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Study of the Effect of Pressurized Irrigation System (Sprinkler and Drip) Implementation on Reclamation of Sterile and Rain fed Lands of Rural Areas and Increase in the Area under Cultivation in Iran

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ABSTRACT

Background: According to the fact that agriculture is one of the main sectors of economy in rural areas, increased crop production together with reduced costs may play an essential role in social and economic development of these areas. On the other hand limited water resources along with increasing growth of population and consumption of agricultural products, make it necessary to pay more attention to agricultural water conservation practices and modification of irrigation systems resulting in adequate water supply, increased agricultural production and improvement of national economy. In this respect one of the technologies contributing to optimal use of water resources is pressurized irrigation system; **Objective:** thus present study aimed to study the effect of implementation of pressurized irrigation system (sprinkler and drip) on reclamation of sterile and rain fed lands of rural areas and increase in the area under cultivation in Iran. Statistical population comprised of 590 individuals exploiting pressurized irrigation systems in Sulduz plain. Using Cochran's formula, 235 farmers among them were chosen as sample based on random sampling technique. Collected data were analyzed using descriptive and inferential statistics and SPSS was employed. **Results:** Finally it was concluded that implementation of pressurized irrigation systems may have a positive impact on reclamation of sterile and rain fed lands in rural areas, increase in the area under cultivation, less labor requirements and easy management. Mean irrigated land owned by system exploiters was 5055 ha before introduction of new systems and it increased to 8018 ha after implementation of new systems. This increase resulted from reduction of the area of rain fed and tillage lands. **Conclusion:** Generally the necessity of employing pressurized irrigation systems in Naghadeh city is well-known (especially with respect to water crisis in Lake Urmia, environmental problems and successive droughts). However among negative points in the process of implementation of pressurized irrigation systems was an intensive bureaucracy which with respect to low literacy level of local farmers acted as a barrier to implementation of systems.

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INTRODUCTION

Rural development is considered as one way towards development and progression in Iran and this important matter is realized via agricultural development. Limited water is one barrier to agricultural improvement. Today water crisis in various parts of the world has caused major problems with respect to supply of the water required by the societies. Since Iran is located in arid and semi-arid parts of the world, thus it is inevitable to use irrigation techniques with maximum output. Thus optimal use of water for agricultural production having high contribution to food supply is a necessity.

Iran is a country with little rainfall and an arid and semi-arid climate. In addition to rainfall deficiency (annually 250 mm), also it is not of a balanced distribution across the country; the other significant issue is seasonality of rainfall in Iran. In this country the most rain fallsoccur in winter and early spring. Though there is a high water demand in summer, but in most parts of the country rainfall is infrequent in this season. Thus with respect to arid and semi-arid climate of Iran and inappropriate dispersion of rainfall in this country, the way the limited water resources being used by three main consumption channels, especially agricultural one accounting for 90 percent of the consumed supplied water, is of a high importance. If no appropriate plan and optimal management of water are implemented, food and agricultural crop crisis would led to an irrecoverable damage.

In recent years, there have been extensive efforts at national level to harness surface waters among them building storage dams may be mentioned. By building these dams, regional surface waters are directed towards the reservoir through channels and this water may be exploited for various uses including agricultural ones.

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North eastern Iran accounts for the most consumption of water in agricultural sector because of having fruitful lands and engagement of most local people in agriculture. On the other hand it is well-known that lack or scarcity of water cause biological disrupsion and affects plant growth. Thus in permanent and temporary dry regions, employment of irrigation systems is a fundamental basis of agriculture and cultivation of agricultural crops would be impossible without irrigation. Irrigation has various scientific definitions but put it literally, it means spread of water on the ground with the aimof water penetration into soil for use in plant growth and agricultural cultivation. Irrigation is an effort exerted by humans to modify hydrologic cycle to enhance conditions for production of agricultural crops or in other words, irrigation is a technique for meeting water requirements of plants.

