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Research Article

THE FACTORS THAT AFFECT THE ADOPTION OF LOW IRRIGATION AMONG THE CORN PRODUCERS IN MIYANEH CITY

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ABSTRACT
In this study, the positive mathematical programming method was used to realize the adoption of irrigation among the producers of corn and barley. To evaluate the objective function, that is to maximize the benefit of farmers, four strategies were determined. In the first strategy it was assumed that the farmer does not face with water stress, in the second strategy is was assumed that the farmers irrigate the plant 90% of irrigation requirement, in the third strategy, 80% of irrigation requirement is done and finally, the fourth strategy is to assume that 70% of irrigation requirement is done. The results showed that no matter how much of the amount of irrigation, can be reduced by the farmers, the gross margin was decreased in the farm. In the first strategy that was on the base of no water stress, gross margin resulting from the activity of barley and maize cultivation is 8.26 million. Under the second strategy, that the plant water stress is 90 percent, the objective of reducing by 30 per cent and the amount of 8.5 million Tomans was shown.. The third strategy that was based on irrigating the crop up to 80% of irrigation requirement, a 50 percent reduction in the objective function was shown and fell to the amount of 2.4 million Tomans. The last strategy that aims to create tension up to 70% irrigation requirement of barley and maize, objective function value decreased 71 percent compared to the basic model and reduced to the amount of 4.2 million. Due to the downward trend in objective function and assuming that the farmer will deal with the issue, it is clear that farmers' irrigation strategies for reducing their profits will not be accepted. Also to evaluate barley and maize cultivation area in Uremia city, we determined the response of plants to water stress. In the first strategy the results showed that under conditions of water stress, the cultivation area for maze is 2/17 ha, and for barely is 0/67 ha which are discussed as the basic model. The second strategy (90% of plant water stress), the cultivated area for maize fell down to72 percent compared to the base model and degraded to the amount of 6.0 hectares. Also barley cultivation area under this strategy has decreased 34 percent (0/44 hectares). The third strategy (water stress 80%), barley and maize respectively had 43 and 76% reduction compared to the base model and the cultivation area is 0/38 and 0/51 hectares. In the fourth strategy, (70% of irrigation requirement), barley and maize respectively experienced 52% and 81% reduction compared to the base model and decreased to 32/0 and 42/0 hectares.

Keywords: *Adoption Behavior, Irrigation, Positive Mathematical Programming, Uremia City*

INTRODUCTION
Statistics show that over 75% of the earth surface is covered by water. Only 5.2 percent of this amount is fresh water (FAO, 2006). Water is the source of life on earth as it is considered a prerequisite to gaining access to economic, social and reducing poverty. The role and value of water in the next century will increase to the point that will be the axis of conflict and developing countries. And it will reach to the value of oil equivalent in the present century (Qadir *et al.*, 2003). Shahroodi and Chizari (2006) stated that the issue of water scarcity is a major crisis that will threaten human being in the near future and will become the subject of tension among nations.
In the meantime, it is not possible to farm without water, so it is one of the most important sections of the economy in Iran. Iran, with an average annual rainfall of around 250 mm per year has been located in the arid regions of the world so that 65% of this country is placed in arid and semi-arid area. The average precipitation is less than 150 mm per year (Rahbar and Masoudi, 2009). Studies conducted by researchers

show that in the next decade Iran will enter the stage of drought stress. The water crisis is inevitable (Sayedan and Firoozabadi, 2006). Due to the drought in recent years irreparable impact has been occurred on the agricultural in the country.

Saleh and Mokhtary (2007) stated that uncontrolled immigration of rural poverty and lack of access to sufficient water for irrigation of agricultural crops will cause some unpleasant consequences of water scarcity in the agricultural sector.

Planners believe that, development of the agricultural sector is one of the effective solutions to control the consequences of drought and the development of water management in the agricultural sector will help to solve this problem (Ejlali, 2008).

Unfortunately, more than 70% of the of the water resources in the agricultural sector remains unusably and in various forms will go out of exploitation (Sarkhosh, 1387). The low efficiency of irrigation and water resources in agriculture in Iran has caused low productivity in water usage (Seiedi and Madadzadeh, 2006).

