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Technical, Allocative and Economic Efficiencies of Potato Production in Iran

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ABSTRACT: In this study technical, allocation and economic efficiencies of 22 potato producing provinces in Iran was investigated using data envelopment analysis approach. The Results showed that average technical, allocative and economic efficiencies were 0.98, 0.77 and 0.75, respectively. It was indicated that it had been possible to reduce the production cost by 25 percent The results identified that the consumption of seed, manure, herbicides, fungicides, nitrogen, direct labor and water was more than the optimal economic amount and insecticides and potash were used less than optimum amount. The results clearly indicated that the main problem in potato production of Iran was resource allocation, so by optimizing the input usage, the profit margin could be increased. The optimum use of seed, manure, herbicides, insecticides, fungicides, phosphates, nitrogen, potash, direct labor was calculated 2633.6 kg, 3.6 ton, 0.7 kg, 1.1 kg, 0.5 kg, 124.2 kg, 181 kg, 58 kg, 17 day-person and 7501762 Rials, respectively. It was expected that efficiency improving could reduce potato production cost about 15189913 Rials almost 22 present per hectare.

***Keywords*:** Technical Efficiency, Economic Efficiency, Optimal Allocation, Production Management

INTRODUCTION

The group of vegetables has a major share in Iranian agricultural sector production. In the period of 2014-2015, 17 million ton of agricultural production is attributed to this group and potato with 5 million ton had 29 percent of total vegetable production. According to the available information, 159321 hectare of agricultural land in Iran is allocated to potato production. Existing data shows that there is a significant difference in potato yield in different provinces of the country that varies from 13373 in Alborz province to 38140 ton per hectare in Kermanshah province (Jihad Agriculture Ministry, 2016). In addition to the differences in yields, how to allocate inputs to potato cultivation in country provinces is not the same, So that the total production cost fluctuates from 79614320 (East Azerbaijan) to 154333340 (Hamedan) Rials (Jihad Agriculture Ministry, 2017) per hectare. this research has been carried out to study the issue of production efficiency and consumption of inputs in relation to potato production in Iran.

Rafiee et al. (2011) investigated the efficiency of dairy farms in Guilan province using data envelopment analysis method. 32 industRials dairy farms were selected by cluster and data were collected through a questionnaire. The average technical efficiency of the units was 88.3%. These units have the ability to increase production by as much as 11.7% while maintaining the current level of inputs. Darijani (2011) studied the effective factors on the technical efficiency of broiler chickens in Gorgan province. For this purpose, the production function was estimated. The results showed that the average technical efficiency of semi-mechanized units was 57.66% and the possibility of increasing the product by using existing inputs and technology was possible. The survey showed that the technology score had a positive and significant effect on efficiency, so that a one percent increase in the technology score would increase 4.48 percent of the production. Amini Shal et al. (2012) evaluated the

efficiency of dairy cattle farms in south of Tehran province using a data envelopment analysis approach. Data was collected from 65 industRials dairy farms and the average technical efficiency level was calculated 93%. The potential for increase in yield by maintaining the current level of inputs was 7% on average in the units studied. Also, the average level of allocative and economic efficiency was 45% and 42%, respectively. The studied units had the potential to reduce production costs by as much as 55% and increase economic profit to 58%. Fathizadeh Golshani et al. (2012) evaluated the technical efficiency in Holstein cattle breeding units of Guilan province using data envelopment analysis. Information was collected from 20 Holstein cattle breeding units. The results showed that the average technical efficiency in the studied units was 72.6%. Which indicates that, on average, 27.4% of the current product could be increased without increasing the input level. Mohammadi (2012) used data envelopment analysis method to study the efficiency of greenhouse cucumbers in Fars province. The results of his study showed that with constant return to scale assumption, the average technical and allocation efficiencies of units were 74% and 93%, respectively. Also, the calculated technical efficiency range was greater than the allocation efficiency. The results of the research indicated that the economic efficiency in constant and variable returns was 69% and 72%, respectively. Ghorbani et al. (2013) showed that the average technical efficiency in dairy farms in Guilan province was 47.02 percent and the highest correlation coefficient between technical efficiency and daily gain was observed. Based on the results of this study, with the proper management, there was a possibility of increasing technical efficiency. The average technical efficiency in the experimental group was 60%, which is more than the control group with 33%. Based on the results of the study, technical efficiency was not affected by geographical location. Watkins et al. (2014) assessed the technical, allocation and economic efficiency of rice production in the state of Arkansas using data envelopment analysis. The results of the research showed that the farms were in the optimal level in terms of technical efficiency and the minimum inputs were used for the production of the product. The technical efficiency in constant and variable returns to scale, allocative efficiency, economic efficiency and scale efficiency were 0.803, 0.875, 0.711, 0.622, and 0.920, respectively.

MATERIALS AND METHODS

In a simple definition, efficiency is the output-to-input ratio. This ratio can be calculated at any level. Among different methods of measuring efficiency, data envelopment analysis method has a special place due to its greater flexibility. Data envelopment analysis uses linear programming method to estimate technical, allocative and economic efficiencies. Equation 1 shows the input-orientated situation with constant return to scale assumption (Coelli, 1997):

$$\begin{aligned} &\min \quad \alpha \\ &st \quad XL \le \alpha x_i \\ &\quad\quad YL \ge y_i \\ &I^T L = 1 \\ &\quad\quad L \ge 0 \end{aligned} \tag{1}$$

Where α is technical efficiency (TE), x_i is the input vector used by the i-th unit and is defined for each firm separately. The vectors of inputs used by different units make X matrix with $N \times K$ dimensions, in which K is the number of inputs used in the production process. To calculate the allocation efficiency, it is need to calculate the economic efficiency by equation 2:

$$\begin{aligned} &\min_{L, x_i^*} \quad w_i' x_i^* \\ &st \quad -y_i + YL \ge 0 \\ &\quad\quad x_i^* - XL \ge 0 \\ &I^T L = 1 \\ &\quad\quad L \ge 0 \end{aligned} \tag{2}$$

In Equation 2, w_i and x_i^* are input price and cost minimization use of inputs, respectively. Using these information, the economic efficiency of the units is obtained by equation 3:

$$CE = \frac{w_i' x_i^*}{w_i' x_i} \quad (3)$$

Where CE represents economic efficiency. Allocative efficiency is calculated by equation 4:

$$AE = \frac{CE}{TE} \quad (4)$$

Where AE represents the allocation efficiency (Coelli, 1997).