The most prevalent irrigation technique is traditional one (surface irrigation) being in use since long time ago. But with increasing growth of population, demand for more food supplies, scarcity of precipitation and also scientific and technological development, this type of irrigation is not cost-effective and faces major problems including low economic output, water wastage, fertilizer wastage, soilerosion, soilsalinity and alkalinity, immersed agricultural lands and small-scale of agricultural lands. With respect to dry climate of the country and the region being studied in present research and also given the necessity for development of agricultural sector as the sector meeting needs of communities for foods, exploiting modern methodologies for irrigation including pressurized irrigation systems (drip and sprinkler) and paying attention to productivity of water supplies being used in agricultural sector are focused more than ever. Significance of this practices become clearer when one considers the fact that implementation of pressurized irrigation systems enhances irrigation output by 70 to 75 percent in the casesof using sprinkler irrigation system and increases it by 90 to 95 percent in the case of using drip irrigation systems. Thus employing pressurized irrigation system, in addition to prevention of water waste contributes to increased economic output, increased production outcomes, increased area under cultivation and prevention of soil erosion and this may have positive environmental outcomes (especially in Lake Urmia and the surrounding ponds studied in present research). Thus implementation of this plan may be considered in agricultural sector policy making in particular and rural development plan in general.

Thus the general purpose of present study was to investigate the effect of implementation of pressurized irrigation system (sprinkler and drip) on reclamation of sterile and rain fed lands of rural areas and increase in the area under cultivation in Sulduz plain of Iran. Sulduz plain with a drainage basin area of 1050.087 km^2 is located in Southern part of West Azarbaijan province and Lake Urmia is located in the north part of this plain. It has a high potential for agriculture and most local people are active in agricultural sector as their main income source. Main crops of this fruitful plain include wheat, barely, sugar beet, apple and grape. But water scarcity given the dry climate and seasonal rainfall and also employment of traditional irrigation practices cause major problems for local farmers including environmental problems, economic difficulties and forced migration.

Local farmers exploit two surface and groundwater as their irrigation water source. Surface water is used for irrigation in late winter, early spring and late fall and groundwater is used in hot months including three months of summer in traditional irrigation system. In addition to water waste, this procedure has led to lowered groundwater level, dryness of ponds and most importantly dryness of Lake Urmia. Local farmers have abandoned their rain fed lands and though cultivation of irrigated lands via traditional irrigation practice is not cost-effective, (because of low economic output, water wastage, soil erosion, fertilizer wastage, soil salinity and alkalinity, immersed agricultural lands and small-scale and dispersion of farms) many farmers inevitably have resorted to this procedure and among outcomes of these difficulties, sales of farm lands and migration to cities may be mentioned. In order to solve above-mentioned problems, modern irrigation systems may be used which prevent water wastage and provide an appropriate solution for above-said problems. Thus present research sought to study the effects of implementation of pressurized irrigation systems on reclamation of sterile and rain fed land in rural areas and increase in the area under cultivation in Sulduz plain and in this respects it sought to answer the following questions: what are the effects of implementation of pressurized irrigation systems in farm lands of Sulduz plain? Has implementation of pressurized irrigation systems contributed to increase in the area under cultivation in Sulduz plain? Has pressurized irrigation systems contributed to reclamation of sterile and rain fed land in rural areas?

Research Literature and Hypotheses:

One major limitation of agricultural activities in recent years has been water scarcity causing dependency of agricultural development to new irrigation systems. With implementation of pressurized irrigation systems, irrigation output increases to a great extent. Implementation of pressurized irrigation system may increase production output and in this way enhance income and economic return for rural people which in turn leads to higher life style quality of them and plays a major role in development and renovation of rural areas.

Results from research works conducted in California showed that employment of drip and sprinkler irrigation technologies improved crop performance. These technologies were used in areas with low soil quality and high water cost. Also theses research works showed that land size was the most influencing factor in

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acceptance of irrigation technologies and peripheral factors also played a significant role in understanding and acceptance of these technologies (Dinar, 1993).

Results from a study conducted by Shresthna and Gopalakrishnan (Shrestha, 2003), with respect to acceptance and promotion of drip irrigation system showed that increased crop production, water use, type of water resources and land size all were among influential factors contributing to acceptance of irrigation technologies. Also familiarity of farmers with this technology increased their knowledge about them and increased acceptability of these technologies (Shrestha, 2003).

Pressurized irrigation system:

Irrigation has different scientific definitions but it literally means to spread water over the earth for exploitation of plants and crop production. In other words agriculture is an effort exerted by humans to modify the hydrologic cycle to produce agricultural crops. Irrigation is done in three ways including surface, underground and pressurized ones.

