rice varieties in the Mazandaran province due to lack of attention to the environmental issues, has led to undesirable consequences. According to the key role of the farmers in the performance of the sustainable agriculture principles, and the importance of their sustainability practices, the present study aimed to identify the factors affecting sustainability behavior of farmers regarding high-yielding rice varieties farming in the Mazandaran province. This study is based on survey method and statistical sample consisted of 270 rice farmers of Amol, Babol and Sari counties in this province. Data were collected using questionnaire. The most important findings of the study shows that there is a positive and significant relationship between the managerial features, putting the value of the reference group opinions, sustainability attitudes, access to educational-extension and communicational factors, access to inputs and feasibility of sustainable agriculture methods, and farmers' behavior regarding sustainability. Based on the results, feasibility of sustainable agriculture methods, access to educational-extension and communicational factors, managerial features, putting the value of the reference group opinions and sustainability attitudes, explain 49% of sustainability behavior variations. Some recommendations have been provided based on the findings.

Keywords: Sustainable agriculture, Sustainability behavior, High-yielding rice varieties, Rice farmers, Mazandaran (Province).

Introduction

In recent years, many concerns regarding effects and consequences of agricultural activities on environment and society are observed worldwide. The problems such as the losses of a large part of the forests, pollution of the aquatic environment, threat of ozone layer by greenhouse gas emissions, threats to human health, and emerging unknown diseases through fertilizers and chemical pesticides residues, genetic erosion and extinction of many species of animals and plants, ecological imbalance in human environment, destruction and erosion of basic production resources (especially soil) and groundwater pollution have accelerated the trend towards alternative agriculture (Afshari Azad & Tavakoli, 2008). In this type of agriculture is paid more attention to environment and human and there is a mutual respect between these two aspects (Minaei et al., 2008). In this system, human do not think about the domination over nature, but tries to behave with nature and natural resources peacefully and harmoniously.

Given the natural potential of the northern Iranian provinces, especially Mazandaran in rice production, although the use of chemical fertilizers and pesticides has made a significant success in increasing this strategic product in the past three decades, but its production due to the lack of optimal use of inputs and the lack of attention to environmental issues has left many damaging effects (Mahdavi and Pourazizi, 2008). So that according to available reports, pesticides and

chemical fertilizers in the Northern provinces are used several times more than other provinces (Jamshidi, 2008). Production of high-yielding rice varieties has significant importance because its higher yields and longer growth period than the other varieties, and therefore the need for more use of inputs, especially fertilizers, pesticides and herbicides during this period.

The human have important role as a decisive factor in keeping productive resources and prevent this destructive trend. In other words, when rice production in the Mazandaran province will be in the direction of sustainability then all growers put their activities in order to the principles of sustainability. This study aimed to identify the factors affecting sustainability behavior of rice farmers in high-yielding rice varieties production in the Mazandaran province. Review the literature associated with this study indicates that different factors influence the farmers' behavior regarding sustainability. Sengsoulivong (2002) and Zubair and Garforth (2005) found that there is a significant relationship between putting the value to the reference group opinions and sustainable agriculture practices. Sengsoulivong (2002), Kabir et al. (2007), and Koesling and Lien (2008) in their research found a positive and significant relationship between attitudes towards sustainable agriculture and the sustainability practices. Also Zubair and Garforth (2005), and Karami and Mansoorabadi (2008) showed that there is a significant relationship between understanding feasibility of sustainable agriculture and sustainable farming activities. The results obtained from Kabir et al. (2007) and Tanaka (2010) studies showed that there is a significant and positive relationship between advisory contacts of rice growers with information sources and index of applying sustainable rice production technologies. Chaharsooghi Amin and Mirdamadi (2008), and Mendoza (2004) in their research also showed a positive and significant relationship between social participation and observe the standards of sustainable agriculture. Also Kelly et al. (2001) and Kurz (2002) found that a significant relationship exists between access to agricultural inputs and financial resources and sustainability behaviors. Positive and significant relationship between different management practices adopted by farmers and sustainable cultivation system has shown in the study of Dollo et al. (2009). Also studies of Koma (2002) and Rasul and Thapa (2004) indicate that there is a significant relationship between yield and the performance of sustainable agriculture principles. The findings of Koesling and Lien (2008) and Ashfaq et al. (2008) Indicates a positive and significant relationship between the variable of farm size and sustainable agriculture practices. Also Chaharsooghi Amin and Mirdamadi (2008) found that there is a significant relationship between the experience of rice production and observing sustainable agriculture criteria. In addition, results obtained from studies of Huang et al. (2001) and Loblely et al. (2009) show the effect of age on the acceptance of the principles of sustainable agriculture. A positive and significant relationship between educational level of farmers and sustainable agriculture practices is shown in the studies of Ashfaq et al. (2008) and Koesling and Lien (2008).