The Main Text

Due to the dry climate in Iran and fluctuations in precipitations in the daily seasonal and annual scales will cause uncertainty in getting the minimum required water for agricultural use (Hamedi *et al.,* 2005). Thus, based on this, in addition to the promotion of correct patterns of water usage, other management models will be needed to make it possible for farmers while also making it less costly so that in times of water shortage and drought periods, they can be used. One of the policies of water productivity is deficit irrigation (low irrigation) that can be applied in different ways at certain stages of the growth period of plant (Khorramian, 2002).

Deficit irrigation to conserve water can be a useful approach in the limited water circumstances with the aim of maximizing the volume of water usage, (English *et al.,* 1990). In fact, deficit irrigation is one of the irrigation methods with a view to increase production per unit of water consumed. The advantage of this method is more important in the large areas in the years when the rainfall causes limited water resources.

And usually in areas facing with water shortages, it can be used as a method for increasing the efficiency of irrigation water (Howell *et al.,* 2004).

Mianeh as the largest city of East Azerbaijan province with an area of 45,162 square kilometers, out of 5/5577 kilometers of the whole province area that is one-eighth of the whole province area and one three hundredth of the whole Iran area.

One of the most important economic activities in Mianeh, is in the sector of livestock, agriculture and particularly in agriculture is horticulture and cultivation, (Hashemizadeh, 2011). Corn is the fourth important crop in cultivation.

Despite being consistent soil and climatic conditions of the area for cultivating maize in Mianeh, the cultivated area is only 80 hectares. Because the corn plant is demanding in terms of water usage and during the growing season, needs more than 11,660 liters of water (Masjeid *et al.,* 2008). On the other hand, water shortages in recent years due to the droughts caused a reduction in cultivating this plant in this region, so that the cultivation area of maize crops was 100 hectares during the years 2007-2008 in Mianeh which is now been reduced to 80 hectares.

In this study, the factors affecting the adoption of deficit irrigation by corn growers will be investigated. In this regard, the obstacles farmers use deficit irrigation method and strategies to solve these problems in Mianeh and consequently the increased area cultivated by this product will be studied (East Azerbaijan Agriculture Organization, 2012).

Mianeh is located in the southeastern east Azerbaijan province. It is limited by SarabBostanabad and Hashtrood in the northern and western. The center of Mianeh is located in a straight line 138 km south-east of Tabriz.

Mianeh and its rural areas are the farthest areas to the provincial capital. The city is located in 47 degrees 42 minutes east longitude and 37 degrees 20 minutes north latitude, between two mountain ranges and Qaflankooh and Bozghoush 1,100 meters above the sea level (Governor of Mianeh, 2013).

Figure 1: REPLACE PERSIAN WORDS WITH ENGLISH WORDS The map of East Azerbaijan province and Mianeh

Regarding the scarcity of qualified and fresh water resources in the studied area as well as too much need for water during the growth of corn, this research tried to investigate the factors affecting the adoption of irrigation on corn farmers in the studied region. So that to provide the necessary solutions to reduce the amount of water for the cultivation of maize fields. The study also sought to have the following sub-objectives.

Understanding the characteristics of the individual, social and economic parameters of maize farmers in the adoption of low irrigation

Identifying and understanding problems in the adoption of low irrigation for corn farmers

To achieve the objective of the research, some hypotheses were considered as follows:

Among the adopters and non-adopters of deficit irrigation method, there is a difference in attitude and understanding.

The attitude towards the deficit irrigation method among the corn farmers in the region is not a positive attitude.

Doing low irrigation by the maize farmers, there is a possibility to improve water use efficiency.

MATERIALS AND METHODS

Method of Research

To achieve the objectives of the study data from the maize farms were collected using a questionnaire in Mianeh in 2013 and Excel 2010 software for data analysis and SPSS software were used to determine the factors affecting the adoption of irrigation scheduling using Positive Mathematical Programming (PMP), and the relationship between socio-economic characteristics with the acceptance deficit irrigation method by the maize producers in the region was studied.