In surface irrigation technique, water flows over the soil surface from irrigation streams or gated pipes and becomes available to plant roots by slowly penetration into the soil. In underground irrigation technique, the moisture required by plant root is supplied based on control of water table.Among the most important characteristics of this technique is the fact that the soil surface does not show any moisture in such a way that to provide water to the root domain the water table is lifted to an extent that it can reaches the plant root based on capillary property. These techniques are among the most inefficient irrigation practices in Iran because they lead to soil erosion, soil salinity and alkalinity, immersion of agricultural lands, extra labor requirements, low economic return, need for land clearing, fertilizer wastage and last but not least, waste of the water supplied by spending a high cost and high investment in its maintenance and distribution.

Pressurized irrigation is a new irrigation technique in which pressurized water flows through primary and secondary pipes and exits from pores known as nozzles, sprinklers or water emitters as small particles or drops and in this way it prevents water wastage in the process of direction of water towards the farm land and water is provided to farm lands and agricultural crops in appropriate quantities. Development of pressurized systems during past 50 years has been at an increasing rate and the most inventions related to these systems have been in USA in such a way that now an area more than 13 million ha of farm lands in this country are covered by various types of pressurized irrigation systems. Water scarcity in most countries across the world including Iran has led farmers to shift from traditional irrigation systems towards pressurized ones. Iran is among the forerunners in the field of employing sprinkler and drip pressurized systems.

Sprinkler irrigation system:

In this technique water is pressurized by a pump and is transmitted through specific pipes and exits from sprinklers and spreads across the land. Water drops spread into the air while exiting sprinklers and fall on the land as rain drops. Compared to surface irrigation, in this practice there is more control on the water and because of the same fact the irrigation output is higher than that of surface irrigation. Land slope which is a major factor causing non-uniform distribution of water in surface irrigation practice is of lower effect in sprinkler irrigation systems and using the latter, even high steep lands may have a uniform distribution of irrigation water. In the case of presence of appropriate slope, it can be exploited to compensate for friction within the pipes and in this way the output of water use may be enhanced in the farm land and the output even would be higher than that resulted from flat lands. Sprinkler irrigation systems can be used in nearly all weather conditions except for regions with intensive winds or very high temperatures in some hours of the day.

Drip Irrigation Systems:

This is among the most sophisticated and high-level irrigation techniques in which water is provided to plants and trees in required quantities ad droplets using emitters. In this technique water only is delivered to the soil surrounding the roots and plant water requirements are met using minimum quantity of water. In other words water is delivered to agricultural plant in small quantities with high frequency.

Among advantages of pressurized irrigation systems the followings may be mentioned:

- Water conservation
- No need to land clearing
- Uniform water distribution across the farm land
- Increased product quality and quantity
- Facilitated agricultural operation
- Applicable to all plants
- Control of soil erosion and runoff
- Prevention of soil crustation and retention of soil porosity
- No need to build streams and drainage systems within the farm

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- Possibility of conducting irrigation along with fertilizer and pesticide spraying and uniform spread of them.
- No need to large number of workers because the fixed number of system components.
- Not entering of weed seeds into the farm because water flows through pipes
- No possibility of growth of weeds because low humidity of the soil around the roots

Pressurized irrigation system also have limitations in addition to its advantages:

- Higher initial investments
- Need for electricity, gasoline and diesel fuel for setting up the irrigation system
- If the water is distributed based on agricultural water right, then building pools for water storage is necessary.
- System may not be used in windy weather
- When water has a high salinity , pressurized irrigation system may not be used

Thus based on above-said discussion, the following hypothesis is provided:

Research hypothesis:

Implementation of pressurized irrigation system design (drip and sprinkler) has a positive effect on reclamation of sterile and rain fed lands of rural areas and the area under cultivation in Iran

Research Methodology:

Data Collection Instrument:

In present research two instruments were chosen for data collection among four major ones widely being used for this purpose (questionnaire, interview, observation, documentary analysis). Obviously researchers should study the relevant documents. In other words they engage in a library study so that an appropriate theoretical framework is provided for the study and it is ensured that all variables associated with research questions are identified. Besides these data, a questionnaire consisting of a series of purposeful questions was also used as one of the most prevalent research instrument. A questionnaire seeks to evaluate viewpoints of the respondents using various scales. In present study a researcher-developed questionnaire was employed and items related to dependent variables are provided in table 1 and are described in section "Data Analysis "in detail.