Materials and Methods

This research was conducted in survey method. Statistical population of this study is rice farmers of high-yielding rice varieties in the Mazandaran province. So that high-yielding rice varieties farmers of Amol, Babol and Sari counties were selected randomly from this province for study. Based on the formula proposed in simple random sampling method (Mansourfar, 2006), the study sample consisted of 270 rice farmers. The data required for this study was collected using questionnaire that were distributed to statistical sample. For assessing the validity of the questionnaire, a panel of experts was used and the reliability of the questionnaire was assessed by a study of 30 farmers out of the main sample, and Cronbach's alpha was used to test it. Data obtained from the questionnaires were analyzed by SPSS software. For data analysis, frequency, pearson's correlation and stepwise multiple regression analysis were used.

Variables and Scales

The sustainability behavior implies applying sustainable agriculture policies and practices by farmers. Sustainability behavior of rice farmers was assessed with 27 items about performance of policies and practices of sustainable high-yielding rice varieties farming using five-point Likert scale. Sustainability attitude is individual attitude toward ideas related to sustainable agriculture principles. Putting the value of the reference group opinions is individual perception of others' attitudes toward sustainable agriculture and, it indicates the individual practical obligation level in order to the regard these attitudes. This variable was assessed by 12 items in five-point Likert scale. Feasibility of sustainable agriculture techniques means farmers' perception of the internal and external resources that affects their sustainability practices. This variable assessed through farmers' perception of the ease or difficulty of performing the method of sustainable cultivation of high-yielding rice varieties and assessed by 9 items in six-point Likert scale. Access to educational – extension and communicational factors means the farmers access to educational and extension classes, magazines and newspapers, Management of Jihad-e-Keshavarzi in the county, agricultural extension and services centers, rural production cooperatives, chemical input suppliers, research centers, television and radio, family, relatives and neighbors to acquire the needed information for sustainable production of high-yielding rice varieties. It was assessed by 11 items in six-point Likert scale. The purpose of the level of participation in rural activities variable is cooperation in agricultural projects, rural production cooperative activities, the activities of local organizations and activities of the local council of the village. To assess the level of participation, 8 items in five-point Likert scale were used. Managerial features are characteristics that rice farmers manage a series of practices to product high-yielding rice varieties by them. To assess this variable 10 items in six-point Likert scale were used. Level of access to required resources and inputs by farmers for high-yielding rice varieties production is assessed by 6 items in six-point Likert and also a question about access to banking facilities and amount of received loan. The features of rice farming systems includes the variables of rice farming experience, the total area of agricultural lands, the total area of rice lands, the area of high-yielding varieties rice lands and distance from the village to cooperative company. Economic feature includes the variable of yield in high-yielding rice production. Individual features include farmer's age and level of education.

Results and Discussion

The results of the study showed that among the total of rice farmers, 41.5% of them with a frequency of 112 were less than 45 years and 25.6% with a frequency of 69 were in the 45 to 55 years age group. Also, 2.2% with a frequency of 6 were in age group over 75 years. The mean age of the sample was about 51 years (Table 1).

Table 1. Frequency distribution of age groups of rice farmers

Age Groups (years)	Frequency	Frequency Percentage	Cumulative Percentage
< 45	112	41.5	41.5
45 to 55	69	25.6	67
55 to 65	57	21.1	88.1
65 to 75	26	9.6	97.8
> 75	6	2.2	100
Total	270	100	-

Maximum = 78

Minimum = 35

Mean = 50.91

SD = 10.90

According to the results from Table 2, 31.1% with frequency of 84 had educational level between 1 to 5 years and 28.5% with frequency of 77 had educational level between 8 to 12 years. Also 4.4% of rice farmers with frequency of 12 had educational level between 12 to 16 years. The mean educational level of the sample was about 7 years (middle school level).