Literature and the History of the Research

Damisa *et al.*, (2008) in their study, evaluated the effect of timely access to water and fertilizer, and the consequences of applying the system and the farm size to the satisfaction of farmers with the irrigation systems, and confirmed them.

Medellin-Azuara *et al.*, (2009) evaluated the economics of irrigation water in the region of California using the PMP method. The results showed that the total economic value of water is at least 6.2 times the price paid by the exploitation.

Cortignani and Severiniin a study (2009) using PMP (Positive Mathematical Programming) method evaluated the effects of policies increasing water costs, the reduction of the amount of water and the price of product in admitting the deficit irrigation techniques in the area of the Mediterranean.

Mousavi and Forqany (1390) evaluated the agricultural water supplied by underground water resources using the PMP method in Eghlid city. The two scenarios in terms of price and quantity of water used for agricultural water demand management were applied. The results of the two scenarios compared with net income of cultivation and production optimization model with the base model, showed not there are not much changes in the policies at the level of 10% reduction in the price of water and twice with the price of water, compared to the optimal cropping pattern. Therefore, with the optimal management we can prevent wasting water.

Mathematical Formulas and Equations

The study aimed to investigate the adoption of low irrigation for corn in different levels included full irrigation, irrigating with 90% of irrigation requirement, 80% and 70%. So this model has four actions. Due to the fact that by applying deficit irrigation, the amount of water consumed will be decreased, and thus the relative performance of the current yield (Ya) to the potential performance under full irrigation (Yp) diminished (Meyer *et al.*, 1993).

$Ya/Yp=1-KY\ [1-Wa/Wp]$

Where Yp is the maximum yield in non-stress conditions, Ya is the real product in real terms (deficit irrigation), KY is the ratio of yield response to water in the whole growth period, Wp is the maximum crop water requirement, and Wa is the total amount of irrigation water needed for plant growth period, this will be equal to Wp in full irrigation circumstances and in under the deficit irrigation circumstances will be calculated through this formula:

$Wai = (1-\Delta)\ Wpi$

Where Δ is the relative decline of water throughout the growing season

In this model there will be two types of constraints, which include resource constraints and calibration.. Adding the calibration limit will cause the optimal solution of linear programming to be exactly the level of the activities observed in the base year to lose. Resources constraints include restrictions of land, labor and capital.

The population in this study was maize producers in Mianeh. The needed data in this research were related to 2012-2013 for corn producers.

Since 130 corn producers are engaged in cultivation of maize in Mianeh, however, only 25 of them also are attempting to cultivate barley. Therefore, the sample consisted of those people. In order to analyze the data Excel 2010 software and to determine the factors affecting the adoption of deficit irrigation Winqsb software in the form of positive mathematical planning model was used. The SPSS software was used to evaluate descriptive analysis.

RESULTS AND DISCUSSION

The Research Findings

It suggests that 100% of the corn producers were male in Mianeh. This is because raising corn is a very hard activity as well as cultivating in general.

Table 1: The relative abundance distribution of corn producers' gender in this research:

Gender	Abundance	Percentage	Cumulative percentage
Male	25	100	100
Female	0	0	0
Total	25	100	

Source: research findings

Due to the abundance of corn growers' ages, the expressed information about the corn producers' gender based on the difficulty of the task in cultivating corn is confirmed. Since the younger and older people have less capable in farming.

Table 2: The relative abundance distribution of corn producers in this research:

Age (age rating)	**Abundance**	**Percentage**	**Cumulative percentage**
Less than 25 years	1	4	4
25-35	11	44	48
35-45	4	16	64
45-55	5	20	84
Older than 55 years	4	16	100
Total	25	100	
Maximum=62 years	Minimum=23 years	SD = 12/28	Mean = 40/32 years

Source: research findings

Evaluating the abundance distribution of corn producers' education showed that the maximum abundance were related to under graduated people(high school degree) (about 76% of the corn producers studied in this research) and the lowest abundance were related to Illiterates.

