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Management in agriculture industries: ways to improve productivity in competitive markets

Abstract. Productivity in the agricultural sector is considered the main key to improving production and increasing the capacity of producers in this sector, and in the field of food security, paying attention to this pillar is of great importance; because, given the limited production resources in the agricultural sector, their optimal and sustainable use is essential to maintain or increase the level of production in order to achieve food security. In this article, while addressing the prerequisites and outputs of improving productivity in the agricultural sector, a dynamic model of the relationship between productivity and related effective and affected parameters, including raw materials, production, machinery and technology, supply chain, and sales system, has been presented. For this research, the agricultural industry of Central Asia (including Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan, and Tajikistan) was evaluated during the years 2020-2024 and various sectors of the agricultural industry were ranked using the Promethee method. The results show that the sales system has achieved the highest productivity, while raw materials and production are at the bottom of the ranking. The results also showed that with the expansion of technology in recent years, the need for development and productivity in this sector can greatly help other sectors of the agricultural industry.

Keywords: Agriculture; Agricultural Industry Productivity; Index Ranking; Promethee Method; Management; Economics; Central Asia; Producer; Agribusiness
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1. Introduction

One of the most important aspects of achieving food security is reliance on production from domestic sources, which has been emphasized in the upstream documents of the system, including the constitution and the general policies of the system in the agricultural sector (Zhou &

Tong, 2022; Irpan et al., 2023). However, this important principle has not been given due attention due to the lack of sufficient emphasis on improving production productivity in the agricultural sector, and as a result, meeting the food needs of the society has been faced with instability. This instability is caused by two major factors, namely «dependence on imports» and «threat to basic production resources», which have intensified over time and their consequences have overshadowed not only food security, but also the national economy. Therefore, improving productivity in the agricultural sector can be considered as the only principled solution in the current situation to reduce existing instabilities, through increasing production with optimal and sustainable use of domestic resources (Zia et al., 2022; Teixeira et al., 2024; Hussein et al., 2024). Achieving sustainable productivity in the agricultural sector requires a change in approaches and practices towards the optimal use of inputs and factors of production, including human resources, capital, and natural resources; in fact, what enables the country to achieve sustainable food needs of the entire society using domestic capabilities is the emphasis on productivity in agricultural production. Increasing productivity in agriculture has a prerequisite and a main output; the main prerequisite for increasing «productivity» is attracting «capital» and its main output is increasing the «competitiveness and attractiveness» of agriculture. After a period of relying on increasing capital and human resources as growth drivers, the economy of the agricultural industry is shifting towards an economy based on innovation and creativity, and economic growth can no longer be guaranteed by simply increasing the factors of production. In fact, as can be seen in Figure 1, from one stage onwards, innovation and creativity, which imply productivity growth, are the main drivers of economic growth, and the knowledge-based economy is the result of this change and transformation. However, the shift from economic growth based on production factors to economic growth based on innovation requires institutional changes in the structure of the economy and its redefinition. In this approach, the first step is to connect to global markets and make the macroeconomic environment competitive, which will also not be possible unless political structure avoids curbing the driving forces of market.

2. Brief Literature Review

Sustainable productivity in the agricultural sector is the optimal and sustainable use of existing resources in order to increase the production of agricultural products while maintaining the productive capacity of these resources. The breadth of dimensions related to the category of productivity and, on the other hand, the high importance of productivity in the sustainable