Table 2. Frequency distribution of rice farmers based on the level of education

Level of Education (years)	Frequency	Frequency Percentage	Cumulative Percentage
Illiterate	26	9.6	9.6
1 to 5 years	84	31.1	40.7
5 to 8 years	71	26.3	67
8 to 12 years	77	28.5	95.6
12 to 16 years	12	4.4	100
Total	270	100	-

Maximum = 16

Mean = 6.91

Minimum = 0

SD = 4.31

In order to understand the farmers' behavior of high-yielding rice varieties regarding performance of sustainable agriculture practices, ISDM¹ method was used. This variable was grouped according to the mean, standard deviation and using the following formula:

- A = Low
- B = Relatively Low
- C = Relatively High
- D = High

$$\text{Mean} + \text{SD} < D$$

Based on the findings of this study (Table 3), 15.2% of rice farmers with frequency of 41 were in the unsustainable group, 33.3% with frequency of 90 were in the relatively unsustainable group, 34.1% with frequency of 92 were in the relatively sustainable group, and 17.4% with a frequency of 47 was in the sustainable group in terms of sustainable agriculture practices.

Table 3. Frequency distribution of rice farmers based on the level of sustainability behavior

Sustainability Levels	Frequency	Frequency Percentage	Cumulative Percentage
Unsustainable	41	15.2	15.2
Relatively Unsustainable	90	33.3	48.5
Relatively Sustainable	92	34.1	82.6
Sustainable	47	17.4	100
Total	270	100	-

Maximum = 74

Mean = 52.94

Minimum = 37

SD = 8.21

Table 4 shows the correlation between independent variables and rice farmers' behavior regarding sustainability. The results show that there is a positive and significant relationship

¹. Interval of Standard Deviation from the Mean

between the yield of high-yielding rice varieties and behavior of rice farmers regarding sustainability ($p < 0.01$ and $r = 0.191$). This is consistent with findings of Koma (2002) in Cambodia and Chaharsooghi Amin and Mirdamadi (2008) in Iran. There is a positive and significant relationship between managerial features and rice farmers behavior regarding sustainability ($p < 0.05$ and $r = 0.130$). This is consistent with findings of Dollo et al. (2009). According to Table 4, there is a positive and significant relationship between access to educational-extension and communicational factors and behavior of rice farmers regarding sustainability ($p < 0.01$ and $r = 0.381$). In fact, the existence of such factors plays an important role to give information about needs of sustainable agriculture of farmers and change their attitudes towards use of methods and practices in accordance with this section. These findings are consistent with studies of Kabir et al. (2007) and Tanaka (2010) in Japan.

The results showed that there is negative and significant relationship between the total area of agricultural lands ($r = -0.140$) and the total area of rice lands variables ($r = -0.136$), and sustainability behavior of rice farmers' in level 0.05 (Table 4). In other words, decreasing the total area of agricultural lands and the total area of rice lands will increase the behavior of rice farmers' regarding sustainability. One reason for this is increased feasibility of the sustainable agriculture methods or increased farmers control over sustainable agriculture practices due to decreased the size of the farm. This finding is consistent with study of Huang et al. (2001). The results showed that there is a negative and significant relationship between distance from the village to cooperative company and sustainability of high-yielding rice varieties production ($r = -0.218$) in the level of 0.01. In other words, decreased the distance from the village to cooperative company will improve the behavior of rice farmers' regarding sustainability. This issue may be due to more accessibility to extension services provided by companies. In fact, this finding emphasizes on the role of cooperative companies as a tool for transmission of information related to sustainable agriculture to rural covered by this companies. Based on the results of Table 4, there is a positive and significant relationship between sustainability attitudes and behavior of rice farmers' regarding sustainability ($p < 0.05$ and $r = 0.128$). In other words by improving the rice farmers' sustainability attitudes, will improve their behavior regarding sustainability. These are consistent with findings of Kabir et al. (2007) and Koesling and Lien (2008).