Table 3: The relative abundance distribution of corn producers' education

Education	**Abundance**	**percentage**	**Cumulative percentage**
Illiterate	1	4	4
Under high school degree(diploma)	19	76	80
Diploma	2	8	88
High diploma	0	0	88
Bachelor's degree or higher	3	12	100
Total	25	100	

Source: research findings

As the table shows, 23 people of corn producers (92%) were married and the rest of them (8%) are single. The following table shows the distribution of corn producers' marital status.

Table 4: Relative abundance distribution of Corn producers' marital status studied in the research:

Marital status	**Abundance**	**Percentage**	**Cumulative percentage**
Single	2	8	8
Married	23	92	100
Total	25	100	

Source: research findings

According to the table it can be seen that 12% of the corn producers have two people in their household members. While 48 percent of households have two to four members, that has the maximum frequency. Also, the frequency of four to six-person households in corn producers' families was 28% and with more than six was 12%.

Table 5: Distribution of the relative abundance of family members in corn producers studied in the research:

Number of household members	Abundance	Percentage	Cumulative percentage
Maximum 2 people	3	12	12
2-4 people	12	48	60
4-6 people	7	28	88
More than 6 people	3	12	100
Total	25	100	
Maximum= 8 people	Minimum= 1	SD= 1/96	Mean =4/20 people

The evaluation of relative abundance of studied corn producers based on their type of occupation showed that 28% of corn producers in Mianeh were just cultivating corn, and this was their main job while 48% of them are active simultaneously in farming and animal husbandry that Assigned the highest abundance among corn farmers. Also, 24 percent of them are employed in agriculture and non-agriculture.

Table 6: Distribution of the relative abundance of job status in studied corn producers:

Occupational status	Abundance	Percentage	Cumulative percentage
Only agriculture	7	28	28
Agriculture and livestock	12	48	76
Agricultural and non-agricultural	6	24	100
Total	25	100	

Source: research findings

The findings indicate that 12 percent of the studied corn producers have lower-than 10 years of experience in agriculture. Also, 40 percent of corn producers have 10 to 20 years of experience which have the highest frequency.

Table 7: Distribution of the relative abundance agriculture backgrounds the studied corn farmers:

Backgrounds in cultivating corn	Abundance	Percentage	Cumulative percentage
Up to 10 years	3	12	12
Between 10 - 20 years	10	40	52
Between 20 - 30 years	4	16	68
More than 30 years	8	32	100
Total	25	100	
Max=50 years	Min=5 years	SD=12/71	Mean=24/92 years

Source: research findings

Table 8: Distribution of the relative abundance of other products except from barely and corn in the studied corn producers

Cultivating other crops	Abundance	Percentage	Cumulative percentage
yes	23	92	92
No	2	8	100
Total	25	100	

Source: research findings

Evaluation of distribution of the relative abundance of ownership status showed that 17 farms (68%) of the farms are privately owned and 32% were rented. As can be seen in table 9, there were no ownership of the partnership or cooperative among the studied corn farmers.

Table 9: State of ownership of the studied corn farms

	private		Rented		Partnership		Cooperative	
Description	**Quantity**	**Abundance percentage**	**Quantity**	**Abundance percentage**	**Quantity**	**Abundance percentage**	**Quantity**	**Abundance percentage**
Ownership status of the farm	17	68	8	32	0	0	0	0

Source: research findings

According to the information received from the corn farmers the maximum area for their farms are up 53 hectares and at least are one hectare andthe total mean land area was arable 14/98 hectares.

Table 10: Distribution of abundance of the studied total land area cultivated corn for the corn farmers:

Total area	**Abundance**	**Percentage**	**Cumulative percentage**
Up to 10 ha	13	52	52
10-20 ha	6	24	76
20-30 ha	1	4	80
More than 30 ha	5	20	100
Total	25	100	
Max=53 ha	Min=1ha	SD=13/34	Mean=14/98 ha

Source: research findings

As the table shows, the most land area devoted to corn cultivation is 20 hectares and the minimum cultivated area for corn is 0/5 hectares. The maximum distribution of land was related to an area of one hectare, and the area of 0ne to two hectares rated the next. The average area of the cultivated farm is 2/57.

