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Total and Partial Factor Productivity Analysis of Irrigated Wheat in Iran by Separate of Exploitation Scales

Hassan Masoumi, Rashed Alavi

***Abstract*—**Wheat is one of the strategic crops in Iran, on which the household food basket is highly dependent. Although this crop is cultivated and produced in almost all provinces of the country, its production efficiency is lower than the global and regional averages due to the lack of optimal use of allocated resources. In this research, which was carried out with a documentary and library method, first, the total and partial productivity indices of irrigated wheat production were calculated in large, medium and small exploitation scales in different provinces of the country, and then the provinces were clustered in terms of these indices. The results showed that the total productivity of production factors had a direct correlation with the scale of exploitation, so that with the increase in the size of exploitations, the total productivity index increased. On the scale of small exploitations, North Khorasan, Zanjan, Chaharmahal and Bakhtiari Province, on a medium scale, Chaharmahal and Bakhtiari Province and on the scale of large exploitations, Zanjan, Chaharmahal and Bakhtiari provinces, Kohkiloyeh and Boyer Ahmad and North Khorasan, with better use of production resources compared to other provinces, were placed in the best cluster in terms of total productivity index. The high total productivity index in Zanjan, Chaharmahal and Bakhtiari Province is related to the higher productivity of factors such as mechanization and land in these provinces. Finally, the methods of using these factors in productive provinces, along with technical and specialized regional guidelines, can facilitate the improvement of productivity in less productive provinces.

***Keywords*—**Clustering, Irrigated wheat, Iran, total productivity.

I. Introduction

WHEAT (*Triticum aestivum*) is one of the most important agricultural crops in the world, which has played a role in providing food security and has been strategically important. This crop has even been used as a political tool in international relations at some points in history. Currently, this crop occupies about 16% of the world's crop area and directly feeds more than 35% of the world's population [6]. In Iran, due to the fact that about 50% of people's daily energy [18] and about 40% of the country's food security depend on wheat [12], this crop has always played a strategic role in the country's policies. According to the information of the Iranian Statistics Center, in the agricultural year of 2020-2021, about 40% of the exploitations, 61% of the area and 19% of the agricultural production of the country were dedicated to this crop [3]. Despite the position of this strategic crop in various aspects of planning, statistics show that the productivity of wheat production in Iran is very low. In other words, the resources allocated for the production of this crop have not been used well in the country [12]. The significant difference between the average yield of wheat in Iran and the global average and some regional countries clearly shows this issue. The average yield of this crop in the country has been reported as 2019 kg.ha^{-1}, while the global average is 4759 kg per hectare and the average of Saudi Arabia, Pakistan, Turkey and Iraq is 6511, 2793, 2744 and 2721 kg.ha^{-1}, respectively [11]. This issue, along with the limitation of available water resources and the increasing demand of the growing population, requires the issue of increasing production and improving the productivity of this crop (yield per unit area) to be considered with more emphasis than in the past in the country's macro plans. Although the increase in wheat production as a strategic commodity has always been included in various development programs of Iran, the analysis of statistics shows that this increase has been less affected by the improvement of productivity. For example, it was predicted that at the end of the 6th five-year economic-social and cultural development plan of the country (2016-2020), wheat production should reach 14.5 million tons [24]. Statistical analysis showed that, although the area under wheat cultivation in this period increased from 4.5 to 7.6 million hectares and its production increased from 13.3 to 13.5 million tons, but the increase in production is mainly due to the productivity of the land factor, not the increase in yield per unit area, which is considered an indicator of productivity improvement. The yield of wheat in this period not only did not increase but also decreased from 2643 (in the crop year of 2017-2018) to 2255 kg.ha^{-1} (in the crop year of 2018-2019) [3].

According to economic literature, productivity is the ratio of the output unit to the input unit, which is divided into two total and partial categories in a general division. Partial productivity is the ratio of the value or amount of output to the value or amount of a specific input, and the total productivity is the ratio of the value or amount of all outputs to the sum of the value or weighted amount of all inputs used in the production of outputs [4]. Normally, partial productivity is calculated more than total productivity in economic surveys due to the simplicity of calculations and also being more understandable by non-experts. Of course, economists believe that because this index, on the one hand, pays too much attention to what human management can do to increase production, and on the other

Hassan Masoumi* and Rashed Alavi are with Department of Agriculture and Economic-Social, Yekom Consulting Engineers, No 133. Baradaran Mozaffar St, Vali-e-Asr Sq. Tehran, Iran. P.O Box 14167 (*corresponding author, e-mail: Masoumi_hassan118@yahoo.com, Hassan.masoumi@yekom.com).

hand, it pays less attention to the increase in production resulting from the more effective use of other factors of production, so it should be analyzed along with the total productivity index in planning [17].