RESULTS AND DISCUSSION

Results showed that the average technical efficiency of 22 provinces was 0.98, which indicates the efficient use of inputs including seed, manure, herbicide, insecticide, fungicide, phosphate, nitrogen, potassium, direct labor and water, but the results of economic efficiency indicates that average score was 0.75. In other words, it is possible to reduce the production cost by 25%. With the separation of economic efficiency to allocation and technical efficiencies it was observed that a significant amount of surplus costs was due to allocation inefficiency, so that the index was 77% on average. Table 1 presents the technical, allocation, and economic efficiencies of the studied provinces.

Table.1 Technical, allocation and economic efficiencies

province	technical	allocative	economic
East Azerbaijan	1	0.65	0.65
West Azerbaijan	1	0.87	0.87
Ardabil	1	0.73	0.73
Esfahan	0.87	0.87	0.76
Tehran	1	0.80	0.80
Kerman, District of The South	0.87	0.73	0.64
Chaharmahal & Bakhtiari	1	1	1
Khorasan Razavi	1	0.84	0.84
North Khorasan	1	0.65	0.65
Khuzestan	1	0.75	0.75
Zanjan	0.85	0.94	0.80
Semnan	1	0.67	0.67
Fars	1	0.91	0.91
Golestan	1	0.67	0.67
Lorestan	1	0.67	0.67
Mazandaran	1	1	1
Hormozgan	1	0.71	0.71
Hamedan	0.90	0.74	0.67
Yazd	1	0.35	0.35
Kurdistan	1	0.73	0.73
Kerman	1	0.72	0.72
Kermanshah	1	1	1
average	0.98	0.77	0.75

As the results show only Esfahan, Kerman (District of The South), Zanjan and Hamedan do not have the full functionality from the technical point of view and only three of these 22 provinces have been economically efficient. Chaharmahal & Bakhtiari, Mazandaran and Kermanshah simultaneously have been operating optimally in terms of technical, allocative and economic efficiencies. The economic efficiency gap and the difference between the available amount and the optimum level depend on the unit performance in terms of technical efficiency and allocative efficiency. Technical efficiency is related to the use of inputs and, if less than one, indicates the lack of

optimal use of inputs. By comparing the existing level of inputs consumption and the optimal level (the minimum observed cost), the recommended consumption levels are reported by the units. The results indicate that in average the consumption of seed, manure, herbicides, fungicides, nitrogen, direct labor and water is more than the optimal economic and the largest gap is for seed by 850.3 kg excess usage. However, insecticides and potash are used less than optimum amount.

The results from efficiency analysis show that the main problem of potato production in Iran is resource allocation, so by optimizing, the profit margin can be increased. The average level of optimum use of seed, animal manure, herbicides, insecticides, fungicides, phosphates, nitrogen, potash, direct labor force are 2633.6 kg, 3.6 ton, 0.7 kg, 1.1 kg, 0.5 kg, 124.2 kg, 181 kg, 58 kg, 17 day-person and 7501762 Rials. In Table 2, the current composition, optimal composition and the required moderation in average values are proposed to improve the efficiency of the provinces under study, along with the required change percentage.

Table 2: Optimal usage of inputs in terms of mean in studied provinces

Input	Unit	Current	Optimal	Change (abs.)	Change (%)	Price (10Rials)	Cost (10Rials)		
							current	optimal	Change(abs.)
seed	Kg	3483.9	2633.6	-850.3	-24.4	1114.3	3882014.8	2934570.9	-947443.8
manure	Ton	5.2	3.6	-1.6	-30.8	69790.2	366081.2	253370.1	-112711.1
herbicides	Kg	1.2	0.7	-0.6	-44.8	38759.1	48184.6	26602.8	-21581.8
insecticides	Kg	0.8	1.1	0.3	38.9	35216.6	29213.8	40579.2	11365.4
fungicides	Kg	0.5	0.5	-0.1	-11.6	27847.1	14898.2	13164.1	-1734.1
phosphates	Kg	156.1	124.2	31.8	-20.4	999.6	156009.3	124177.4	-31832
nitrogen	Kg	273.8	181	-92.8	-33.9	761.8	208543.2	137866.3	-70676.9
potash	Kg	46.8	58	11.2	23.9	974.7	45656.2	56564.7	10908.5
Direct labor	Day-person	18.2	17	-1.2	-6.4	68536.9	1246874	1167433	-79440.5
water	10Rials	1026021.1	750176.2	-275845	-26.9	1	1026021.1	750176.2	-275844.9
Total (10Rials)							7023496.1	5504504.8	-1518991

CONCLUSION

the results show that the maximum and minimum expected reductions relative to the current consumption level of inputs are related to seed and fungicide, respectively. In terms of value, priority must be given to seed and water inputs. It is expected that improving economic efficiency can reduce potato production cost about 15189913 Rials per hectare in Iran. The results clearly indicate that it is not economically possible to provide a consistent instruction for all inputs.

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