Table 1: Operational definition of research dependent variables

Description	Independent variable	Dependent variable	Items and measures
Research hypothesis	Set up, implementation and application of new modern irrigation systems	Reclamation of rain fed and sterile lands	-Increased area under irrigated cultivation -Decreased area under rain fed cultivation and tillage (switch to irrigated cultivation) -Development in steep lands surrounding the farm -Removing empty spaces remaining from old trenches (traditional irrigation) and increasing the area under cultivation -Expansion of agricultural lands -Water well drilling and pressurized irrigation development

Statistical Population and Sample Size:

Present research was conducted in Sulduz plain with an area of 1050.086 km^2 with geographical coordinates 35°-58'-39°36' N and 44°03'-47°23'E. This plain is located in southern West Azarbaijan province in Iran.

Statistical population of present study comprised of all famers exploiting pressurized irrigation systems in Sulduz plain of Iran. According to statistics provided by Agricultural Bureau of Naghadeh city, the number of system exploiters was 590 among them 572 ones exploiting sprinkler irrigation system and 15 ones exploiting drip irrigation system and total area covered by these two systems were respectively 4130 and 90 ha. Exploiting pressurized irrigation systems started in Naghadeh city since 1994 and 322 system exploiters were associated with Hasanlu Dam downstream.

To determine sample size, Cochran's formula was used and according to this formula, sample size was found to be 232 households. But considering the fact that a number of questionnaires would not be returned or completed correctly, the number of distributed questionnaires was 250 ones among them 235 questionnaires were usable. According to statistical population comprising of farmers exploiting pressurized irrigation systems in Sulduz plain, sample was selected using simple random technique.

Data Analysis:

In present research, according to the nature of collected data, parametric (paired sample t-test, one-sample t-test, andhypothesis test for difference of means), non-parametric tests (Friedman's test and Chi square test) were

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used to assess research variables. To describe data, descriptive statistics were used and inferential statistics were employed to test hypotheses.

RESULT AND DISCUSSION

Statistical Description of items related to the area under cultivation:

In order to evaluate research hypothesis, the variables increased area under cultivation, decreased the area under rain fed cultivation and tillage, purchase of agricultural lands (trying to develop lands and interest in cultivation), initiation of agricultural operation in steep and sterile lands surrounding the farm land after setting up pressurized irrigation systems, leasing agricultural lands, development in steep lands not appropriate for traditional irrigation, removing empty spaces remaining from old trenches which have been obsolete because of sprinklers, change in cultivation pattern, increased production, etc. were studied and the following results were obtained:

Agricultural land areas:

frequency of areas of irrigated, rain fed and till**age** lands of farmers comprising the study sample was as shown in table 2. In this table, the response frequency row represents the number of farmers owned the type of agricultural lands mentioned in table columns during the studied periods(before and after setting up pressurized irrigation systems). For example, 160 subjects had irrigated lands before pressurized irrigation system set up and this number increased to 231 after setting up pressurized irrigation system (4 subjects owned irrigated garden lands). This result represents increase in the number of farmers having no irrigated lands before initialization of pressurized irrigation systems but after introduction of these systems switched their rain fed lands to irrigated ones using pressurized irrigation systems. Also mean areas of irrigated agricultural lands was 5.55 ha for sample subjects (3.78 ha for N=235) and this number increased to 8.18 ha after setting up pressurized irrigation systems. Standard deviation (a measure of dispersion) was 3.809 before introduction of these systems and it increased to 5.209 after introduction. On the other hand minimum area of irrigated agricultural lands was 0.5 ha and it increased to 1.20 ha after setting up pressurized irrigation systems. Maximum area of irrigated agricultural land owned by responders was 32 ha in both study periods. In total area of irrigated agricultural land owned by farmers was 888.80 ha before initiation of pressurized irrigation systems but after introduction of these systems this figure increased to 1890.80 ha. Thus increase in irrigated agricultural area had positive effect on productivity of agricultural lands.

