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Factors affecting the use of technology in agriculture by wheat growers: The case of Iranian farmers

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Today, population growth and other constraints is increasing in areas under cultivation, agricultural development to achieve food security is becoming a problem. Therefore, one of the most effective ways to agricultural development and food security is to increase the productivity per unit of area. One way of increasing productivity per area of unit is the use of new technologies by farmers. The purpose of this study is to investigate factors affecting the use of technology in agriculture by wheat farmers in Shiraz, Iran. Using stratified random sampling method, the questionnaires were given to 480 farmers. According to the results, variables such as adoption of land consolidation project, social trust, social cohesion and awareness of the benefits of land consolidation project on the use of technology in agriculture have positive effects on gross income obtained from a hectare of wheat cultivation while number of non-family labor forces has negative effect. Considering the maximum effect of the land consolidation acceptance on the level of technology and that land consolidation operations required investment, costs for construction of the canal as well as secondary roads among farms and other facilities, it is recommended that government in collaboration with related agencies provide the credit facilities for the farmers.

Keywords: Technology, Consolidation, Adoption, Shiraz, Iran.

Introduction

Because of population growth, the increased nutrient demands and scientific progress need to be optimized for food production. Production per unit level is important and is a determinant factor. Iran agricultural sector has a major share in economic development. This sector with a focus of more than 20% of the active population generates nearly 14% of GDP (Shomal News, 2006). One of the most effective ways to agricultural development and food security is increasing productivity per unit area since the population is growing

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and the cultivation area is becoming limited. One way to increase productivity per unit of area is the use of new technologies by farmers (Dinpanah *et al*., 2009). Technology has two aspects: hardware and software. Hardware includes the physical tools of technology and the software includes the basic information in order to proper utilization of technology (Rogers, 1983). In general agricultural technologies can be classified into two major categories:

Material technology: In this concept, knowledge appears in the form of technology products such as tools, equipments, chemical materials crop, modified transplant species, breeding animals and vaccines.

Knowledge-Based Technologies: Technology includes issues such as technical knowledge, managerial and other skills required for success in the process of producing crops or livestock which is related to the knowledge-based technology. Transferring the material technology to the farmers usually requires the production, distribution, sale of seeds, tools, chemical materials and other inputs in crop production. Therefore material technology transfer is easier than training and developing the technical knowledge and managerial skills in a large group of less educated farmers. However, ways which are used to transfer different technologies have many differences. Generally private sector performs better in the field of production and distribution of material technology. On the other side, more knowledge-based technologies are taught through the vocational training programs of rural youth or governmental promotion among farmers. However, most of the material technologies for optimal and effective use required the technical knowledge from products and tools. Therefore, material and knowledge-based technologies are considered interdependent (Swanson, 1996). Appropriate technology to achieve agricultural purposes should have the following characteristics:

Be proportionate to the farmers' knowledge.

Be consistent with evolving culture of farmers.

Be proportionate with the natural - climatic conditions of farmers.

Be proportionate with the economic conditions of farmers.

Be in a harmony with facilities and technical capacity and farmers' accuiring talents (Dinpanah *et al.*, 2009; Shahbazi, 1996).

Nell (1999) considered four elements to transfer and accept the technology by farmers such as identifying problems, real and main needs of the users of technologies, compatibility test of new technologies to local, technical, social, economic and environmental conditions to profitable and sustainable use, well documented and validated laws and administrative regulations for adoption and promotion of new technologies for users of new technologies. In general, the decision to make use of technology in agriculture depends on how

it perceived by farmers. Using technologies by farmers can also be affected by various social and economic factors (Thinegocchi and Yadama, 2002).

Factors that may affect the level of use of technology and its acceptance by the farmers include: characteristics and advantages of technology, users of the technology, representatives of the introduction of technology such as propagators and professionals and social, economic, biological, physical and environmental conditions in which technology is used (Cruz, 1978).

Dadrasmoghaddam and Golmohammadi (2009) show that a high income, high participation features, a higher irrigation share, a long experience in pistachio farming and education are factors that influence the adoption of new technologies by pistachio producers. Another study shows that social rank, amount of using media, social participation and amount of using communication channels have a significant positive relationship with the adoption rate of technology (Dinpanah *et al.*, 2009). Subashini and Tyagarajan (2002) showed that education, farm size, social participation, socio - economic rank and contact with promotion agencies have positive and significant relationships with the level of technology adoption.

