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Factors Affecting Land Allocation to Saffron and its Expansion in Marand County, Iran

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Abstract

Currently, water, as the most limiting factor in production, determines the priority of planting in different areas of Iran. Saffron is one of the good candidates for drought conditions since it has high economic value and low water requirements that can help with sustainable development. By identifying the factors influencing the decision on saffron cultivation and its expansion, appropriate policies can be implemented to improve the planting of this crop. Marand, located in East Azarbaijan Province, Iran, is one of the areas where farmers have started to grow saffron in recent years. The allocation of 68 hectares of agricultural land to this crop has turned the county into the hub of saffron production in the northwest of the country. This study investigated the factors affecting the decision on saffron cultivation and its development in Marand. To this end, a total of 140 farmers from two groups of saffron growers and non-saffron growers were chosen, and the Heckman's two-step procedure was then employed. The results of estimating the first step of the Heckman procedure showed that age, familiarity with saffron growing, attending saffron training courses, the number of extension courses, marketing status, and profit status of saffron all had a positive effect on the decision on growing saffron. Moreover, the results of estimating the linear pattern of the second phase corroborated the view that the farmer's education level, the total area under agricultural and horticultural cultivation, as well as features of agricultural land had a positive impact, and access to water resources had a negative effect on the cultivation area of saffron.

Keywords:
Heckman's two-step procedure, land allocation, Marand, saffron

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INTRODUCTION

Due to the climatic conditions of Iran where water is a major factor limiting agricultural development, it seems necessary to change the planting pattern toward the crops that have low water requirements. It is more helpful to achieve sustainable development in Iran. Among crops, saffron is a plant with little expectation of high economic efficiency, because it needs water when the other crops do not demand water or, at least, are not facing the water shortage. Marand is one of the counties of East Azerbaijan that has the potential to grow saffron due to its moderate-to-cool temperate climate. The county started planting this crop in 1996, and every year, the area under the cultivation of this commercialized valuable product that can bring foreign income so that it reached 68 hectares in Marand in 2014 (Marand Agriculture Department, 2014). Due to good soil and mild climate, saffron bulbs of Marand are of high quality, and the county is one of the important centers of saffron bulbs in Northwester Iran. Given saffron's potential to bring exchange as well as its features such as high medicinal and spice value, ease of maintenance and transportation, and most importantly, the talent of the Marand region to produce high-quality saffron, it is imperative to consider its planting and development.

In this regard, we should be addressed from two different aspects: one is increasing the number of saffron farmers and examining the factors affecting the farmers' determination to cultivate saffron, and the other one is increasing the saffron cultivation area and studying the factors affecting the development of the area on the farmers' side. This issue is important, because the factors affecting farmers' decisions to produce a certain crop do not necessarily match the factors that determine the cultivation area of the crop, but can be two different sets of variables. In other words, the decision to allocate land for saffron cultivation is done in two stages by producers: In the first step, the question is whether or not to allocate the land to the cultivation of saffron and the second step addresses the decision on the size of the area under cultivation. Salami and Einollahi (2001) argue that equating these two groups of factors and perceiving the farmers' decision as a one-step procedure can lead to failure to identify the factors leading some farmers to abandon growing this crop and may also result in the lack of access to the actual behavior of producers and erroneous conclusions. In addition, they may finally lead to incorrect policy recommendations. In such circumstances, one should use a model to evaluate and identify important factors that could make this distinction and offer reliable results. Given this, in this study, Heckman's two-step procedure was used in which the model was broken into Logit and regression models for determination and differentiation of factors in each stage of the decision to cultivate saffron and decision to increase the area under saffron cultivation in Marand. The results of this research can be useful in identifying saffron producers' real behavior and increasing the efficiency of policies taken to develop saffron cultivation.

Many studies have been carried out to identify factors affecting the acceptance and development of the cultivation area crops and the use of the models with limited dependent variables in a variety of topics. This section reviews the methodology and results of some of these studies.

