

**Potato production efficiency in Samarkand region, Uzbekistan: A
nonparametric approach (DEA)**

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Abstract: Food security issues and its future expectations are becoming more strategic concern across the globe. Uzbekistan is the country that pursuing gradual reforms toward sustainable food security through its agricultural transition. In this regard, potato production is considered as one of sector for sustain supply of food consumption in the country. Nevertheless, the efficiency and productivity aspects are still remaining unknown. In this paper, we analyzed the technical efficiency of potato farmers using DEA approach. Results indicated the 0,72 and 0,81 efficiency scores under the CRS and VRS. This implying that potato producers able to minimize their production costs by 28% and 19% with the same production unit.

Keywords: Food security, potato production, technical efficiency, DEA

1. INTRODUCTION

To ensure food security in the republic, to develop consumption and seed potato production, expand cluster and cooperation mechanisms in the field of potatoes, and to further support the introduction of modern technologies by the state, as well as to meet the domestic market demand for potatoes and in order to satisfy the demand, the decision of the President of the Republic of Uzbekistan dated May 6, 2020, No. PD-4704 was announced¹. In this regard, the association of potato growers will create potato growing clusters and cooperatives in the districts specializing in potato growing based on innovative and resource-saving technologies and create a value chain for the industry, meet the population's demand for food and internal consumption. It was emphasized that important work should be done to increase the market demand, as well as to expand its export. In his speech at the 75th session of the UN General Assembly, the President paid special attention to the issue of food security and improving the living standards of the population. Consequently, the

¹ Decision of the President of the Republic of Uzbekistan No. PD-4704. "On measures to expand potato cultivation and further development of seed production in the republic" Tashkent, May 6, 2020

global pandemic has had a negative impact on the food and agriculture sector, as on all sectors. Even in developed countries, many problems have arisen in providing food to the needy population².

It should be noted that Uzbekistan has a worthy place in terms of food safety not only in the Central Asian region but also internationally. The fact that fruit and vegetable products are exported from Uzbekistan to more than 70 countries today is a clear confirmation of this.

In particular, according to the State Statistics Committee, in January-February 2022, Uzbekistan imported 122,400 tons of potatoes worth 21 million US dollars from 7 countries. It is noted that the import of potatoes has increased by almost 42,000 tons compared to the same period last year. In the first 2 months of 2022, Pakistan imported 91.3 thousand tons of potatoes to Uzbekistan, Kazakhstan - 12.6 thousand tons, Iran - 5.2 thousand tons, Russia - 4.4 thousand tons, Kyrgyzstan - 4.3 thousand tons, Afghanistan - 4 thousand tons, Belarus imported - 631.6 tons of potatoes (UzStat 2022).

Among the developed countries of the world, such as Belarus, Germany, the Netherlands, Russia, Turkey, and France, potato cultivation is considered a highly profitable industry, and the average net profit from 1 hectare is 6-7 thousand US dollars, and this indicator in the republic is 5-6 million. is only soum. For example, in India in the 1980s, 8.0-10 million tons of potatoes were developed, and by today 50 mln. producing about tons of potatoes, it ranks second in the world. In order to achieve such a high result, special attention was paid to the use of "in vitro" laboratory and aeroponic methods, specialization of areas, and state support programs were developed (Forbes G.A et al., 2020). Also, 100 percent of the difference between road and rail costs for product transportation, 25 percent for the purchase of equipment for seed production development, 50 percent for conducting training, and 50 percent of costs for chemical preparations and equipment will be covered. However, random sample surveys taken in potato-growing districts revealed that small farms do not even cover the costs of growing potatoes. Due to the fact that potato farms do not have in-depth knowledge and skills in seed potato production, the system of cultivation and preparation of high-quality potato seeds, which is required, has not been completely improved, and the potato-growing areas have not been fully specialized, as well as the insufficient integration between potato growers and science is one of the urgent issues of this field. . The experience of developed countries in the field of potato production shows that these countries annually adopt state programs to

² Speech of the President of the Republic of Uzbekistan Shavkat Mirziyoyev at the 75th session of the United Nations General Assembly

support potato farms in various forms.

In recent years, the issues of potato cultivation and its export have been one of the central issues in the socio-economic policy of Uzbekistan. Now the issues of improving the standard of living of the population and increasing their income, fully providing the population with food are closely related to potato production in ensuring food security. It is known that at the initiative of the head of our country, the potato production industry, which is considered one of the most important sectors of the economy of Uzbekistan, is being radically reformed at the new stage of reforms. Especially during the global economy after the current pandemic, the expected result cannot be achieved without ensuring food security, meeting the demand for potatoes in the domestic market, ensuring price stability of potatoes in the markets, and developing agro clusters and cooperatives that grow potatoes in order to achieve a specific goal. According to the data, by 2025, the goal is to increase the volume of the country's gross domestic product to 100 billion dollars, and annual export to 30 billion dollars. In order to achieve these indicators, it is necessary to use the available resources in the agricultural sector. At the same time, the economic analysis of the production efficiency of farmers and peasant farms operating in the network remains relevant.

2. MATERIAL AND METHOD

The strategy for the development of agriculture in the Republic of Uzbekistan for 2020-2030, approved by the head of our country, has defined important priorities for ensuring food security. It is very important to study potato production, which is an important branch of agriculture, and its role in the food industry. From this point of view, this article analyzed the technical efficiency of 72 potato-growing farms in the example Bulungur and Toylok districts, which are among the most advanced districts of the Samarkand region in terms of potato cultivation. In the course of the analysis, data from interviews with potato-growing farms and peasant farms based on the random selection in Bulungur and Toylok districts, as well as aggregated data from the Samarkand Regional Statistics Department, were used. The descriptive statistics of the variables is illustrated in table1.