The reasons for the use and adoption of technology by farmers include high education level, lower age of farmers and high savings. Reasons for not using and not acceptance of technology by farmers include lack of belief in introducing technologies in agriculture, lack of consideration of different dimensions of technology, fear of low performance, low education, older age of farmers and lack of belief in new technologies, the use of traditional methods of cultivation by farmers and farmers with large lands (Thinegoc chi and Yadama, 2002).

As many studies point one factor that made the use of technology in agriculture difficult and that is the fragmentation of agricultural lands. Mohammadi showed that undesirable traits in wheat fields of Fars province are scattering the lands into small fragments. This condition leads to misuse of machineries in order to level and prepare the land, improper use of land, crop rotation and pest control measures. In such circumstances, any attempt to reduce the number of parts and assemble the scattered pieces will have a positive impact on reduction of waste of resources and better use of agricultural technologies such as machinery and fertilizers (Mohammadi, 2001).

Studying the effects of land consolidation on technology adoption and its inequality in the region Hymal Pradesh of India, Saini concluded that the land consolidation reduce the number of owned parts, accelerate new technology acceptance and it also has a significant positive effect on farms comprehensive development (Saini, 1995). Simons believes land consolidation leads to facilitate the access to the new machinery and labor efficiency (Simons, 1987).

Considering that one of the ways of increasing productivity per unit of area is the use of new technologies by farmers, studying the effective factors on the level of use of technology among farmers is very important. The purpose of this study was to investigate the factors affecting the level of use of technology in agriculture by wheat farmers in the city of Shiraz, Iran.

Materials and methods

This research was conducted in the villages of Shiraz city using survey. Research population is wheat growers in Shiraz city. The sampling method was stratified random sampling. Statistical sample size was calculated to be 480 farmers using Cochran formula. In this study, the dependent variable was the level of use of technology in agriculture. To determine the validity of the questionnaire several copies of the questionnaire were placed at the disposal of Faculty of Agriculture of Shiraz University. To determine the reliability of the research instrument and sampling variance the pilot test was conducted. In the present study, technology means the use or non-use of laser leveling devices, no-tillage direct cultivation machine, combined tillage, row wheat work, and different types of chemical fertilizers such as nitrate, potash and others among wheat farmers of Shiraz city. In order to implement the pilot test, 30 questionnaires were completed by wheat farmers in Marvdasht city near Shiraz. Pilot test results have been shown in Table 1:

Results and discussions

The result of the pilot test is presented in Table 1.

Table 1. The results of the Cronbach of the variables

Variables	Cronbach's alpha coefficients
Social Trust	0.82
Social cohesion	0.73
The use of technology	0.82

Characteristics of Wheat Growers (Income and Agronomic Features)

Gross income here means the income of one hectare of wheat without subtraction of costs of that land. Table 2 shows that the mean gross income of a hectare of cultivated wheat is about one million and ninety-five thousand tomans (353$).

Table 2. Descriptive statistics related to gross income of wheat growers

Variable	Mean	**SD**	Minimum	Maximum
Gross income obtained from wheat per ha (Toman)	1095636	682201.31	360000	9000000

Table 3 shows that the type of ownership of most wheat growers is personal property with a frequency of 293 (61 percent). Wheat growers with collective ownership and frequency of 143 (29.8 percent) are located in second priority. In the last level wheat growers are located with shared ownership and frequency of 17 (3.5 percent). Also most of wheat growers have continuous cropping pattern with the frequency of 224 (46.7 percent); the least wheat growers have alternative patterns with frequency of 2 (0.3 percent). Furthermore most wheat farmers have an agricultural system with a frequency of 253 (52.7 percents and the least wheat growers have the system of agriculture - gardening with frequency of 3 (0.6 percent). Also other data in this table shows that 1.7 percents of wheat growers have sandy soil, 94.3 percents (453 people) of wheat growers have clay soil texture and 4 percent (19 farmers) of wheat growers have a mixed sand and clay soil texture. 96.9 percent of the wheat growers equal to 465 of them have irrigated wheat, and 3.1 percents equal to 15 of them have dry farm wheat. In other words most of the farmers in the sample of the study have irrigated wheat. Finally, 85.4 percents means 410 farmers of wheat growers of the sample have pieces of lands with high fertility. Also, 14 percent of wheat growers (67 people of them) have land with moderate fertility.