Various studies have been conducted at the national and international levels regarding the partial and total productivity indices of wheat production, some of the most important of which are mentioned below. In a study, the total productivity of wheat production factors due to the use of different levels of technology as well as improving the efficiency of inputs in the three northern provinces of the country (Gilan, Mazandaran and Golestan) were analyzed, and it was shown that the changes of this index in Golestan Province were more influenced by the changes in technology levels, and in Gilan and Mazandaran has been affected by improving in efficiency of consumption inputs [1]. Esmaili and Sadeghi in their study about the total productivity of wheat production factors in the selected cities of Ilam Province during the period of 2013-2018 showed that the size of the farm had a positive and significant effect on the total productivity of production factors [7]. Examining the changes in the productivity of the total factors in the wheat crop in China and in the period of 1980-2018 also showed that the use of new technologies (improved seeds, new irrigation systems, suitable planting dates, etc.) will increase the productivity more compared to the use of inputs in higher amounts [25].

In Iran, wheat is cultivated and produced in both irrigated and rainfed methods in almost all provinces of the country, but about 70% of its production is related to the irrigated production method [3], which due to difference in environmental conditions and also difference in methods of using production inputs, have different efficiencies [19], [21]. According to the mentioned issues, studies with the aim of calculating and analyzing of wheat productivity indices (total and partial) in different provinces of the country were entrusted to YEKOM consulting engineers by the Islamic Development Bank and under the supervision of the Agricultural Planning Economic and Rural Development Research Institute (APERDRI). The present article is a part of the aforementioned studies focusing on blue wheat.

II. Material and Methods

A. Partial Factor Productivity

Partial productivity is shown by the average production of the considered factor. Partial productivity is defined as (1). In this formula, AP_i is the productivity of the ith factor, Q is the amount of production, "i" is the amount of input consumed during production. If there are more inputs in the production process, the partial productivity of other inputs is also calculated according to the above procedure [5].

$$AP_i = \frac{Q}{i} \tag{2}$$

B. Total Factor Productivity

There are parametric (econometric) and non-parametric approaches to measure productivity in subjects similar to this research. In the parametric approach, first the production function or cost is estimated, and then a variable representing technological changes is entered into the estimated model. How the technological variable affects the production level can indicate a change in productivity or technological progress. In the non-parametric approach, the productivity measure is performed by calculating the index number. The use of this method requires the calculation of the input quantity index and output quantity index. A variety of numerical indices are used to calculate productivity, among which the TORNQVIST (Translog) index was used in this research. This index has appropriate flexibility and has been introduced as one of the best indicators of productivity calculation in various researches [16]. The mathematical form of this index is used as follows [22]:

$$Q_T(P^0, P^t, y^0, y^t) \equiv \prod_{i=1}^{n} \left[\frac{y_i^t}{y_i^0} \right]^{\frac{1}{2}(R_i^t + R_i^0)} \tag{2}$$

$$R_i^t = \frac{P_i^t \times y_i^t}{\sum_{i=1}^{n} P_i^t \times y_i^t} \tag{3}$$

The components of the above relationships are: Q_T: a quantitative index of the TORNQVIST-Theil; P^0 and P^t product price in years zero and t; y_i^t, y_i^t: The share of the ith product from the total revenues of years zero and t; P_i^t و y_i^t : The amount of i-th product in years zero and t; $\prod_{i=1}^{n}$: Multiplication sign.

In (3), the average of shares of each year with the shares of the base year was used as a weight for summation. The weights were calculated based on the share of each income from the total income of the company. The inputs index is also defined as the output index. With the difference that instead of product quantity, input quantity was placed and instead of product price, input price was placed. In order to enable a more accurate analysis, the geometric mean was taken from the productivity indices calculated in different years according to the area and resources used, and the averages were analyzed.

C. Used Information Resources

In this research, the information of "Provincial Questionnaires of Production Costs in the Period of 2014-2018" which was prepared by the Ministry of Jihad Agriculture was used [15]. The received information included the amount of consumption of various types of inputs, the amount of production of main and subsidiary products, costs, incomes, and the area of production operations. Since the land size information was also included in these questionnaires, it was possible to classify and calculate general and partial productivity indices by different exploitation scales. In order to categorize the exploitations, first the average area under wheat

cultivation in each province was calculated and then the scope of the largest and smallest exploitation in each province was determined. In the following, the average was taken from the upper and lower limits of the exploitations, and the cultivation levels lower than the average were considered as small-scale exploitations. Lands whose area was larger than the average multiplied by two were selected as large-scale exploitations. Medium-scale lands were also determined between the two upper limits of small-scale lands and the lower limit of large-scale lands. After determining the scale range of exploitations, the consumption of inputs, production amount, costs and incomes were calculated in each of the scales and finally, the productivity indices were calculated. Table I shows the number of questionnaire samples by scales of exploitation in different provinces and in the period of 2014-2018.