Table 11: The cultivated area devoted to corn:

The area of the farm	**Abundance**	**Percentage**	**Cumulative percentage**
Up to one ha	11	44	44
1-2 ha	9	36	80
2-4 ha	2	8	88
More than 4 ha	3	12	100
Total	25	100	
Maximum= 20 ha	Minimum=0/5 ha	SD=3/82	Mean=2/57 ha

Source: research findings

According to the figures in the table, 36% of corn farmers announced up to 20 tons per hectare for their production. Also, 24 percent of corn farmers were producing 20 to 30 tons per hectare. And 40 percent of the corn farmers have been producing more than 30 tons per hectare.
Distribution of abundance of production of corn per hectare:

Table 12

The amount of Corn production	Abundance	Percentage	Cumulative percentage
Up to 20 tons per ha	9	336	36
20-30 ton per ha	6	24	60
More than 30 tons per ha	10	40	100
Total	25	100	
Maximum= 75 tons	Minimum=4 tons	SD= 22/83	Mean 35/36

Source: research findings

The information in the table show that eight percent of corn farmers, believed in irrigation once a week. 72% of the corn producers, irrigated every two weeks. This group had the highest frequency of irrigation period. Finally, 20 percent of the corn farmers irrigated in more than two weeks.

Table 13: Distribution of abundance of irrigation period in corn:

Irrigation period	Abundance	Percentage	Cumulative percentage
Once a week	2	8	8
Every other weeks	18	72	80
More than 2 weeks	5	20	100
Total	25	100	

Source: research findings

The table shows, 28% of corn farmers had no agricultural machines to cultivate corn. 32% of them have just a tractor and eight percent have only plow for plowing fields.

Table 14: Distribution of abundance for corn cultivation machines:

Machineries of corn cultivation	Abundance	Percentage	Cumulative percentage
No machines	7	28	28
Tractor	8	32	60
Plow	2	8	68
Planting or harvesting machine	0	0	68
Sprayer device	1	4	72
Lorry	0	0	72
Existence of 2 cases of the devices listed	6	24	96
Existence of 3 cases of the devices listed	1	4	100
Total	25	100	

Source: research findings

According to this table, only 44 percent of the corn farmers are members of the cooperatives And the rest of them are not members of any cooperatives.

Table 15: The relative distribution of abundance for the membership of the studied corn farmers in cooperatives

Membership in cooperatives	Abundance	Percentage	Cumulative percentage
Yes	11	44	44
No	14	56	100
Total	25	100	

As it is clear, the average cultivated area with barely and corn respectively are2/53 and 2/57. Compared to the average of the total cultivated area (15 hectares), these two products are part of the main cultivation product of the region.

Table 16: Descriptive statistics of the farmers cultivating corn and barely:

Divination	Quantity
The average cultivated area for barely (ha)	2/53
The average cultivated area for corn (ha)	2/57
The average production of barley (ha)	2/79
The average production of corn (ha)	4/2
The average selling price of barely (Tomans / kg)	868
The average selling price of corn (Tomans / kg)	586/6
Average irrigation frequency for barley (during cultivation time)	9/5
Average irrigation frequency for corn (during cultivation time)	9/58
The average price of water in the area during cultivation period (Tomans)	151520
Cultivation of conventional crops	Wheat, rice, alfalfa and beans

With regard to the issue of climate change and drought, including the threat of atmospheric that threatens precipitation, and also decreasing of groundwater resources, including factors that threaten the amount of available water for farmers. The efficiency of irrigation in the region according to common method of flood irrigation is low. Paying attention to water resources in order to improve the efficiency of the priorities in recent decades is one of the important cases in this decade. Therefore, in this study to evaluate the acceptance deficit irrigation, four levels of irrigation for have been proposed for barely and corn. The full irrigation which was the base model, that the other irrigation strategies will be compared with that.