Table 3. Frequency distribution of agronomic features of wheat growers

Variable		**Frequency**	**Frequency percentage**
Type of ownership wheat land	Personal ownership	293	61
	collective	143	29.8
	Rental	27	5.6
	Share	17	3.5
	Total	480	100
Crop cultivation pattern	Continuous cultivation	224	46.7
	Without cultivation	163	34
	Mixed cultivation	72	15
	No	19	4

	cultivation - cultivation rotation		
	cultivation rotation	2	0.3
	Total	480	100
cropping system	cultivation	253	52.7
	Farming - Animal Husbandry	207	43.1
	Farming - Animal Husbandry - Garden	17	3.5
	Farming - Garden	3	0.6
	Total	480	100
Agricultural soil texture	sandy	8	1.7
	clay	453	94.3
	Mixture of sand and clay	19	4
	Total	480	100
Type of cultivated wheat	Irrigated	465	96.9
	Dry farming	15	3.1
	Total	480	100
Fertility of the land pieces	Low	3	0.6
	Average	67	14
	High	410	85.4
	Total	480	100

Investigation of water resources for wheat production

Table 4 is related to frequency distribution of water resources used in irrigated wheat cultivation of wheat growers. Data in the Table 4 indicates that among farmers which have irrigated agriculture about 97.1 percent use water from rivers, 96.9 percent use water from dams, 10.6 percent use water wells. Also the results show that none of the wheat growers use aqueducts to irrigate their lands.

Table 4. Frequency distribution of water resources in irrigated wheat of wheat growers

Type of irrigation		Frequency percentage	Frequency
River	yes	97.1	466
	no	2.9	14
Dam	yes	96.9	465
	no	3.1	15
Well	yes	10.6	51
	no	89.4	429
Spring	yes	1.5	7
	no	98.5	423
	Total	100	480

The relationship between variables with the level of use of technology in agriculture

Table 5 shows that there is no significant relationship between literacy rate, age, family size, history of farming, history of wheat farming, the number of rented labor and the level of use of technology.

Table 5 shows significant positive relationships between social trust and social cohesion with level of use of technology in agriculture. So the higher the level of social trust and social cohesion of wheat growers is, the higher the level of use of technology in agriculture is. Other results of table 5 show that there is a significant and inverse relationship between number of family labor and the amount of gross income from one hectare of wheat cultivation with the level of use of technology in agriculture. In other words, if the number of family labor and the amount of gross income per hectare of cultivation wheat increases the level of use of technology in agriculture will decrease. It may be because of reduction of the use of machineries and equipments with more family labors. Low correlation coefficient indicates that this inverse relationship is weak. The results concerning the correlation of the gross income of a hectare of wheat cultivated farms and the level of use of technology in agriculture opposed Dadrasmoghadam and Golmohammadi study results (2009).

Table 5. Correlation between variables and the level of use of technology in agriculture

Variable	r	Significant level
Literacy rate	0.02	0.62
Age	0.06	0.13
The number of family size	0.03	0.48
Agricultural work experience	0.08	0.06
Work experience in wheat		
The number of family labor	0.19	0.03
Number of non family labor	-0.11	0.01
rented labor	-0.03	0.41
Gross income of a hectare of cultivated wheat	-0.12	0.007
Social Trust	0.79	0.0001
Social Cohesion	0.78	0.0001

Factors determinant the level of use of technology in agriculture

The results in Table 6 using stepwise regression method show that the factors affecting the level of use of technology in agriculture are social trust, land consolidation plan adoption, income of one-hectare cultivating wheat farm, the number of family labor, social cohesion and knowledge about the advantages of land consolidation plan. The results of the table show that social trust is the important variable in the equation in the first step. Generally speaking, the variables in regression analysis determine about 66 % of the variations of the level of use of technology in agriculture.

Table 6. The effect of variables on use of technology in agriculture

Variable	**R**	**R^2**	**Adjust R^2**	**F**	sig
Social Trust	0.790	0.642	0.623	792.037	0.0001
Adoption of Land Consolidation Project	0.803	0.645	0.644	432.998	0.0001
Gross income of a hectare of cultivated wheat	0.808	0.653	0.651	298.974	0.0001
The number of non family labor	0.812	0.659	0.656	229.825	0.0001
Social Cohesion	0.815	0.665	0.661	188.184	0.0001
Awareness of the benefits of Land Consolidation Project	0.818	0.668	0.664	158.839	0.0001

The results of Table 7 show that if one unit adds to the standard deviation of adoption of land consolidation project in other words if the plan is accepted, 0.31 unit will be added to the standard deviation of the level of use of technology in agriculture. In this case, studies in Bulgaria show that fragmentation of lands is the main obstacle for the use of modern technology and applying new techniques and technology and the efficiency of production factors reduces because of this fragmentation.