Table 2: Frequency of various types of lands under cultivation before and after introduction of pressurized irrigation systems/ha [3-6]

Description	Irrigated agricultural area before introduction	Irrigated agricultural areas after introduction	Rain fed agricultural area before introduction	Rain fed agricultural area after introduction	Tillage area before introduction	Tillage area after introduction
Response frequency	160	231	186	30	37	9
Mean	5.55	8.18	5.74	4.48	3.36	2.72
Mean of total sample	3.78	8.04	4.54	0.57	0.52	0.104
Standard deviation	3.809	5.209	3.724	2.408	2.219	0.712
Variance	14.515	2.1387	13.872	5.801	4.926	0.507
Minimum	0.50	1.20	1	1	1	2
Maximum	32	32	33	10	10.20	4
Total	888.80	18.8090	106.408	134.50	124.40	24.50

As is seen in table 2, number of system exploiters having at least a piece of rain fed farm land among their agricultural lands was 186 before implementation of pressurized irrigation systems but this figure decreased to 30 after introduction of these systems. Mean area of rain fed lands was 5.74 ha and it decreased to 4.48 in current period. Area of tillage lands was 3.36 before introduction of new irrigation systems and it decreased to 2.72 after the introduction.

Also before introduction of new systems the system exploiters with garden lands owned 13.74 ha in total and this figure remained the same after introduction of new irrigation systems and these gardens only were equipped to drip pressurized irrigation system. Mean area of garden lands was 3.43 among the sample of gardeners and it was 0.058 based on total sample.

Purchase of agricultural land:

with initialization of new technology in agricultural lands and with respect to its satisfying outcomes in terms of performance, production and output, one expected practice is expansion of agricultural area and development of farming operations. Undoubtedly one major variable influencing achievement of this goal is purchase of agricultural lands. Thus this was studied as one variable for evaluation of research hypothesis and it was assumed that purchase of land and increasing development of it are indicators for land reclamation because

most people selling agricultural lands are those who migrate to cities and consider agriculture as their secondary job and given this fact they show less attention to and interest in various steps of planting, growing and harvesting. Thus though the lands may be cultivated, but required treatments (irrigation, fertilization, trimming, mowing) are not performed in appropriate manner and the outcome is low productivity. But purchase of these lands by farmers is considered as a high motivation for engaging in agricultural activities and planting, growing and harvesting steps which in turn lead to reclamation and more productivity of agricultural lands. Based on these facts, the number of farm lands and their areas purchased by framers who exploited pressurized irrigation systems after introduction of these systems and increase in their income were inquired and the results are shown in table 3.

Table 3: Frequency of agricultural land areas purchased by farmers exploiting pressurized irrigation systems [3-6]

Description	Number of purchased lands	Purchased area/ha
Number of responses	110	110
Mean for respondents	2.82	1.19
Mean for total sample	1.28	0.557
Standard deviation (SD)	0.41741	1.4647
Minimum	1	0.5
Maximum	3	8
Total	131	301.90

As seen in table 3, among 235 respondents, 110 ones stated that they embarked upon purchasing agricultural land after introduction of pressurized irrigation systems and they had purchased 131 pieces of land amounting to 301/90 ha in total. Mean pieces of lands purchased by the above-said 110 farmers was 1.19 pieces with a mean area of 2.82 ha. This number was 0.557 piece of land with a mean area of 1.28 ha based on 235 respondents. Maximum number of pieces purchased by one farmer was 3 ones and maximum area of lands purchased by one farmer was 8 ha.

Expansion of agricultural lands towards steep lands and sterile lands:

There were steep lands surrounding the studied farm lands and irrigation of them was not possible exploiting gravity and streams. They were left as sterile lands and occasionally were exploited by farmers who were interested in rain fed agriculture. With introduction of pressurized irrigation systems, farmers added these lands to farming ones and this resulted in increase in the area under cultivation. In the studied population the results are as shown in table 4.

Table 4: Descriptive statistics of development area of steep and sterile lands surrounding farming lands of users of pressurized agriculture systems/mm^2 [3-6]

Number	Mean based on93 subjects	Mean based on total sample	Standard deviation (SD)	Minimum	Maximum	Total
93	2024.73	801.27	1732.264	100	10000	188300

As shown in table 4, among 235 farmers who exploited pressurized irrigation systems, 93 ones took measures to develop steep and sterile lands surrounding their agricultural lands. Mean land development by each farmer among above-said 93 ones was 2024.73 m^2 and it was 801.27 m^2 based on averaging over all 235 subjects comprising the sample. In total 188300 m^2 (18.83ha) was added to the area under cultivation by exploiting this strategy and steep and sterile lands of the studied region were reclaimed.