TABLE I
SPECIFICATIONS OF THE SAMPLES USED TO ESTIMATE THE PRODUCTIVITY OF WHEAT PRODUCTION FACTORS

Province	Scale of Exploitation	Range of Exploitation	Number of Samples					
			2014	2015	2016	2017	2018	Sum
Eastern Azerbaijan	Small	(< 1.28)	83	82	79	92	78	414
	Medium	(1.28-5.09)	110	72	80	83	75	420
	Large	(> 5.09)	21	7	11	7	12	58
Western Azerbaijan	Small	(< 1.95)	92	51	44	56	66	309
	Medium	(1.95-7.8)	97	82	96	82	87	444
	Large	(> 7.8)	12	21	22	26	19	100
Ardabil	Small	(< 3.22)	52	34	57	28	53	224
	Medium	(3.22-12.85)	44	17	11	17	19	108
	Large	(> 12.85)	6	3	3	8	0	20
Esfahan	Small	(< 1.92)	162	189	220	229	206	1006
	Medium	(1.92-7.66)	136	104	75	90	107	512
	Large	(> 7.66)	42	28	36	38	49	193
Alborz	Small	(< 6.77)	44	34	28	27	26	159
	Medium	(6.77-27.06)	16	5	4	8	15	48
	Large	(> 27.06)	8	9	8	7	5	37
Ilam	Small	(< 10.94)	40	44	38	43	46	211
	Medium	(10.94-43.73)	22	18	23	15	20	98
	Large	(> 43.73)	7	9	8	14	14	52
Bushehr	Small	(< 2.83)	7	10	10	10	10	47
	Medium	(2.83-11.3)	18	14	14	14	15	75
	Large	(> 11.3)	1	2	2	2	5	12
Tehran	Small	(< 7.84)	104	105	111	98	95	513
	Medium	(7.84-31.36)	57	50	44	57	79	287
	Large	(> 31.36)	30	18	18	29	18	113
Chaharmahal and Bakhtiari	Small	(< 1.24)	44	82	70	75	61	332
	Medium	(1.24-4.93)	52	37	48	49	42	228
	Large	(> 4.93)	17	14	19	13	14	77
Southern Khorasan	Small	(< 1.9)	104	150	103	128	136	621
	Medium	(1.9-7.59)	67	78	48	54	47	294
	Large	(> 7.59)	23	10	12	16	10	71
Khuzestan	small	(< 17.12)	297	260	274	271	271	1,373
	Medium	(17.12-68.46)	167	149	170	162	162	810
	Large	(>68.46)	68	81	55	49	48	301
Zanjan	Small	(< 3.1)	18	21	24	27	26	116
	Medium	(3.1-12.38)	12	9	17	12	8	58
	Large	(>12.38)	5	2	4	4	7	22
Khorasan-e-Razavi	Small	(< 3.47)	463	457	476	463	468	2327
	Medium	(3.47-13.87)	122	112	106	95	86	521
	Large	(> 13.87)	71	47	81	110	44	353
Northern Khorasan	Small	(< 3.2)	56	60	69	68	54	307
	Medium	(3.2-12.77)	44	32	28	31	33	168
	Large	(> 12.77)	10	11	16	15	14	66
Semnan	Small	(< 3.68)	83	80	92	95	98	448

Province	Scale of Exploitation	Range of Exploitation	Number of Samples					
			2014	2015	2016	2017	2018	Sum
	Medium	(3.68-14.7)	50	39	44	53	46	232
	Large	(> 14.7)	19	21	21	20	18	99
Sistan and Baluchestan	Small	(< 2.22)	229	230	223	241	180	1103
	Medium	(2.22-8.85)	125	130	114	116	83	568
	Large	(> 8.85)	53	53	58	50	42	256
Fars	Small	(< 3.8)	251	292	263	215	244	1265
	Medium	(3.8-15.19)	285	238	241	240	239	1243
	Large	(> 15.19)	83	63	60	55	50	311
Qazvin	Small	(< 8.44)	37	51	48	42	45	223
	Medium	(8.44-33.76)	22	17	21	25	20	105
	Large	(> 33.76)	12	8	10	11	9	50
Qom	Small	(< 8.06)	10	10	5	6	9	40
	Medium	(8.06-32.24)	4	1	1	2	3	11
	Large	(> 32.24)	2	1	1	1	1	6
Kurdistan	Small	(< 1.69)	22	18	21	24	25	110
	Medium	(1.69-6.76)	21	22	28	27	24	122
	Large	(> 6.76)	10	4	6	6	6	32
Kerman	Small	(< 2.5)	173	264	230	237	207	1111
	Medium	(2.5-9.99)	53	49	44	48	57	251
	Large	(> 9.99)	41	34	40	42	27	184
Karmanshah	Small	(< 2.71)	13	42	58	60	71	244
	Medium	(2.71-10.82)	23	37	50	49	62	221
	Large	(> 10.82)	12	11	16	19	8	66
Kohkiloyeh and Boyer Ahamad	Small	(< 1.99)	32	21	20	25	26	124
	Medium	(1.99-7.96)	47	30	29	25	21	152
	Large	(> 7.96)	9	5	8	5	9	36
Golestan	Small	(< 6.41)	79	111	114	206	116	626
	Medium	(6.41-25.61)	52	38	43	90	35	258
	Large	(> 25.61)	26	14	11	30	11	92
Lorestan	Small	(< 2.08)	38	59	41	67	57	262
	Medium	(2.08-8.32)	20	39	50	27	30	166
	Large	(> 8.32)	8	9	16	14	17	64
Mazandran	Small	(< 7.27)	18	16	49	103	59	245
	Medium	(7.27-29.07)	3	1	5	11	5	25
	Large	(> 29.07)	0	10	4	15	3	32
Markazi	Small	(< 2.37)	83	67	69	66	59	344
	Medium	(2.37-9.46)	42	42	29	28	50	191
	Large	(> 9.46)	22	12	18	27	20	99
South of Kerman	Small	(< 3.33)	86	64	245	57	43	495
	Medium	(3.33-13.31)	69	31	281	51	40	472
	Large	(> 13.31)	17	10	64	13	14	118
Hormozgan	Small	(< 4.39)	23	21	25	19	19	107
	Medium	(4.39-17.56)	15	19	18	20	18	90
	Large	(> 17.56)	7	8	7	7	6	35
Hamadan	Small	(< 2.95)	34	38	34	39	37	182
	Medium	(2.95-11.78)	38	31	43	41	46	199
	Large	(> 11.78)	7	8	11	17	13	56
Yazd	Small	(< 0.94)	123	127	127	128	112	617
	Medium	(0.94-3.76)	127	67	59	53	64	370
	Large	(> 3.76)	32	25	18	18	16	109
Whole Iran	Small	-	**2900**	**3090**	**3267**	**3245**	**3003**	**15505**
	Medium	-	**1960**	**1610**	**1864**	**1675**	**1638**	**8747**
	Large	-	**681**	**558**	**664**	**688**	**529**	**3120**