Rusta and Teymouri (2009) have suggested that fragmentation of lands and small parts in Iran leads to the traditional agriculture in almost all parts of the country and the use of modern agricultural technology is not possible. The study of Ahmadi and Amini (2007) on effective factors on the demand of land consolidation project in Lenjan zone of Isfahan and Kermanshah from the viewpoint of experts showed land consolidation has a large effect on the use of technology. Accordingly, it can be concluded that the consolidation of lands affects the level of technology use in agriculture. This supports the results of this study. If a unit adds to the standard deviation of social trust, 0.23 units will be added to the standard deviation of the level of use of agricultural technology, and also, if a unit adds to the standard deviation of wheat farmers' social cohesion, 0.19 unit will be added to the use of technology in agriculture. Subashinei and Tyagarajan (2002) research showed that social characteristics of farmers have positive effect on use of technology, so that the results of this study regarding the effects of social trust and social cohesion of the wheat growers and the level of use of technology is proved. Also, if a unit adds to the standard deviation of awareness of advantages of land consolidation, 0.09 units will be added to the standard deviation of the use of technology in agriculture.

Finally, according to the results if a unit adds to the standard deviation of income from a hectare of cultivated wheat, 0.09 units will be subtracted from the standard deviation of level of technological use. In other words, their findings show that income has a positive effect on technology acceptance. Finally we can say, if a unit adds to the standard deviation of number of non-family labor, 0.09 units will be subtracted from standard deviation of level of technology use. Generally, the results of the table 7 show that Land Consolidation Project adoption and integration of land wheat farms have more effect on the use of technology in agriculture among other factors therefore more optimized level of technology is used in more integrated lands.

Table 7. Coefficients of the variables affecting the use of technology in agriculture

Variables	B	Beta	T value	sig
Constant coefficient	8.62			
Social Trust	0.15	0.23	2.72	0.007
Adoption of Land Consolidation Project	3.71	0.31	4.31	0.0001
Per capita income from crop cultivation (Rs / ha)	-4.15	-0.09	-3.52	0.0001
The number of non family labor	-0.22	-0.09	-3.44	0.001
Social Cohesion	0.10	0.19	2.30	0.02
Awareness of the benefits of consolidation plan	0.04	0.09	2.17	0.03

According to the results of Table 7, it can be written the following equation:

$Y=8.62+0.15X_1+3.71X_2-4.15X_3-0.22X_4+0.10X_5+0.04X_6$

$X_{1=}$ Social Trust
$X_{2=}$ Adoption of Land Consolidation Project
$X_{3=}$ Per capita income from crop cultivation (Rs / ha)
$X_{4=}$ Number of non family labor
$X_{5=}$ Social Cohesion
$X_{6=}$ Awareness of the benefits of consolidation plan

Conclusion and Recommendations

Iran's agricultural sector has a major share in country's economic development. One of the most effective ways to achieve agricultural development and food security is to improve the productivity per unit of area. One of the ways of increasing productivity is the use of new technologies by farmers.

Results of this research show that the variables adoption or rejection of land consolidation project, social trust and social cohesion have positive effect on the use of technology in agriculture and gross income per hectare of wheat has a negative effect on the use of technology in agriculture. Since the adoption of land consolidation has the greatest effect on the level of use of technology and the land consolidation operations need to invest and costs for the construction of canals, secondary roads between farms and other facilities, it is recommended that the government in cooperation with relevant interested people prepare the facilities for farmers, and the regional authorities should also consider the land consolidation projects and land leveling along with appropriate incentive policies and they should raise awareness of farmers with applying appropriate implementation models according to the zone conditions.

It should be mentioned that social trust and social cohesion variables have the most effects on the level of technology use after the adoption of land consolidation variable so it should be pointed that the use and introduction of

new technologies need to attract the attention of influential farmers and regional leaders. Social agricultural organizations can be established under governmental controls in order to enhance social cohesion and social trust of wheat farmers and other farmers in rural areas. To raise the level of technology use among farmers it is better to hold some courses about the advantages of new machineries and the maximum limit of using chemical fertilizers for wheat. On the other side, promotion experts should develop appropriate communication channels with the farmers so that they can state the shortcomings and problems and they can be in the flow of information of new technologies.

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