Wekesa et al. (2003) first investigated factors affecting the adoption of cultivation of the improved varieties of maize, including access to cash, access to credit, and attending training classes using the Logit model. Then, Tobit model was estimated to review the adoption of the chemical fertilizers where the results showed that, in addition to the factors mentioned above, variables such as the farm size, off-farm income, age, and education level of the farmer were also effective in the adoption of the agricultural fertilizers. Bergtold et al. (2012) studied management and demographic factors affecting the profitability of winter cover crops (clover) in America using the Logit model. The results indicated that the high loan rate, high sales, conservation tillage, and the use of nitrogen for cover crops had positive impacts, and the years of agriculture, farm size, and the high cost of the cover crop had negative effects on the profitability of the cover crop. Keil et al. (2009) examined the factors influencing the allocation of land to corn and concluded that land's being mountain terrain or being under rice cultivation, literacy, wealth, gender and ethnicity of the farmer as well as the proximity to the road were some factors affecting households to allocate land to corn. In a study on identifying the factors underpinning the development of sugar beet cultivation in Khorasan Province, Iran, Salami and Einollahi (2001) used the Tobit model and cross-sectional data to analyze various economic, social, and technological factors affecting the changes of the cultivation of sugar beet cropping pattern in Khorasan Province. According to the findings of this study, factors such as the grade of the product in the previous year, distance of the field to the sugar plant, crop insurance, agricultural machines, the ratio of the cultivated land to total area, the ratio of income from the cultivation of sugar beet to total income, and the interaction of education and the relative profitability of the product are among the most important determinants of sugar beet cultivation development in Khorasan Province. They showed the importance of the application of the econometric Tobit models and Heckman's two-step procedure to determine the factors affecting the sugar beet cultivation. They also indicated the necessity of making difference between two groups of factors influencing the farmers' decision on crop and determinants of the crop acreage. The results revealed that the factors influencing the farmers' decision to grow sugar beet are not identical to the factors affecting the acreage of this product; therefore, the use of econometric models such as Heckman models that consider this distinction is essential.

Shafiee (2007) studied the factors underpinning the development of olive cultivation in Kerman Province, Iran using the Logit model. The results showed that overall education, number of children over 14 years old, the extension agent's relationship with the farmer, mutual trust with the farmer, the total area under cultivation, farmers' familiarity with olive, and the savings and income levels less than 10% affected the acceptance of olive planting by farmers. Moreover, the number of land pieces, the technological level, credits, and receiving loans did not have a significant impact on the adoption of olive growing. Hayati et al. (2010) utilized Heckman's two-step procedure to examine the factors affecting willingness to pay by visitors of Elgoli and Mashrouteh Parks in Tabriz, Iran. The results of the estimated Probit Model showed that monthly income, family size, gender, satisfaction with social security, and the number of visits to the park during the year were among the factors affecting willingness to pay, and in the second stage, age, education, duration of each visit, and education level affected willingness to pay. Bakhshi (2011) used the Tobit and Heckman's two-step procedures to identify the economic, individual, and social factors influencing the adoption and development of canola crops in Tabriz and Marand. The results showed that the level of education, the loan amount, the actual price of canola, the relative share of farm income in total income and the relative profit of canola had a positive and cost of machinery, farm to road distance and the number of land pieces had a negative effect on the cultivation area of this crop. Furthermore, to distinguish the factors affecting the cultivation of canola and the cultivated area, she used Heckman's two-step procedure. The results of the Probit model showed that machinery ownership, participation in extension classes, the share of farm income, education level, as well as canola planting experience had positive effects, and age and number of land pieces had negative effects on the probability of accepting to plant canola. The results of the estimation of the second step confirm that the amount of allocated loan, the relative benefits of canola, and the number of family labor influenced the cultivation of canola positively, and land to road distance and machinery costs per hectare influenced it negatively.

MATERIALS AND METHODS

As mentioned in the introduction section, the decision to allocate a land to the cultivation of a crop like saffron by producers is made in two stages. In such cases, the Heckman's two-step procedure is an appropriate option to separate these two stages, which are described in further detail below.

In Heckman method, the model is broken into two separate models to determine the effective factors in each of the two above-mentioned variables. In the first model pertaining to the first stage of the decision to grow crops on the farmer's part, the dependent variable has only two values. This means the dependent variable appears as a binary choice that only takes 0 or 1. In the literature, while the dependent variable is a dummy variable with two 0 and 1 values, the Logit, Probit, and Tobit models are used as variables that can be estimated in such an environment. In this study, the factors influencing the decision to grow saffron were estimated by the Logit model. In the second model pertaining to the second step to decide about the area under cultivation, the dependent variable is the area under the cultivation of the crop, and therefore, the linear regression model is used. In sum, in the two-step method of Heckman employed in this study, factors that can influence the farmers' decision to grow saffron were included in the Logit model as the independent variables and the factors that can be effective on the area under the cultivation of saffron were included in the linear regression model as the independent variables. It is noteworthy that, in the second model, a new variable called Inverse Mills Ratio was added, which was created using the estimated parameters of the first model. With this new variable, the second model was related to the independent variables in the first phase.

Logit Model

The Logit cumulative probability distribution is as follows (Green, 2000).

$$P(Y=1)=1/(1+exp(-\beta x) \quad (1)$$

where $P(Y=1)$ shows the decision to cultivate saffron, X is the explanatory variables, and β shows the characteristics of the model.