D.Conversion of Cost Information of Mechanization and Water Consumption into Quantitative Indicators

In the investigated questionnaires, instead of information on the amount of mechanization and water consumption, the costs related to these inputs were recorded. For this reason, a "quantitative index" of these inputs was calculated based on the cost of each hour of machine operation and the price of the product. For this purpose, information from Iran Statistics Center (including the price and cost of agricultural services in rural areas of the country, price index of machine services for one hectare) was collected. Then, the mentioned information verified using expert opinions and field surveys, and the price index of machine services in the period of 2014-2018 for one hectare of wheat. Then the mentioned information was verified using expert opinions and field surveys and finally the price index of machine services (for each hectare of wheat) was calculated in the period of 2014-2018. 2017 was considered as the base year. In the following, using the mentioned price index, a "quantity index of machinery use" was made. For this purpose, the cost of the machines of each sample was divided by the price index and the price index of the machines was extracted. Since, according to the law of fair distribution of water, "water price" is a function of the crop price, therefore, the price index of the crop during the statistical period under review is calculated and by dividing the water price by the water price index, the quantitative water consumption index is calculated.

E.Cluster Analysis

Cluster analysis is a mathematical tool for grouping observations with the similarity value of one or more variables. In these methods, observations that are more similar to each other are placed in a group or cluster. In other words, cluster analysis is dividing the observations into homogeneous groups so that the observations of each group are similar to each other and the observations of different groups are the least similar to each other [23]. There are different techniques for clustering observations. In this article, the "Ward" method was used, which is one of the highly efficient hierarchical clustering methods. Cluster analysis in this research was done in SPSS software (Ver. 21).

III.Results and Discussion

A.The Scale of Exploitations

Based on the information presented in Table I, about 27372 samples were examined in the period of 2014-2018 in three exploitation scales (small, medium and large). Of these, 15505 samples (equivalent to 56.6% of all samples) are assigned to small scale, 8747 samples (equivalent to 32% of total samples) to medium scale, and 3120 samples (equivalent to 11.4% of total samples) to large-scale exploitations. Also, from the total number of examined samples, 5541 samples (20.2%) for 2014, 5258 samples (19.2%) for 2014, 5795 samples (21.2%) for 2015, 5608 samples (20.5%) to 2016 and 5170 samples (18.9&) were related to 2018. According to the information in this table, the minimum area of exploitation regarding irrigated wheat has fluctuated between 0.02 and 0.05 hectares in the years under review. The maximum area of the farms in question has fluctuated between 500 and 938 hectares in statistical years. The average size of the farms in question has fluctuated between 8.2 and 10.1 hectares in different years. As can be seen, the index of exploitation area was different in different provinces. Therefore, the information provided by the questionnaires covered a significant variety of climates, political divisions, and exploitation size and provided the possibility of proper statistical analysis.

B.Total Factor Productivity (TFP)

In Tables II to IV, the average of Total Factor Productivity of irrigated wheat in the period of 2014-2018 is presented according to the scale of exploitation and province. Based on the information in these tables and in the country as a whole, with the increase in the size of exploitations, the average productivity of the total factors of irrigated wheat production increased. The average of this index in small, medium and large-scale lands was 1.08, 1.40 and 1.69, respectively. The analysis of Table I showed that the range of changes in this index were different among the provinces of the country. For example, in small-scale exploitations, the range of productivity changes was variable between 0.79 (Sistan and Baluchestan Province) and 1.52 (Northern Khorasan Province), and in medium scales between 0.95 (Kermanshah Province) and 2.06 (Chaharmahal and Bakhtiari Province). Also, in large-scale exploitation, this index was variable between 0.95 (Kermanshah Province) and 2.57 (Zanjan Province).

Based on the clustering done, the provinces of the country were grouped into five, six and four clusters, respectively, in terms of this index in small, medium and large exploitation scales (Tables II-IV).