The results shows that there is a positive and significant relationship between putting the value of the reference group opinions and behavior of rice farmers regarding sustainability in the level of 0.05 ($r = 0.150$). In other words, with the increasing putting the value of the reference group opinions by rice farmers, their sustainable behavior increases. These are consistent with findings of Zubair and Garforth (2005) and Sengsoulivong (2002). These results show that the family, neighbors, extension experts, pioneer farmers, religious groups, radio and television, extension magazines and other reference group that their comments has particularly value and credit among farmers, affect on farmers' attitudes toward sustainable agricultural activities and their behavior regarding sustainable agriculture. Based on the findings of this study, there is a positive and significant relationship between feasibility of sustainable agriculture techniques and rice farmers behavior regarding sustainability ($p < 0.01$ and $r = 0.627$). In other words, increasing the feasibility of sustainable agriculture techniques improves the rice farmers' behavior regarding sustainability principles. These findings are consistent with results of Zubair and Garforth (2005) and Karami and Mansoorabadi (2008). These results show that the existence of the facilitating or hindering factors in the implementation of sustainable agriculture methods and practices such as using organic fertilizers, conservation tillage method, alternative irrigation method and surrounding plots by nylon fences, possibility of intercropping and multi-cropping systems and etc., play an important role in improving the sustainability behavior of rice farmers. Also, there is a positive and significant

relationship between access to inputs and sustainability behavior of high-yielding rice varieties farmers in the level of 0.01 ($r = 0.278$). In other words, increasing the farmers' access to genetically modified seeds, agricultural machinery and equipments will improve their sustainability behavior. This is consistent with the results of Kurz (2002) and Kelly et al. (2001).

Table 4. Correlations between research variables and sustainability behavior of rice farmers

Variables	Correlation Coefficient (Pearson)	Significant Level
Age (years)	0.038	0.530
Level of education (years)	-0.030	0.625
Level of participation	0.112	0.067
Yield of high-yielding rice varieties	0.191	0.002
Managerial features	0.130	0.033
Access to educational-extension and communicational factors	0.381	0.000
Experience of rice production (years)	-0.033	0.585
Total area of farming lands	-0.140	0.021
Total area of rice lands	-0.136	0.026
Land area of high-yielding rice varieties	0.034	0.576
Distance from the village to cooperative companies	-0.218	0.000
Putting the value of the reference group opinions	0.150	0.013
Sustainability attitude	0.128	0.036
Access to inputs	0.278	0.000
Feasibility of sustainable agriculture methods	0.627	0.000

Table 5. Results of stepwise multiple regression analysis with the dependent variable of sustainability behavior

Independent Variables	B	SE B	Beta	T	T sig	R	R ²	R ² Adj
Feasibility of sustainable agriculture methods (X ₁)	0.979	0.083	0.576	11.846	0.000	0.627	0.393	0.391
Access to educational-extension and communicational factors (X ₂)	0.222	0.071	0.188	3.141	0.002	0.674	0.454	0.450
Managerial features (X ₃)	0.238	0.062	0.199	3.829	0.000	0.685	0.469	0.463
Putting the value of the reference group opinions (X ₄)	0.243	0.072	0.169	3.367	0.001	0.700	0.490	0.483
Sustainability attitude (X ₅)	0.243	0.107	0.126	2.283	0.023	0.707	0.500	0.491

Constant = 7.759 F = 52.865 Signif F = 0.0001

In order to estimate the variations of sustainability behavior as dependent variable by independent variables, stepwise regression analysis was used. The variables in this analysis include the number of family members, yield of high-yielding rice varieties, managerial features, total area of rice lands, putting the value of the reference group opinions, sustainability attitudes, access to educational-extension and communicational factors, and feasibility of sustainable agriculture

methods. According to the regression coefficients (B) and calculated constant coefficient, the regression equation is as follows:

$$Y = 7.759 + 0.979 X_1 + 0.222 X_2 + 0.238 X_3 + 0.243 X_4 + 0.243 X_5$$

The results of this study showed that the independent variables of feasibility of sustainable agriculture methods, access to educational- extension and communicational factors, managerial features, putting the value of the reference group opinions, and sustainability attitudes explained 49% of variations in the dependent variable of sustainability behavior of rice farmers (Table 5). According to the table 5, feasibility of sustainable agriculture methods explains 39% of sustainability behavior variations.