Table 1. Summary statistics of employed variables in potato production

| Variables | Unit of measurement | Mean | Standard deviation | Minimum | Maximum |
|----------------------|---------------------|----------|--------------------|---------|---------|
| Output: | | | | | |
| Potato yield | kg/ha | 27941.78 | 741.463 | 17701 | 43500 |
| Inputs: | | | | | |
| Seeds | kg/ha | 38500.28 | 205.956 | 35000 | 45000 |
| Organic fertilizers | kg/ha | 25000.04 | 313.734 | 5000 | 40000 |
| Chemical fertilizers | kg/ha | 950.25 | 60.026 | 600 | 2400 |
| Labor | man-days/ha | 48.733 | 20.2473 | 37 | 63 |

The descriptive statistics table presents that potato farms having about 28 tons yield per hectare and it ranges from 17 tons at minimum and 43 tons at maximum. In addition, farmers applied about 25 tons of organic fertilizers (mostly manure) per hectare in order to increase the productivity per hectare.

There are several methods to analyze the technical efficiency. One of broadly used and well know nonparametric technique is Data Envelopment Analysis (DEA), based on linear programming as well as it widely used in order to measure the relative efficiencies of decision making units (DMU) with multiple inputs and/or multiple outputs (Coelli et.al 2002).

An input-oriented VRS DEA model is specified as follow for N Decision Making Units (DMU), each producing output by using K different inputs (Coelli, T. et al 2005).

$$\begin{aligned}
 & \min \quad \theta, \lambda, \theta \\
 & \text{Subject to} \quad -y_i + Y\lambda \geq 0 \\
 & \quad \theta x_i - X\lambda \geq 0 \quad (1) \\
 & \quad N1' \lambda = 1 \\
 & \quad \lambda \geq 0
 \end{aligned}$$

Where, θ is a scalar and $N1'$ is convexity constraint and λ is $N*1$ vector of

constant. Y and X represents an output and input matrixes respectively. The value of θ obtained will be the efficiency score of i -th decision-making unit. It will satisfy $\theta \leq 1$, with the value of 1 indicating a point on the frontier and hence technical efficient farm, according to (Farrell 1957) definition. This linear programming problem must be solved N times and one for each firm in the sample.6].

3. RESULTS AND DISCUSSIONS

An input-oriented DEA VRS model was utilized in order to calculate overall technical (TECRS) efficiencies of farmers engaged in potato production. Table 2 presents the performance of potato-growing farms in study area.

Table 2. Frequency distribution of technical efficiency scores of potato growing farmers in Data Envelopment Analysis (DEA)

| Efficiency scores | CRS | VRS | SE |
|--------------------|------|------|------|
| 1.00 | 4 | 11 | 16 |
| 0.90-1.00 | 10 | 19 | 42 |
| 0.80-0.90 | 20 | 21 | 10 |
| 0.70-0.80 | 23 | 11 | 3 |
| 0.60-0.70 | 10 | 10 | 1 |
| 0.50-0.60 | 5 | | |
| Mean efficiency | 0.72 | 0.81 | 0.92 |
| Minimum efficiency | 0.53 | 0.54 | 0.65 |
| Maximum efficiency | 1.00 | 1.00 | 1.00 |
| Standard deviation | 0.12 | 0.12 | 0.06 |

CRSTE = technical efficiency from constant return to scale DEA

VRSTE = technical efficiency from variable return to scale DEA

SCALE = scale efficiency = CRSTE/VRSTE

The calculated technical efficiency scores of potato farmers differ among sampled wheat farmers and ranging from 0.53 to 1.0. Accordingly, out of 72 potato farms, 4 farms under CRS and 11 farms under VRS were found fully efficient. Since, the highest technical efficiency achieved at score 1.0, model results can imply that, there is considerable room for increasing the technical efficiency with the current production inputs. The mean values of technical efficiency scores under CRS and VRS were found 0,72 and 0,81 respectively. This implying that potato producers able to minimize their production costs by 28% and 19% with the same production unit.

Moreover, the mean scale efficiency of farms is relatively high 0,92, while they are operating near to their optimal size. Therefore, we propose that farmers can improve their efficiency through reallocation of existing resources.

4. CONCLUSION

Uzbekistan has been implementing gradual reforms in order to ensure food security since its independence. In order to meet the demand of population for food products wheat and potato production were considered as main crops in agricultural sector. As results of policy reforms and implications, the cultivated areas and potato yield have been increased through the agricultural transition years. Nonetheless, the potato productivity is still remaining low and farmers are suffering from unstable yield due to lack of local varieties. In addition, the price of production resources is rising rapidly under the conditions of Covid-19 pandemic and world policy uncertainties worldwide. Therefore, we proposed to analyze the production efficiency of potato-growing farms considering those above mentioned conditions in so as to identify the effective resources allocation and increase the profitability of rural producers engaged in potato growing in Samarkand region.

The findings revealed that farms are performing on average efficiency scores of 72 and 81, while there is considerable room to minimize the amount of applied inputs with the same production unit or vice versa. Therefore, we suggest further studies must be conducted in order to explore the determining factor of production efficiencies of potato farmers in Samarkand region.

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