Based on the tables, on the scale of small exploitations, Northern Khorasan, Zanjan, Chaharmahal and Bakhtiari Provinces, on a medium scale, Chaharmahal and Bakhtiari Province, and on a large scale, Zanjan, Chaharmahal and Bakhtiari, Kohkiloyeh and Boyer Ahmad and North Khorasan Provinces, had allocated themselves the highest productivity of all production factors among the provinces of the country. This shows that these provinces have made the most use of inputs resources for the production of irrigated wheat in the mentioned exploitation scales. It is noteworthy that Chaharmahal and Bakhtiari Province in all three exploitation scales, and Zanjan and Northern Khorasan Provinces in small and large exploitation scales were placed in cluster one (group including provinces with the highest productivity index of total factors of production). Therefore, in a glance and without analyzing the partial productivity of production factors, the production methods of irrigated wheat in these provinces can be considered as a model for other provinces of the country.

The obtained results are consistent with the results of some researches. For example, Khiavi and their colleagues aimed at analyzing the growth of the total productivity of sugar beet production factors in Iran using the Malmquist Index showed that this crop had a positive growth in the total productivity of the production factors and technology changes have improved

the total productivity [14]. Garshasbi and Dadashi compared the technical, allocation, and economic efficiency of irrigated wheat in different provinces of the country during 2000-2009 and showed that the highest and lowest technical efficiency was in Kermanshah and Eastern Azerbaijan Provinces, allocative efficiency in Kermanshah and Western Azerbaijan Provinces, and economic efficiency in Kermanshah and Western Azarbaijan Provinces [10]. In another research with the aim of analyzing regional differences in the productivity of the agricultural sector with the data coverage analysis approach, while calculating wheat productivity indices during the years 1999-2000 to 2003-2004, has shown that there were significant differences between the provinces from aspect of total productivity factors [2]. Fathi and Zibai in their research with the aim of investigating the convergence of productivity growth of wheat crop in six provinces of Khorasan, Tehran, Fars, Kerman, Khuzestan, Esfahan, using TORNQVIST-Theil index, showed that the growth of productivity had large fluctuations in the studied provinces and they have not converged in the short term, but in the long term, the productivity difference between the provinces will decrease and convergence occur. Therefore, it is possible to use the fairly same policy in the long term for the wheat crop [9].

C.Partial Factor Productivity

In this section, the average partial productivity index of wheat in the period under review was analyzed in the context of factors such as mechanization, land and water in different provinces of the country and at different scales of exploitation (Tables II-IV). In the following, the analysis of the mentioned tables is presented separately for each factor.

D.Mechanization Factor

The productivity of the mechanization factor was different in the examined exploitation scales. In general, as the exploitation scale increased, the numerical value of this index also increased (1.29, 1.33 and 1.42 in small, medium and large exploitation scales, respectively). In the clustering done and in small, medium and large exploitation scales, the country was divided into six, five, and six groups, from an aspect of this factor. In all three scales of exploitation, Zanjan, Tehran and Mazandaran Provinces had the highest productivity in term of mechanization factor. Considering that Zanjan province was in the top cluster in terms of total productivity index, it can be concluded that one of the reasons for this was the high productivity of this province in the use of machinery (Tables II-IV). In research that was conducted with the aim of investigating the effects of mechanization levels on total productivity in the lands of agro-industrial companies in China, it was shown that the improvement of mechanization can promote the planting Green Total Factor Productivity significantly. Also, with the improvement in the mechanization level, the promotion effect of mechanization on planting GTFP will become clearer [26]. In another study, which was conducted with the aim of investigating the effects of different levels of mechanization on the productivity of farms in the north of the country, it was shown that improving the levels of this factor improves farm productivity through the replacement of labor [20].

3.Land Factor

The results showed that the productivity index of the land factor was also higher in large-scale lands than the other two exploitation scales. The numerical index of this factor in small, medium and large scales of exploitation was 1.11, 1.22 and 1.30, respectively. Among the provinces of the country and on the scale of small exploitation, the provinces of Zanjan, Chaharmahal and Bakhtiari, on the medium scale, the provinces of Chaharmahal and Bakhtiari and Kurdistan, and on the scale of large exploitation, the provinces of Zanjan, Kurdistan, Khorasan-e-Razavi, Chaharmahal and Bakhtiari have used from this factor better than other provinces of the country in order to produce irrigated wheat. Among the mentioned provinces, Chaharmahal, Bakhtiari and Zanjan are also in the top cluster in terms of total productivity index. The review of references also confirms the role of the land factor in enhancing the productivity of wheat production. For example, Fallahinejad and their colleagues in their research aimed of investigating the effect of farm size on the sustainability of wheat production in the fields of Jovin region (Khorasan-e-Razavi Province) and reported that “as the farm size increased from small to large, the energy yield ratio and energy investment ratio increased by 11.11% and 101%, respectively, while the unit energy value, renewable energy ratio, energy investment ratio, and environmental sustainability index decreased by 27.31, 50.61, 45.45, and 18.65%, respectively” [8].

2.Water Factor

Based on the calculations, the average productivity of the water factor increased with the increase in the exploitation scale. The value of this index in small, medium and large scales was calculated as 1.24, 1.38 and 1.57, respectively. Among the provinces of the country and in small-scale lands, the provinces of Northern Khorasan, Qazvin, Hormozgan, Fars, Esfahan, Khorasan-e-Razavi and Southern Khorasan and in medium and large-scale lands, Northern Khorasan Province had the highest productivity of water factor and was ranked in the top clusters (Tables II-IV). In a research conducted with the aim of analyzing the productivity of irrigated wheat production resources in the provinces of Iran, it was shown that the provinces of Mazandaran, Ilam and Hormozgan had the highest water productivity [4].