Removing empty spaces of old trenches:

in immersed irrigation a part of land is used for building water trenches and after introduction of pressurized irrigation systems these water trenches are no longer in need and in this way the area under cultivation increases. The less the slop of land and the less the water volume of these trenches, the more the number of them and the more the area of the farm land being occupied by these water trenches. However using pressurized irrigation systems has added these areas to the area under cultivation and subsequently has joined them to the production cycle and the related results were as shown in table 5 for the studied region and based on total size of the sample.

Table 5: Area of empty spaces of old trenches added to the area under cultivation/m^2

Description	Empty spaces of trenches related to traditional irrigation system /m^2	Area occupied by old trenches in total area of agricultural land of the system exploiter/ m^2
Number of responses	160	
Mean based on respondents	222.437	1248.0625
Mean based on total sample	151.44	849.74
Standard deviation (SD)	1216.0391	1053.9046
Minimum	50	100
Maximum	1000	9000
Total	199690	

As shown in table 5, among 235 respondents, 160 ones (68 percent) had water trenches in their agricultural lands to facilitate water flow and after introduction of pressurized irrigation systems they added these areas to their agricultural land under cultivation. The minimum area occupied by these trenches was 50 m^2 and the maximum was 1000 m^2. Based on 160 respondents to this question, the mean area added to the agricultural land by removing the trenches was 222.43m^2/ha and based on total sample this mean area was 151.44 m^2. In column "Area occupied by old trenches in total area of agricultural land of the system exploiter", the figure in the previous column was added to the area of irrigated lands of that farmer before introduction of pressurized irrigation systems. For example if a farmer had 3 ha irrigated lands before introduction of new irrigation systems and the area occupied by trenches was 200 m^2 per ha, the area under cultivation after introduction of systems increased by 600 m^2. Generally 199690 m^2 (19.969 ha) was added to the area under cultivation in the studied city by the respondents. The mean added area was 849.74 m^2 per system exploiter.

Water well drilling and development of pressurized irrigation system:

with increasing agricultural income, employment of modern irrigation and decreased working hours in the farm, farmers save their time to engage in other works and this creates motivations for land reclamation, mechanized agriculture and renewal of cultivation stages. Based on this fact, two 4-point Likert scale questions were asked and the results are provided in Table 6. This table demonstrates priority of each item after introduction of new modern systems from the respondents' viewpoints.

Table 6: Frequency of priority of land reclamation and increasing the area under cultivation from system exploiters' viewpoints

Item	Frequency	Done	Under progress	In near future	Not interested
Purchase of agricultural land	Number	152	37	44	2
	Percentage	64.7	15.7	18.7	0.9
Purchase of agricultural equipment and machinery	Number	111	66	47	11
	Percentage	47.2	28.1	20	4.7
Water well drilling and development of pressurized irrigation system	Number	100	43	56	36
	Percentage	42.6	18.3	23.8	15.3
Development of agricultural lands, agricultural modernization	Number	158	41	29	7
	Percentage	67.2	17.4	12.3	3

As shown in table 6, 64 percentage of the sample 9152 farmers) embarked upon purchasing agricultural lands and 111 respondents (47.2 percent) from the sample considered purchase of agricultural equipment."Water well drilling and development of pressurized irrigation system" and "Development of agricultural lands and/or agricultural modernization" were respectively indicated as their priorities by 100 and 158 respondents; other responses for the above-said items are also shown in the table.

Hypotheses Testing

Research hypothesis:

Implementation of pressurized irrigation system design (drip and sprinkler) has a positive effect on reclamation of sterile and rain fed lands of rural areas and the area under cultivation in Iran.

- To evaluate this hypothesis, variables mentioned in descriptive statistics were considered and for each variable the appropriate statistical test was conducted. The first variable was the mean area of rain fed and irrigated agricultural lands owned by system exploiters and we sought to study changes in these areas before and after of introduction of pressurized irrigation systems. Reduced rain fed land area and increased irrigated land area shown in table 2 supported the research hypothesis. Since intra group mean for one population was tested in two points (before and after introduction of pressurized irrigation systems) and since ratio and interval scales were considered for variables, thus paired samples test was used and the results are shown in table 7.