Table 17: Descriptive statistics of corn and barely farmers of the region:

Farming activities	Barely	corn
The average levels of activity (ha)	2/53	2/57
Price (Tomans/ton)	868000	586600
Production(Ton/ha)	2/79	33/38
Variable costs (Tomans/ha ha)	908040	2114170
Worker (people/ha)	3	3/36
Liquidity requirements per hectare (Million Tomans)	1/1	0/55

Source: research findings

According to the table it is clear that average cultivated area under by the farmers in Mianeh is 14/9 hectares, that the average area of 5/01 hectares from that total are assigned to barely and corn. In order to calculate the cost of water per cubic meter, the average value of the costs during a year to spend a certain amount of water was calculated. To obtain the cost per cubic meter of water during a year, the cost of water consumption was divided by the amount of used water. In this study it is assumed that the farmers only cultivate corn and barley according to existing facilities; so all the samplings are followed assuming this assumption.

Limitations that are included in the model are restrictions on land and water availability with respect to the water requirement of the plant, labor and capital. Something that is important is to determine crop water requirement.

Table 18: The objective function and the cultivation of barley and corn with different strategies:

Model	Objective function value (Million Tomans)	Percentage of changings compared to the base model	The amount of production of barley (Ha)	Percentage of changings compared to the base model	The amount of production of corn (Ha)	Percentage of changings compared to the base model
Non-stressed model (base)	8/26	________	0/67	__________	2/17	_________
Template with 90% of water requirement	5/79	30%	0/44	34%	0/6	72%
Template with 80% water requirement	4/18	50%	0/38	43%	0/51	76%
Template with 70% water requirement	2/83	71%	0/32	52%	0/42	80%

Source: research findings

The results show that the performance regarding the basic model has changed a lot. This shows that the efficiency of cultivation patterns is highly depended on the amount of irrigation water. However, the cost of water is in level that does not detract from the farmer costs.

So the main response of farmers to reduce the need of plant will be the reduction of cultivation area. As you can see, no matter how farmers can reduce the water consumption of farm gross margin is decreased. This decrease is due to the cultivation of barley and corn as are shown in the table.

As it is clear in this figure, the first strategy which is based on the absence of water stress, gross margin from the activity of barley and corn cultivation is 8.26 million. In the second strategy, which is based on 90% of plant water stress, the objective function is faced with a 30% reduction in the amount of 5.8 million Tomans.

The third strategy which is based on 80% of crop water requirement, the objective function has a 50% reduction compared to the base model and dropped to the amount of 4.2 million tomans.

In the last strategy that aims to create tension to 70% of barley and corn crop water requirement, the objective function value decreased 71 percent compared to the base model, and the value is reduced 2.4 million.

Due to the decline in objective function and assuming that the farmer will deal with the issue economically, it is clear that the farmers will not accept the irrigation strategies for reducing their profits.

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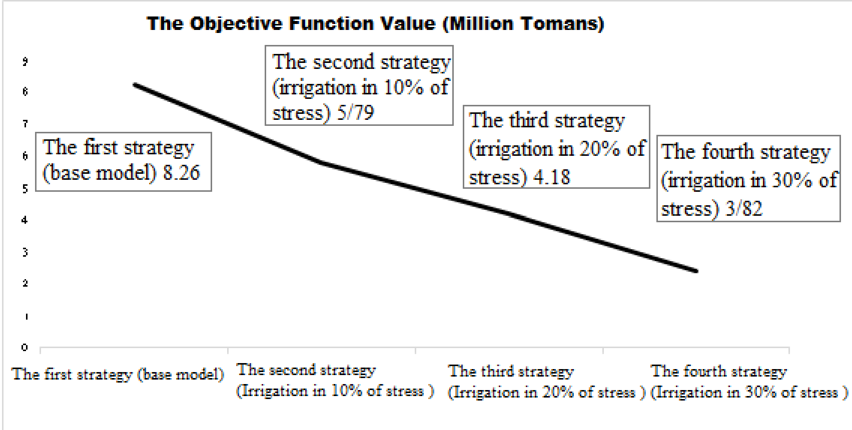

Figure 2

Continually to investigate the best amount of cultivated area by barley and corn in Mianeh, we will try to investigate the response of plants to water stress. As specified in the figure, in the first strategy that there is no water stress, the cultivated area for corn is 2.17 ha and for barely is 0.67 ha that is discussed as the base model. In the second strategy is based on 90% stress water requirement, the area cultivated by corn fell by 72 percent compared to the base model, and reduced to the amount of 0.6 hectare. Barely under this strategy has decreased 34 percent in the cultivation area and decreased to 0/44 ha. In the third strategy which based on 80% of water stress, barley and corn respectively had reduction to 43 and 76% compared to the base model and are 0.38 and 0.51 ha. Finally, under conditions of 70% of water stress, barley and corn respectively experienced 52% and 81% reduction compared to the base model and reduced to 0.32 and 0.42 ha.