IV.Conclusion

Wheat is one of the strategic crops of Iran which the food basket of households is highly dependent on its products, and a significant subsidy is allocated to it by the government every year. For this reason, improving productivity in the cultivation of this crop is one of the essential issues for sustainable economic development in the country. In this article, the total and partial productivity of irrigated wheat in the country was analyzed by province and exploitation scales. Based on the obtained results, even though irrigated wheat is cultivated and produced in almost all provinces of the country, but the efficiency of using its resources is different in different

provinces. According to the obtained results, although irrigated wheat is cultivated and produced in almost all provinces of the country, the efficiency of using resources to produce this crop is different in various provinces. In the country as a whole, the total productivity of production factors showed a direct correlation with the scale of exploitations, so that with the increase in the scale of exploitations, the total productivity also increased.

In the small-scale of exploitations, Northern Khorasan, Zanjan, Chaharmahal and Bakhtiari Province got the highest total productivity index with better use of production resources. The adaptation of the clustering of total and partial productivity indices showed that among the above provinces, Zanjan had more appropriate use of machinery, land and water factors at the same time and was placed in the best cluster compared to other provinces. Mazandaran, Khorasan-e- Razavi and Kerman Province were also in the second cluster in terms of productivity and better use of production resources. On the other hand, the provinces of Hamadan, Eastern Azerbaijan and Sistan and Baluchestan had the lowest total productivity among different provinces. The main reason for the low total productivity in these provinces is the lack of optimal use of factors, such as machinery and land. According to the information of the Iranian Statistics Center, the average land size in about 70% of the lands under water wheat cultivation in the country is less than 3 hectares. In other words, wheat cultivation in the country is mainly done in small-scale lands and in the form of small and peasant exploitation system. For this reason, encouraging less productive provinces to use factors such as machinery, land and water, similar to productive provinces, along with improving investments and clarifying technical guidelines for each region, can improve productivity and will also cause enhancing the country's food security regarding this strategic product.

In the scale of medium exploitations, Chaharmahal and Bakhtiari Province had a higher total productivity than other provinces, and from this point of view, it was placed in the top cluster.

TABLE II
TOTAL AND PARTIAL PRODUCTIVITY OF WHEAT PRODUCTION FACTORS ON A SMALL EXPLOITATION SCALE BY PROVINCE

Province	Total Productivity		Labour		Mechanization		Land		Water	
	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*
Northern Khorasan	1.52	1	1.16	4	1.42	3	1.19	2	2.39	1
Zanjan	1.48	1	2.11	1	1.75	1	1.54	1	1.13	2
Chaharmahal and Bakhtiari	1.46	1	1.74	2	1.40	3	1.42	1	0.93	3
Tehran	1.33	2	1.17	4	1.63	1	1.12	2	1.28	2
Yazd	1.33	2	1.36	3	1.47	2	1.23	2	1.20	2
Semnan	1.27	2	1.20	4	1.47	2	1.18	2	1.26	2
Fars	1.26	2	1.19	4	1.46	2	1.09	2	1.47	1
Kohkiloyeh and Boyer Ahamad	1.25	2	1.46	3	1.21	4	1.17	2	0.89	3
Qom	1.24	2	1.45	3	1.42	3	0.90	4	1.12	2
Bushehr	1.22	3	0.86	6	1.51	2	0.95	4	1.20	2
Ardabil	1.21	3	1.23	4	1.49	2	1.02	3	1.16	2
Khorasan-e- Razavi	1.19	3	1.08	5	1.37	3	1.24	2	1.43	1
Mazandran	1.17	3	1.13	4	1.57	1	1.06	3	0.39	4
Golestan	1.15	3	1.12	4	1.45	2	1.14	2	0.90	3
Southern Khorasan	1.15	3	0.95	5	1.22	4	1.08	2	1.40	1
Hormozgan	1.15	3	0.79	6	1.34	3	1.04	3	1.55	1
Qazvin	1.14	3	0.78	6	1.24	4	1.03	3	1.64	1
Ilam	1.11	3	1.66	2	1.37	3	1.09	2	0.80	3
Markazi	1.11	3	1.05	5	1.40	3	1.01	3	1.16	2
Western Azerbaijan	1.11	3	1.06	5	1.31	3	1.09	2	0.86	3
South of Kerman	1.09	3	1.21	4	1.24	4	1.19	2	1.04	2
Esfahan	1.08	3	0.91	5	1.12	5	1.00	3	1.46	1
Khuzestan	1.08	3	0.93	5	1.14	5	1.09	2	1.14	2
Kerman	1.03	4	0.79	6	1.20	4	1.10	2	1.30	2
Lorestan	1.01	4	0.84	6	1.26	4	1.01	3	0.95	3
Alborz	0.99	4	1.19	4	1.32	3	1.12	2	0.59	4
Kurdistan	0.94	4	0.94	5	1.11	5	1.09	2	0.47	4
Karmanshah	0.89	4	0.67	6	1.11	5	1.06	3	1.01	2
Hamadan	0.83	5	0.67	6	1.01	6	0.97	4	0.86	3
Eastern Azerbaijan	0.82	5	0.49	7	1.23	4	1.10	2	1.06	2
Sistan and Baluchestan	0.79	5	0.46	7	0.94	6	0.95	4	1.12	2
Whole Iran	1.08	-	0.93	-	1.29	-	1.11	-	1.24	-

*Provinces with common numbers are located in a cluster. number 1; indicates the number of the cluster with the highest productivity. As the number of clusters increases, the provinces located in them are in clusters with lower productivity.