Table 7: Paired t-test of the variable "land area"

Variable	Paired differences					T	df	-Sig
	Mean	SD	Mean error	CI 95 %				
				Lower bound	Upper bound			
Irrigated land area before system- irrigated land are after system	-3.22	3.807	0.300	-3.82	-2.6340	-10.7	159	0.000
Area of Rain fed land before system- area of rain fed land after system	2.56	5.360	0.978	0.564	4.5683	2.622	29	0.014
Tillage area before system- tillage area after system	0.568	1.533	0.542	-0.594	1.969	1.268	7	0.245

As shown in table 7, mean area of all three types of lands (irrigated, rain fed and tillage) owned by farmers exploiting pressurized irrigated systems was significantly different with that of before introduction of system. T-value for the variable "irrigated land area" (-10.7) showed that a significant increase in mean area of this type of land was seen after introduction of the new irrigation system. Thus with confidence interval 95 percent and

significance value of 0.000 it can be said that pressurized irrigation system contributed to switch of rain fed lands to irrigated ones. In average a mean difference of 3.22 was seen after introduction of new systems compared to before introduction. In other words, mean area of irrigated land area increased by 3.22 ha after introduction of new systems. On the other hand, reduced rain fed land area and switching them to irrigated ones was another step towards land reclamation and increase in the area under cultivation. With confidence interval 95 percent and significance value of 0.000 it can be said that pressurized irrigation system contributed to change in rain fed land area owned by system exploiters. According to descriptive statistics, reduced area of rain fed land and increased area of irrigated one was confirmed. In average 2.65 ha of rain fed land was switched to the irrigated one. However with respect to statistical analysis, in average there was no significant difference between tillage area of system exploiters before and after introduction of new system and significance level was 0.245 (higher than error level 0.05).

- On the other hand in evaluation of the item "purchase of agricultural land after introduction of new system", mean difference of one group was obtained in one point (after implementation of new system) using one-sample test as shown in table 8.

Table 8: One-sample test for the variable "purchase of agricultural land"

Variable	Test Value					
	T	df	Sig	Mean difference	CI 95	
					Lower bound	Upper bound
Land pieces purchased after introduction of systems	29.924	109	0.000	19091	1120.1	1.2698
Land Area purchased after introduction of systems	19.929	106	0.000	2.82150	5408.2	3.1022

According to the obtained results in table 8, with confidence interval 95 percent and significance value of 0.000 it is inferred that implementation of pressurized irrigation system contributed to purchase and development of agricultural lands.

- The same test was repeated for the variable "expansion of agricultural lands in steep and sterile districts surrounding agricultural lands of system exploiters after implementation of new system" and the results are shown in table 9.

Table 9: One-sample test for the variable "expansion of agricultural lands in steep and sterile districts surrounding agricultural lands of system exploiters

Variable	Test Value					
	T	df	Sig	Mean difference	CI 95	
					Lower bound	Upper bound
Increase in land area due to development in steep and sterile lands	5.268	79	0.000	6251.25000	1565.5596	6346/9404

According to this test it is inferred that after implementation of pressurized irrigation system, expansion of agricultural land towards steep and sterile areas around farm lands of system exploiters was significant; with confidence interval 95 percent and significance level 0.000 (less than error 0.05) it can be said that this findings support the research hypothesis.

- Removing spaces allocated to water trenches before implementation of new system and addition of the area occupied by them to the cultivation area was another variable assessed by one-sample test (table 10).

Table 10: One-sample test for the variable "removing empty spaces of trenches and addition to cultivation area"

Variable	Test Value					
	T	df	Sig	Mean difference	CI 95	
					Lower bound	Upper bound
Removing empty spaces	24024	159	0.000	222.43750	204.3195	240.555

According to inferential findings including t-value of 24.24, df of 159, confidence interval 95 percent and significance level 0.000, implementation of pressurized systems contributed to increase in the area under cultivation and land reclamation by removing empty spaces of traditional water trenches and addition to the area under cultivation based on modern irrigation.

In total, among seven variables used for hypothesis test, six variables were confirmed. In other words implementation of pressurized irrigation system (drip, sprinkler) had positive effect on reclamation of sterile and rain fed lands of rural areas and increase in the areas under cultivation.