The alternative form of the above equation is as follows:

$$P_i=1/(1+e^{-(\alpha+\beta x_i)}) \quad (2)$$

where X_i is the ith independent variable, e is the base of the natural logarithm, p_i is the likelihood to grow saffron, β is the parameter of the model in the logistic function that must be estimated, and α is the intercept.

Linear Regression Model

This relationship is only estimated for observations where saffron cultivation is used. As was noted, at this stage, the Inverse Mills Ratio variable λ_i was added to the set of independent variables in the regression model. The presence of the variable inverse Mills ratio in the above linear regression model resolves heteroskedasticity of the basic model where the use of the OLS is permitted.

$$Y_i=\beta x_i+\sigma\lambda_i+e_i \qquad i=1,2,3,....,n \quad (3)$$

where β and σ are the parameters of the model, ei is the error term in the above model, and λ_i is the inverse Mills ratio obtained as follows:

$$\lambda_i=\varnothing(\beta' x_i | \sigma)/\phi(\beta' x_i | \sigma) \quad (4)$$

where λ_i is obtained using the estimated parameters of the Logit model for all observations in which saffron has been cultivated. In the linear model of the second stage, the coefficients represent the ratio of absolute changes to the dependent variable in the explanatory variables. In other words, it states how much the dependent variable varies for every one percent change in the explanatory variable. To investigate the existence or lack of heteroskedasticity in the Logit and Probit models, usual methods such as the Breusch-Pagan, White, and Goldfeld-Quandt tests cannot be used. Davidson and MacKinnon (1984) offered a statistic called LM2 to test heteroskedasticity in the Logit and Probit models. This statistic is based on the LM method in which an artificial regression is used by employing the Logit or Probit model estimates, and this artificial regression is used to test heteroskedasticity between the error terms (Greene, 1993). Due to the importance of elasticity in economic issues, the estimated coefficients were converted to partial elasticities of the factors (Abrishami, 2011).

The Empirical Model

According to the materials presented, the empirical model for the two-stage Heckman model to saffron is as follows:

The First Stage:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \alpha_4 X_{4i} + \alpha_5 X_{5i} + \alpha_6 X_{6i}$$

where Y_i shows the possibility of decision to cultivate saffron that is equal to unity for farmers cultivating it and zero for those not cultivating it, αi are the model parameters that must be estimated, X_1 is age (years), X_2 is familiarity with growing saffron estimated as on a five-point Likert scale, X_3 is attending saffron training course defined as a dummy variable zero and one, respectively, for failing to take the course and attending it, X_4 is the number of extension courses attended, X_5 is the relative profitability of saffron measured as on a five-point Likert scale, and X_6 is the saffron marketing status that is composed of several items in the post-harvest stages including transportation, warehousing, packaging and marketing of saffron, the role of intermediaries, as well as the current price of saffron.

The Second Stage:

$$A_i = \beta_1 Z_{1i} + \beta_2 Z_{2i} + \beta_3 Z_{3i} + \beta_4 Z_{4i} + \beta_5 Z_{5i}$$

where A_i is the area under saffron cultivation (ha), Z_1 is the availability of water resources measured on a five-point Likert scale, Z_2 is the education level defined as a rating variable, Z_3 is the total area under cultivation including cropping and horticulture (ha), Z_4 is the features of arable land as measured on a five-point Likert scale showing favorability of land for saffron cultivation, and λ is the inverse Mills ratio.

In this study, the data were collected from two groups of saffron producing and non-producing farmers for the 2013-2014 growing season. Saffron in Marand is mostly planted in three areas: *BonabJadid, Javash*, and *Osdaghi.* The data set was collected by the help of a questionnaire distributed to farmers in these three regions in the form of appropriate sampling. The study population was all local farmers including 380 people in which 316 farmers are non-producers of saffron and 64 were producers of saffron. In this study, a total of 140 questionnaires were completed, of which 64 questionnaires were filled by farmers in the three districts of *Marand* in consensus model and 76 questionnaires were collected from non-producers of saffron.

RESULTS AND DISCUSSION

Table 1 shows the results of examining the factors affecting the decision to cultivate saffron in the Logit model.

As can be seen in Table 1, the variables of *familiarity with saffron planting, attending saffron training courses,* and *the number of extension courses attended* are significant at the one percent probability level. The variables of age and relative profitability of saffron are significant at the five and 10 percent levels, respectively. In addition, it can be concluded from this table that all variables have a positive effect on the probability of farmers' willingness to accept saffron planting. It means that the higher the level of familiarity with the process of planting saffron, attending training courses, the number of courses attended, promotion courses attended, marketing status, and the profitability of the saffron is, the higher the tendency to grow saffron is likely to be. Results of estimation of the linear regression model to estimate the factors affecting the area under saffron cultivation are given in Table 2. The variables included in the model are *access to water resources, education level,* and *the total cultivation area ranging from agriculture to horticulture, features of arable land, and inverse Mills ratio*.