TABLE III
TOTAL AND PARTIAL PRODUCTIVITY OF WHEAT PRODUCTION FACTORS ON A MEDIUM EXPLOITATION SCALE BY PROVINCE

Province	Total Productivity		Labour		Mechanization		Land		Water	
	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*
Chaharmahal and Bakhtiari	2.06	1	5.40	1	1.33	3	1.70	1	1.06	4
Northern Khorasan	1.83	2	2.42	3	1.50	1	1.34	2	2.70	1
Kohkiloyeh and Boyer Ahamad	1.76	2	4.24	2	1.09	4	1.36	2	0.84	4
Zanjan	1.61	3	5.09	1	1.61	1	1.47	2	1.10	4
Yazd	1.52	3	1.89	3	1.33	3	1.26	3	1.26	3
Southern Khorasan	1.47	3	1.92	3	1.24	3	1.12	4	1.40	3
Tehran	1.46	3	1.64	3	1.71	1	1.17	3	1.37	3
Semnan	1.45	3	1.86	3	1.55	1	1.29	3	1.38	3
Kerman	1.45	3	2.39	3	1.37	2	1.37	2	1.56	2
Kurdistan	1.44	3	3.72	2	1.39	2	1.67	1	0.45	5
Khorasan-e- Razavi	1.39	4	1.69	3	1.46	2	1.46	2	1.65	2
Markazi	1.36	4	2.23	3	1.47	2	1.15	4	1.27	3
Fars	1.35	4	1.46	4	1.47	2	1.11	4	1.56	2
Mazandran	1.34	4	1.87	3	1.55	1	1.07	5	0.26	5
Qom	1.32	4	2.01	3	1.43	2	1.23	3	1.64	2
Ardabil	1.31	4	1.79	3	1.54	1	1.12	4	1.28	3
Esfahan	1.30	4	1.91	3	1.11	4	1.03	5	1.46	3
South of Kerman	1.28	4	1.74	3	1.38	2	1.32	2	1.13	4
Western Azerbaijan	1.25	4	2.03	3	1.26	3	1.04	5	0.84	4
Golestan	1.25	4	1.63	3	1.53	1	1.21	3	0.93	4
Qazvin	1.22	5	1.14	4	1.32	3	1.14	4	1.74	2
Hormozgan	1.21	5	1.03	4	1.38	2	1.10	4	1.60	2
Lorestan	1.20	5	1.87	3	1.30	3	1.12	4	1.06	4
Alborz	1.14	5	1.56	3	1.40	2	1.26	3	0.54	5
Ilam	1.07	6	1.83	3	1.30	2	1.19	3	0.92	4
Khuzestan	1.06	6	1.02	4	1.08	4	1.07	5	1.07	4
Eastern Azerbaijan	1.05	6	1.30	4	1.05	4	1.01	5	1.04	4
Sistan and Baluchestan	1.01	6	1.42	4	0.85	5	0.96	5	1.21	3
Hamadan	1.00	6	1.93	3	1.14	4	1.14	4	0.91	4
Bushehr	0.99	6	1.09	4	1.01	4	0.76	6	1.05	4
Karmanshah	0.95	6	1.35	4	1.02	4	0.97	5	1.10	4
Whole Iran	1.40	-	2.03	-	1.33	-	1.22	-	1.38	-

*Provinces with common numbers are located in a cluster. number 1; indicates the number of the cluster with the highest productivity. As the number of clusters increases, the provinces located in them are in clusters with lower productivity.

In small-scale exploitations, this province was placed in the top cluster due to the more appropriate use of production factors. The high total productivity in Chaharmahal and Bakhtiari Province and in the medium exploitation scale was mainly due to the better use of labour and land factors. After this province, Northern Khorasan, Kohkiloyeh and Boyer Ahmad were placed in the second cluster. Among the provinces located in this cluster, the partial productivity index regarding machinery, land, and water was estimated to be higher in Northern Khorasan than in other provinces of the country. This province had the highest water productivity index on the scale of small exploitation. In other words, in this province and in both small and large exploitation scales, less water has been used to produce one kilogram of wheat. The provinces of Ilam, Khuzestan, Eastern Azerbaijan, Sistan and Baluchestan, Hamadan, Bushehr and Kermanshah were also included in a cluster that had the lowest total productivity index due to the lack of optimal use of resources such as machinery, land and water.