Discussion and Conclusions:

Human evolution is under progress and people always try new things when face new difficulties. This is also the case in agricultural sector. This is evidenced by passing through various stages including hunting and

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gathering, agriculture, plant irrigation, increased agricultural production, agricultural revolution, green revolution, etc. H owever water crisis in some parts of the world and drought and dryness in other ones together with increased production through irrigation of farm lands led innovative farmers to use water in agriculture in an optimal way and the outcome was invention and application of pressurized irrigation practices during two recent centuries. These methods and practices have been enhanced and improved since the late half-century and these systems also have been growing in use in Iranian context. After all, rural development should start by agricultural development and the latter requires equipment and modernization. First this makes it possible to increase agricultural production and in turn national production and second, it prepares the ground to use production resources (including water) in an optimal way and facilitates rural development.

Given the fact that 93 percent of national resources of water is used by agricultural sector and also with respect to increasing growth of population and importance of food production, and also regarding the fact that sterile lands may be reclaimed to increase the area under cultivation but national water resources have a decreasing trend, thus using available water in optimal way by employing pressurized irrigation practices is an important strategy to solve this problem.

With study of pressurized irrigation systems implemented in Sulduz plain of Iran it was found that these systems had a positive impact on reclamation of steep and sterile lands of the studied city and increased the area under cultivation in this region. Mean irrigated land owned by system exploiters was 5055 ha before introduction of new systems and it increased to 8018 ha after implementation of new systems. This increase resulted from reduction of the area of rain fed and tillage lands.

Role of pressurized irrigation system was evident in increase in farmers' agricultural production. In addition after implementation of new system, the farmers were satisfied with facilitated irrigation, increased quality of crops, enhanced irrigation output and decreased agricultural costs. Increased output of irrigation had also led to increased production. Also increased production of agricultural crops was studied and it was found that three products including sugar beet, wheat and barley showed a significant increase per ha after implementation of pressurized irrigation systems.

Generally the necessity of employing pressurized irrigation systems in Naghadeh city is well-known (especially with respect to water crisis in Lake Urmia, environmental problems and successive droughts). However among negative points in the process of implementation of pressurized irrigation systems was an intensive bureaucracy which with respect to low literacy level of local farmers acted as a barrier to implementation of systems.

After conducting research and interpreting the collected field data and familiarity with difficulties associated with implementation of these new systems, the following recommendations are provided. It is hoped that relevant authorities consider these points in their efforts towards rural and agricultural development:

- Since modern irrigation systems are considered as a type of agricultural modernization and acceptance and employment of modern technologies by illiteracy or low literacy farmers is a slow process, thus the necessity of implementation and exploitation of these systems should be promoted. Obviously the Broadcasting Organization, Agricultural crusade Organization and agricultural rural cooperatives are appropriate entities for this mission.
- Present research clearly showed increased production of crops per ha after implementation of modern irrigation system. Thus facilitation of implementation process and encouraging other farmers to employ the systems are necessary. In order to realize this goal, the related barriers including small scale of agricultural lands, inheritance law, etc. should be addressed.
- Since system exploiters are not technically familiar with system equipment, companies supplying the systems should be required to provide necessary training to the farmers.
- One concern expressed by system exploiters was that the type of pressurized irrigation systems was dictated by Agricultural Crusade Organization and the decision was only based on the available credit facility. Type of irrigation system should be chosen and recommended to the farmers by appropriate engineering under governmental regulation based on soil characteristics, land slope, water resources, weather features, cultivation pattern and type of crops.
- Inappropriate dispersion of exploitation of irrigation systems and the areas under exploitation show that farmers of some villages were not adequately familiar with advantages and characteristics of modern systems. Identification of the reasons for acceptance or non-acceptance of systems by the farmers should be studied.
- Farmers need adequate power supply for optimal implementation of systems. Thus it is necessary to develop required coordination among relevant public administrations (including Iran Power Generation Transmission & Distribution Management Company, Iran National Water and Wastewater Engineering Company, Agricultural Crusade Organization, etc.).
- Loans and credit facilities should be provided to applicants with appropriate terms and provisions
- Loan repayment period should be extended and interest rate of loans should be set based on income level of potential exploiters of the modern irrigation systems.

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