Conclusion

Many experts believe that the intensive nature of rice production process particularly high-yielding rice varieties, affect the quality of environment and sustainability of agricultural system. Intensive farming of a limited number of high-yielding rice varieties, in broad agricultural lands and at a long time period, leads to severe loss of biodiversity and declining soil fertility. The pollution of soil and water resources endanger the human health due to inefficient and excessive use of chemical inputs and global warming due to greenhouse gas emissions, particularly Methane gas emissions as the main product of organic materials fermentation in rice fields. So paying attention to sustainability issues in farming this product with the aim of establishing food security in proportion to population growth, employment and income generation especially in rural areas, protecting agricultural and natural resources and the environment become increasingly more important.

According to findings of this study, improving managerial features, putting the value of the reference group opinions and sustainable agriculture attitudes are associated with improve the sustainability behavior of rice farmers. As well as increasing access to educational- extension and communicational factors and the access to inputs and feasibility of the sustainable agriculture methods leads to improve the rice farmers' behavior regarding sustainable agriculture principles. So that increasing these variables improve the rice farmers' behavior regarding sustainable agriculture. Also the increase of yield in high-yielding rice varieties production is associated with rice farmers' behavior regarding sustainable agriculture. The results showed the negative relationship between the total area of agricultural lands, the total area of rice lands, distance from the village to cooperative company and sustainability behavior of rice farmers. In other words, with increasing these variables, rice farmers' behavior towards sustainable agriculture decreased. Variables of feasibility of sustainable agriculture methods, access to educational – extension and communicational factors, managerial features, putting the value of the reference group opinions and sustainability attitudes explained majority of sustainability behavior variations.

Recommendations

- According to the role of feasibility in using sustainable agriculture methods as the most important factor in increasing sustainability behavior of rice farmers, it is suggested that government as much as possible should provide the necessary arrangements to remove restrictions and execute sustainable agriculture policies and practices. Flattening and integrating rice fields, equipment and strengthening farm irrigation and drainage systems, encourage farmers to implement combination systems such as rice planting with animal husbandry to easy access to organic fertilizers, and pay attention to the training element to facilitate the farmer use of farming, physical - mechanical and biological methods in high-yielding rice varieties production, are the most important actions.

- Given the positive effect of access to educational-extension and communicational factors on sustainability behavior of rice farmers, it is suggested that be attempted to promote the level of knowledge and attitude of rice farmers in the province in order to promote sustainable agriculture goals and their sustainability behaviors by expansion of educational-extension services with desired quantity and quality, and by considering farmers educational needs and using media specially local media. In this regard, educational-extension classes and publication of magazines and local newspapers aimed at informing the farmers about the principles of sustainable agriculture and its related practices, play an important role in farmers' notifications and increases their environmental knowledge level. Also making various programs with sustainable agriculture concepts and aimed at explaining environmental hazards caused by excessive use of chemical inputs and broadcasting them from local channels are recommended.

- Considering the association between rice farmers' access to inputs and their sustainability behavior, it is recommended that the government through numerous ways do the necessary actions to more access of rice farmers to required resources and inputs in high-yielding rice varieties farming, especially improved seeds and farming machinery. One of these actions is allocation of adequate credit to farmers for purchase of a new machine tool and specially rice machinery so they can facilitate moving towards sustainable agriculture practices.

- Considering the effect of putting the value of the reference group opinions on improving the sustainability behavior of rice farmers, it is suggested that by holding training courses about sustainable production activities of high-yielding for extension experts, rural production cooperatives managers and pioneer farmers as the key reference groups improved sustainability attitudes and behavior of rice farmers in the Mazandaran province.

- It is recommended that the index of sustainability level of farming systems be considered as an important indicator in evaluating agricultural projects.

- Given the importance of rice farming, especially as a strategic product in Iran, and the need for national self-sufficiency in its production, and environmental degradation and natural resources pollution, especially soil and water pollution due to excessive use of chemical inputs in rice farming, it is suggested to carry out this research on the other provinces of the country and the results be compared.

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