On the scale of large exploitation, the top provinces were almost the same provinces that were in the top cluster in two scales of small and medium exploitation. In this exploitation scale, the provinces of Zanjan, Chaharmahal and Bakhtiari, Kohkiloyeh and Boyer Ahmad and Northern Khorasan were placed in the top cluster with more appropriate use of production factors and allocating the highest total productivity indicies to themselves. Among these provinces, Chahar Mahal and Bakhtiari had better use of production resources than other provinces in all three scales and were always in the top cluster. This province was in the top cluster in terms of labour factor productivity on all three scales. Northern Khorasan Province, which had the highest water productivity index in the other two exploitation scales, has produced its wheat in exchange for less water consumption than other provinces in this scale as well. On the other hand, the provinces of Hamadan, Eastern Azerbaijan and Sistan and Baluchestan always had the lowest total productivity index in the production of irrigated wheat in the country. In these provinces, the partial productivity index in terms of factors such as mechanization and land was mostly lower than other provinces in the country.

TABLE IV
TOTAL AND PARTIAL PRODUCTIVITY OF WHEAT PRODUCTION FACTORS ON A LARGE EXPLOITATION SCALE BY PROVINCE

Province	Total Productivity		Labour		Mechanization		Land		Water	
	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*	Mean of Index	Number of Cluster*
Zanjan	2.57	1	23.86	1	2.10	1	2.09	1	1.45	3
Chaharmahal and Bakhtiari	2.49	1	14.58	2	1.29	4	1.88	1	1.06	4
Kohkiloyeh and Boyer Ahamad	2.31	1	16.85	2	1.19	5	1.84	1	0.88	5
Northern Khorasan	2.23	1	5.05	4	1.72	2	1.50	2	3.10	1
Kerman	1.82	2	6.57	3	1.54	3	1.69	1	1.80	2
Mazandran	1.81	2	6.91	3	1.81	2	1.14	3	0.32	6
Khorasan-e- Razavi	1.79	2	3.08	4	1.81	2	1.89	1	2.08	2
Semnan	1.59	3	2.27	4	1.56	3	1.41	2	1.36	3
Southern Khorasan	1.58	3	2.45	4	1.12	5	1.21	3	1.46	3
Qom	1.56	3	2.43	4	1.72	2	1.38	2	1.89	2
Esfahan	1.55	3	3.52	4	1.29	4	1.28	3	1.71	2
Yazd	1.54	3	2.46	4	1.15	5	1.25	3	1.29	3
Western Azerbaijan	1.52	3	4.23	4	1.39	4	1.06	3	0.81	5
Markazi	1.52	3	3.80	4	1.55	3	1.25	3	1.32	3
Kurdistan	1.48	3	6.74	3	1.35	4	2.01	1	0.40	6
Tehran	1.47	3	2.37	4	1.78	2	1.20	3	1.32	3
South of Kerman	1.41	3	2.62	4	1.35	4	1.38	2	1.23	3
Fars	1.40	3	1.82	4	1.48	3	1.11	3	1.56	3
Bushehr	1.31	4	1.11	4	1.48	3	1.05	3	1.27	3
Alborz	1.30	4	2.63	4	1.55	3	1.34	2	0.64	5
Qazvin	1.29	4	1.90	4	1.38	4	1.21	3	1.72	2
Lorestan	1.26	4	3.75	4	1.31	4	1.16	3	1.12	4
Golestan	1.25	4	2.80	4	1.49	3	1.09	3	0.95	5
Eastern Azerbaijan	1.24	4	3.45	4	1.20	5	1.14	3	1.24	3
Hormozgan	1.23	4	1.51	4	1.25	4	1.10	3	1.59	3
Khuzestan	1.20	4	1.93	4	1.18	5	1.19	3	1.13	4
Ardabil	1.18	4	2.22	4	1.40	4	1.20	3	1.39	3
Sistan and Baluchestan	1.17	4	2.10	4	0.93	6	1.08	3	1.26	3
Hamadan	1.15	4	3.98	4	1.24	4	1.20	3	0.88	5
Ilam	1.06	4	2.52	4	1.32	4	1.08	3	1.03	4
Karmanshah	0.95	4	1.75	4	1.01	6	0.98	3	1.13	4
Whole Iran	1.69	-	5.36	-	1.42	-	1.30	-	1.57	-

*Provinces with common numbers are located in a cluster. number 1; indicates the number of the cluster with the highest productivity. As the number of clusters increases, the provinces located in them are in clusters with lower productivity.

Finally, and according to the analysis done, it can be suggested the following in order to improve the productivity of the irrigated wheat production factors.

- Improving the technical knowledge and skills of wheat producers in different exploitation scales through the expansion of extensional programs in all provinces with high and low productivity (becoming knowledge-based of wheat production in the country);
- Paying attention to completing the circles of the wheat value chain in order to increase the competitiveness of its production with an emphasis on small-scale beneficiaries;
- Correct implementation of crop rotation according to the dominant technical system (wheat-oriented) in the country's agriculture sub-sector and taking into account spatial-geographical considerations, ecological capacity and principles of sustainable development (social acceptability, economic usefulness, environmental desirability);
- Creation of incentive schemes by the government to use the methods used in productive provinces by less productive provinces;
- Emphasizing the development of mechanization and the use of new machines by providing facilities in medium and large-scale lands;
- Guiding public investments in the direction of developing the use of new technologies in accordance with the dominant exploitation system of the agriculture sub-sector (small ownership) with a food security approach and providing the opportunity for investors to benefit;

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