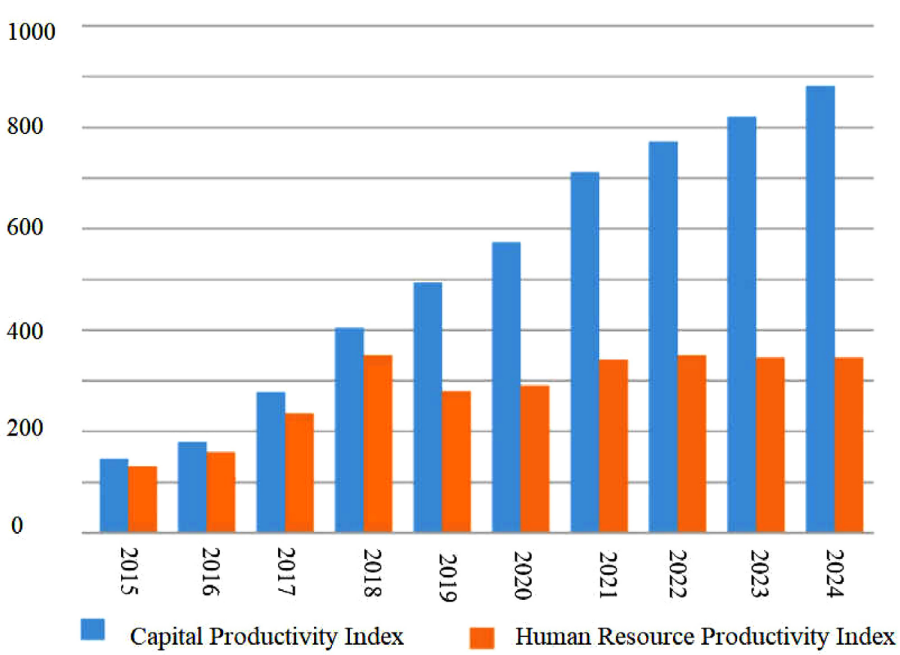

Figure 1:
Productivity shift from human resources in agriculture industry of Kazakhstan (2015-2024)
Source: Eurasian Research Institute:
https://www.eurasian-research.org/publication/agricultural-potential-of-central-asian-countries

increase of agricultural production have made achieving it one of the priorities of policymaking in the agricultural sector; so that in many laws and upstream documents, the issue of promoting agricultural production through improving productivity has been emphasized, and its main manifestation can be seen in the approval of the law on increasing the productivity of the agricultural sector and natural resources (Volyk et al., 2023). The most important shortcoming in the structure of the country's agricultural sector's production is its lack of proper reliance on knowledge and research and the continuation of traditional production methods, which has led to low production efficiency in this sector. In other words, whatever the problems of the agricultural sector, regardless of the impact of external factors, signs of low productivity due to the lack of a knowledge-based production approach can be found in it. These problems are evident in all stages before and after the production of agricultural products, such as the supply and consumption of inputs, production methods, harvesting, transportation, storage, distribution, conversion and consumption. So far, much research has been conducted on calculating and comparing the productivity of different companies and organizations in an industry, but comparisons between different industries have a more limited history, some of which are mentioned as: Huseynov et al. (2024) studied productivity growth in manufacturing industries; Raji et al. (2024) compared labor productivity in small and large industries; Furaijl et al. (2024) studied productivity trends in four major industries; Hemathilake & Gunathilake (2022) studied productivity changes in various countries around the world; Atsegeba et al. (2024) studied labor productivity in public and private sector industries; Dhande et al. (2024) also studied the productivity of large industries; Teixeira et al. (2024) conducted research on productivity indicators in different groups of industries based on novel technologies. In this article, to examine productivity in the agricultural industry and its improvement, different sectors of the agricultural industry have been ranked in terms of productivity in order to provide a basis for balanced growth and development in different sectors of the agricultural industry of central Asia, so that in addition to meeting domestic needs as an export factor of central Asia, it can play a strategic and economic role at international level.

3. Method

This research is an applied research in terms of its purpose and a descriptive survey correlational research in terms of its data collection method, which uses a decision-making model to estimate productivity in different sectors of the agricultural industry of central Asia. The data for this research were extracted from the Agriculture sector of Central Asia during the years 2020-2024 (Eurasian Research Institute data). Then, this data was ranked using the valuation matrix for productivity variables in the agricultural industry to determine and evaluate the impact and contribution of each of the variables of the agricultural industry sector in its productivity.

Productivity is the percentage of effective application of each factor of production, it can be said, the ratio of all tangible outputs to inputs. Therefore, productivity is expressed as the rate of the goods production (outputs), to one or more data (inputs) effective on the production of those goods. Inputs may be land, human labor, capital, energy, etc., and conversely, output is the total value of goods produced in an industrial unit during a given period. In simpler terms, productivity can be:

$$Productivity = Output / Total\ resources\ of\ production. \quad (1)$$

If only one type of input, such as human labor or capital, is included in the denominator of the above fraction, it is called partial productivity, such as labor or capital productivity. But if a set of inputs used in production are included in the denominator as a composite, it is called total productivity or total factor productivity.