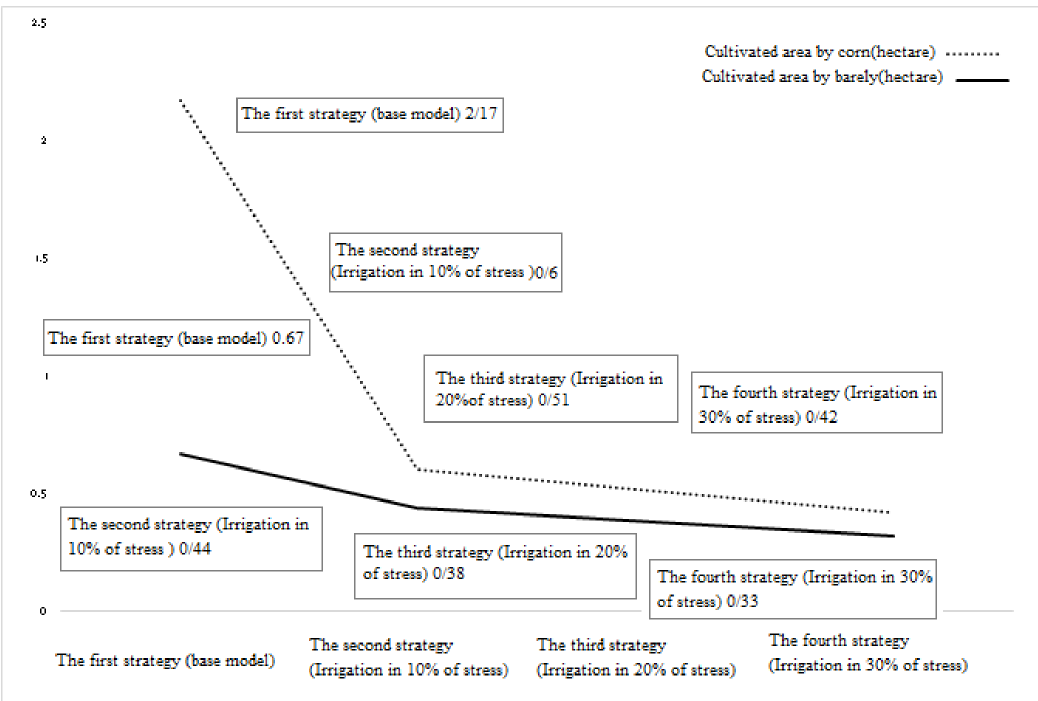

Figure 3

As it is clear in the figure the response of corn against water stress in the second strategy is very severe and shows a decrease of 72 percent. It shows the important role of water for the cultivation of this crop.

According to the results of the model the following suggestions can be offered:
Since the cost of water for agriculture is calculated on an annual basis and the costs is too much compared to the farmer's income, therefore, we must design a mechanism that controls the amount of available water for the farmers and report the amount of consumption.. The cost of irrigation water is very low compared to other costs and for farmers to save and reduce water used in cultivation is not economically justified; thus, by controlling the amount of water used for cultivation and the right price for water, we can help the farmers to optimize the usage of water. Regarding that both barley and corn have serious reaction to water stress; the varieties of these two products should be modified. Since the drought and water crisis in the coming years will be more serious, the genetic studies to modify the seeds and finding the drought tolerant plants should be paid more attention. To create tension in the irrigation, the plants are not faced with a sharp drop in performance. Depending on the irrigation method in the region, we should have technological changes to create the appropriate infrastructure for the using pressurized irrigation systems. Now a day the use of traditional irrigation methods are obsolete, Government and farmers have to use pressurized irrigation systems; thus, the infrastructure and facilities in the public sector should be considered to help farmers, and training on how to use these systems should be presented.

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