To test the variance heteroskedasticity, the Breusch-Pagan test was used, and its value was calculated as 9.48, which is significant; accordingly, the model has variance homoscedasticity. After resolving model variance heteroskedasticity, it is observed that all the variables are significant and the value of adjusted R^2 is equal to 0.847 that shows a good fitness of the model. The variable IMR is significant at the 5% level showing a significant difference among the variables affecting the probability of acceptance of saffron planting and the ones affecting the cultivation area of saffron. The variable *access to water resources* is significant at the 5% level and has a negative effect on the area under the cultivation of saffron. It means that under constant conditions, if access to water resources is decreased by one unit, saffron cultivation will increase by 0.132 units. In fact, when farmers' access to water resources declines, they reduce the area under the cultivation of other crops and increase the area under the cultivation

Table 1

The Results of Estimating the Logit Model to Investigate the Factors Influencing the Decision to Cultivate Saffron

Variables	coefficients	t-statistic values	Elasticity	Marginal effects
Intercept	-12.267***	-4.43	-	-
Farmer age	.024**	1.94	1.361	.009
Familiarity with saffron planting	.707***	3.26	3.264	.25
Attending saffron cultivation training course	1.250***	3.33	-	.393
The number of extension courses attended	.561***	2.9	.739	.199
The relative profitability of saffron	.567*	1.81	3.04	.201
Marketing status	.968***	2.68	4.06	.343
Percentage of right predictions= 84.29	Cragg-Uhler R^2= 0.66			
Likelihood ratio test= 95.23	Mcfadden R^2= 0.493			
Mckelvey – Zavoina R^2= 0.753	Efron R^2= 0.597			

*p<0.1, **p<0.05, ***p<0.01

Table 2

The Results of the Linear Regression Model to Examine Factors Affecting the Area under Saffron Cultivation

Variables	Coefficients	t-statistic values
Access to water resources	-0.132**	-2.37
Level of education	0.068***	2.78
The total area under cultivation	0.261***	5.21
Features of arable land	0.189***	3.62
Inverse Mills ratio (IMR)	-0.127**	-1.98
$\overline{R^2}$ =0.847		

**p<0.05, ***p<0.01

of saffron. Other variables are significant at the 1% level, and all have a positive impact on the rate of saffron cultivation. In other words, saffron cultivation will increase as the education level of farmers, the total acreage under the cultivation ranging from agriculture to horticulture, and the features of the arable land are increased. It should be noted that a farmer's high area of agricultural and horticultural land is the evidence of his/her more prosperity and income diversity that can be interpreted in this way: The farmers who have more land and income diversification may have more risk-taking capacity, and therefore, may devote more area to the cultivation of saffron.

CONCLUSION AND RECOMMENDATIONS

In this study, assuming that the cultivation of saffron in Marand has a relative advantage, the factors influencing the decision to plant and develop the local area under its cultivation were analyzed. The Heckman's two-step method was used for this purpose. The results of the first stage of Heckman showed that age, familiarity with the saffron cultivation, attending saffron training courses, the number of extension courses attended, saffron relative profitability, and marketing status all have a positive impact on the probability of acceptance of saffron cultivation. The results of the linear model estimation of the second phase showed that farmer education, the total acreage of agricultural and horticultural land, and property in arable land have a positive effect, and on the other hand, access to water resources has a negative effect on the area under saffron cultivation. Finally, according to the results, the following suggestions are presented:

The results showed that holding saffron producing training courses is among the factors affecting the land allocation to saffron cultivation; therefore, it is recommended that the Agriculture Jihad Organization should use educational programs and extension programs to develop the farmers' skills and provide the ground for farmers to take advantage of these courses. According to the results, communication with Agriculture Jihad through attending extension courses has had a positive impact on the land allocation to saffron cultivation. This is partly a sign of positive activity of agriculture experts of Marand. Thus, consolidation of this process and its improvement by Agriculture Jihad Organization is recommended to motivate farmers to grow saffron.

Improving the transportation, warehousing, packaging, marketing and singling out profit-seeking intermediaries and increasing the government support for the supply of inputs, and the price of saffron are all in the form of marketing variable and have a positive impact on the adoption of saffron cultivation. Overall, the improvement of marketing is one of the most important factors affecting the local farmers' interest in saffron cultivation. Therefore, the government should also provide the necessary support in this regard. One of the results of this research holds that, according to saffron farmers, cultivation of saffron will increase by reducing access to water resources because of saffron's low water requirements. Due to the severe limitations of water resources in the country, on the one hand, and the potential to produce saffron in the country, on the other hand, especially in the current situation, it seems that any support by the government to create more incentives for farmers to enhance saffron production can help the current status.

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