The Promethee technique is among the most widely used methods in the field of multi-criteria decision-making. The Promethee method is easily able to use criteria with different measurement scales (without the need to match the criteria scales) and defines six separate functions according to the information and the criterion scale, so it is a strong point for the decision maker in multi-criteria decision-making, where the criteria usually have different measurement scales.

M is a set of options from which a choice must be made. Assuming that there are k criteria effective in decision-making for each option, $m \epsilon M$ is the value of $fj(m)$ indicating the value of the $-jth$ criterion in option m. In general, ranking with the help of this technique is done in three steps:

Step 1: Initially, a weight factor, namely wj, is considered for each indicator fj; then the preference function PJ is assigned to each of the criteria J. The value of $Pj(m, n)$ is calculated for each pair of options, this value varies between zero and one. If the relationship $(fj(m) = fj(n)$ holds, the value of $Pj(m,n)$ is zero, and with the increase of $fj(n) - fj(m)$ this value increases and when the difference becomes large enough, the value of $Pj(m,n)$ also reaches one. Figure 2 shows the first type preference function used in this study; based on this function, if the difference between two options m and n in the jth index is zero, the value of $Pj(m,n)$ is zero, and if this difference is greater than zero, the value of $Pj(m,n)$ is one.

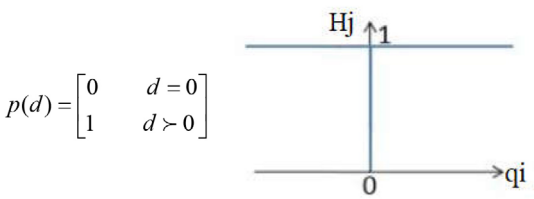

Figure 2:
Preference function
Source: Authors' findings

In the next ***Step 2***, the overall priority score $(\pi)m,n$ for each option m is calculated over option n. The higher the score $(\pi)m,n$, the more preferred option m is. $(\pi)m,n$ is calculated as equation 2:

$$\pi(m,n) = \sum_{i=1}^{k} WiPi(m,n), \qquad (\sum_{i=1}^{k} Wi = 1). \tag{2}$$

Then, $(\pi)m,n$ shows the degree of preference of option m over option n. To calculate the overall preference strength of option m over other options, the output stream is determined:

$$\phi^{+}(m) = \frac{1}{n-1} \sum_{x \in M} \pi(m,x). \tag{3}$$

This equation shows how much option m has priority over other options and this flow is actually the strength of option m (the largest means the best option). The degree of preference of other options over option m, which is called the input flow, is the result of the following calculation:

$$\phi^{-}(m) = \frac{1}{n-1} \sum_{x \in M} \pi(x,m). \tag{4}$$

This equation shows how much other options have priority over option a, and this equation is actually the degree of weakness of option m (the smallest means the best option). Therefore, by having and examining the two flows and separately, a partial ranking can be performed. To perform a complete ranking of options, the net ranking flow must be defined for each option (Promethee type 2):

$$\phi(m) = \phi^{+}(m) - \phi^{-}(m). \tag{5}$$

This equation is the outcome of the balance of positive and negative rating flows. A higher net flow indicates a superior choice.

4. Results

In line with the research objectives, this section attempts to identify and introduce the most important options and indicators required for the research problem. For this purpose, in the first step, the decision problem indicators were selected by reviewing the research background and

similar domestic and foreign studies and approved by experts and academic professors, and in the second step, the decision problem options were identified and analyzed from among the most important manufacturing industries in the country that had the highest added value in the statistics. Decision problem indicators: Various criteria have been identified and introduced as effective indicators in the productivity of manufacturing industries so far, of which six indicators: labor, energy, capital, total productivity, net profit margin and sales per capita were selected as the main indicators of the present study. The following are the most important reasons for this selection: the highest frequency in the review of research background and similar studies, approval by experts and academic professors, selection as the main indicators of productivity in the agricultural industry of central Asia, and the availability of accurate and reliable information about these indicators in the industries under study.

In this section, initially, information related to the average productivity indicators in different sectors of the agricultural industry of central Asia was extracted from the Productivity Management Center of the Agriculture sector (https://www.eurasian-research.org/publication/agricultural-potential-of-central-asian-countries), and then, with the help of the Promethee technique and Decision Lab software, the required calculations and analyses were performed. It is worth noting that the productivity growth rate in each sector of the agricultural industry (while adjusting for the inflation rate of each sector) was calculated. Then, with the help of the Promethee technique, the final ranking of the options was calculated (Table 1).

Table 1:
Agricultural industry productivity indicators in Central Asia

Variables	Labor	Capital	Energy	Total factor	Net profit margin	Sales per capita	ø
Raw materials (M1)	66.4	38.5	64.8	47.9	92.7	21.7	-0.23
Production (M2)	102.5	105.8	107.8	49.9	119.3	109.78	-0.01
Machinery & Technology (M3)	51.3	39.3	45.7	141.4	159	47	0.08
Supply chain M(4)	82.5	53.2	75.2	98.2	105.8	71.5	0.34
Sales system (M5)	179.7	189.3	202.0	182.7	154.9	258.1	0.52

Source: Authors' findings

The results obtained indicate the superiority of the sales sector (M5) in the total productivity indicators, while supply chain management, equipment and technology, and production obtained the next priorities in order. In the five-year process of examining productivity indicators, the sales sector has always had a better situation in the total indicators and has been assigned the first rank, and the raw materials sector has always obtained the last rank. Other sectors have also had an almost constant position during these years, despite small fluctuations. Table 2 shows the ranking of the options in the five-year process and the final rank obtained using the average rank method.

Table 2:
Ranking of various sectors of agricultural industry over the last 5 years (2020-2025) in Central Asia

Variables	2020	2021	2022	2023	2024	2025	Total
Raw materials (M1)	5	5	5	5	5	5	5
Production (M2)	2	4	2	2	4	4	3
Machinery & Technology (M3)	4	3	3	4	2	3	4
Supply chain M(4)	3	2	4	3	3	2	2
Sales system (M5)	1	1	1	1	1	1	1

Source: Authors' findings

The almost constant and similar priority of the options during these five years indicates a steady and uniform process of productivity growth in agricultural production industries, which needs innovation in the industry. Whilst the results show that the set of conditions governing the sales sector can be considered a suitable model for the progress of other sectors of the agricultural industry in productivity indicators.

5. Conclusion

Although in the current situation, the most important mission of the agricultural sector should be considered to be helping to achieve food security; however, it should not be overlooked that agriculture is an activity of an economic nature that also has a fundamental contribution to

poverty alleviation in the country, and it is essential that its role in the national economy and, conversely, the consequences of the country's favorable/inappropriate economic environment on this sector be considered in the analysis of the dynamics of factors affecting sustainable agricultural productivity. As a result of globalization and the expansion of consumer markets, a large volume of goods, services, and information is being moved in domestic and foreign markets, and the increase in the number of competitors and the intensity of competition between them has made competitiveness a key criterion for the success of enterprises, industries, regions, and countries in order to capture a greater share of the market. Because, competitiveness, due to looking at the opportunities ahead and creating a platform for increasing productivity and capturing a greater share of the market, better meets the strategic goals of political systems and the profitability of the agricultural industry based on an economic approach. In addition, the technical readiness of the agricultural industry and their agility and adaptability to new technologies - especially information and communication technology - can play a decisive role in increasing productivity and strengthening the competitiveness of the agricultural industry by increasing the accuracy, speed and quality of the production process of goods and eliminating additional steps in their supply process. Therefore, the present study aims to examine the effect of ranking technical factors on productivity, competitiveness and technology of the agricultural industry. The results obtained indicate the appropriate status of productivity indicators in the agricultural industry sales system sector, which has always had a good rank in productivity indicators and has undergone uniform growth. Therefore, it can be considered a suitable model for other sectors of the country's agricultural industry in productivity indicators. Meanwhile, the results of some comparisons show that despite the almost upward trend in productivity indicators of different sectors of the agricultural industry in the last five years, the raw materials sector has taken a downward trend and requires a serious review of concepts and productivity indicators with the help of appropriate models.

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