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Factors affecting the cost of grain transportion in Northern Kazakhstan

Abstract: The article considers the factors influencing the cost calculation for thegrain transportation in the conditions of Northern Kazakhstan. Grain production is the leading branch of agriculture in Kazakhstan. Therefore, it has great strategic importance in implementing priority state programs aimed at developing the agro-industrial complex and rural regions. In turn, the sustainable development of agriculture is the provision of the food security strategy of Kazakhstan.

The grain industry is costly due to substantial production volumes, the involvement of many human resources, technical support, and transportation.

Minimizing grain transportation costs by identifying factors affecting them will increase competitiveness and accelerate the development of grain logistics. When planning for harvesting and transporting grain, it is necessary to consider the peculiarities of transporting agricultural goods. Finally, implications for pricing, capacity, and understanding the basis of pricing are discussed.

Keywords: transportation costs, grain transportation, load capacity, cargo turnover, wheat, transportation, route.

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Introduction

Crop production is the basis of agriculture. Crops such as spring wheat, oats, barley, corn, millet, buckwheat, and rice are grown on the territory of the Republic of Kazakhstan.

The main branch of agriculture in Kazakhstan is the production of grain. To date, the total crops of grain occupy about 80% of the sown area of crops. At the same time, as seen in Figure 1, based on the data for three years (2019, 2020, 2021), the main areas for grain production are three regions of Kazakhstan: Akmola, Kostanay, and North Kazakhstan regions, which are adjacent to each other. These regions are distinguished by the presence of chestnut, black soil, forest loamy soils, and a temperate climate [1].

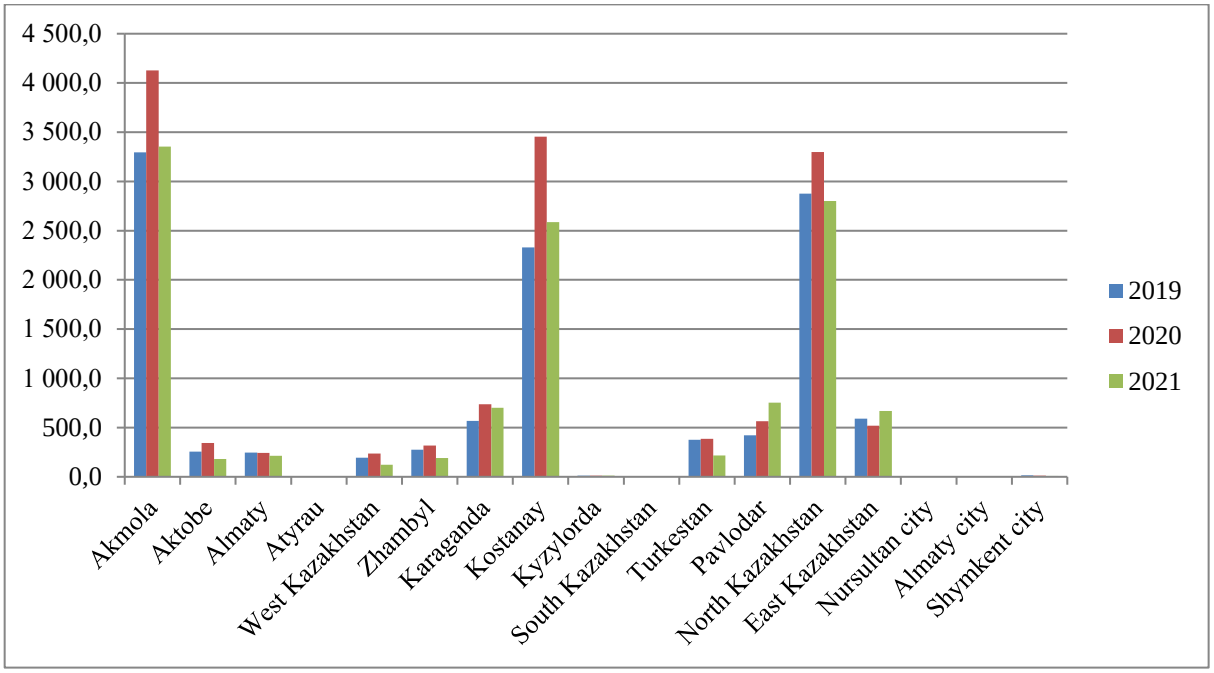

Figure 1. Gross grain harvest (wheat) for 2019-21

The average annual growth rate of gross crop production in the Republic of Kazakhstan for 2012-2020 amounted to 31.6%. In 2020, gross crop production reached 3,606 billion tenge, an increase of 27.9%. The share of crop production in the country's total GDP is 5.1% at the end of 2020. In 2020, investments in agriculture, forestry, and fisheries increased by 12.6% compared to the previous year, amounting to 573 million tenge. The average annual growth rate for the period 2016-2020 equal to 22.8% [1].

At the end of 2020, the main grain-growing regions: North Kazakhstan, Akmola, and Kostanay, sent 242 billion tenge to the industry, which amounted to 42% of the total agricultural investment, forestry, and fisheries. 88% of assets were directed to cultivating one- or two-year-old crops [1].

This amount of work implies a significant role of transport in agricultural production. As a link in a single technological agro-industrial output chain, it provides material flows of various farm products at all stages of production. In addition, it acts as an integrator of the production activities of agricultural, processing, and service enterprises [2].

Reducing the cost of agricultural products and increasing the profitability of enterprises of the agro-industrial complex is possible by reducing the total labor costs for production, transportation, and handling operations, which reach 40-45%, and fuel costs up to 50% [2].

The main tasks of vehicle transport used in the harvesting of grain crops are: timely and safe transportation of grain from specialized machines to granaries; creating conditions for the rational use of harvesting equipment, reducing downtime in the process of loading and unloading vehicles; ensuring traffic safety and fire safety; creating conditions for the introduction of advanced methods of organizing the work of the harvesting and transport process and, on this basis, reducing labor and material costs [2].

To solve the problems of uninterrupted provision of the harvesting and transport process by vehicles, it is necessary to take into account the yield of grain, the area of the harvested territory, the distance from the field to the granary, the number and technical characteristics of each harvester, as well as the carrying capacity of all vehicles involved in grain logistics [2].

Due to the emergence of software and hardware, it has become possible to increase the efficiency of harvesting and transport processes and improve harvesting technologies. So, for example, scientists studying transportation in agriculture found their specific features, the constituent elements of which are characterized by patterns inherent in the conditions of only this transportation. In addition, the operations that make up the transportation process are heterogeneous and differ in duration. Some operations, when combined, create certain stages of this process, each of which performs its tasks. Separate operations and

stages of the process depend on each other (for example, before transporting, it must be loaded, etc.). Thus, this process is multi-stage and multi-operational, with a considerable technological and economic heterogeneity of operations.

Moreover, it is cyclical. This means that the movement of goods is carried out by repeated production cycles, following one after another. The rhythm of these cycles is determined by their frequency, which, in turn, depends on the average duration of one cycle. The cycles of individual transportation processes fluctuate over time [3].

Other researchers solve the task of grain transportation logistics by determining the number of cars and start by assessing the volume of grain transportation from each specific field. Harvesting grain is inseparable from the transport process [2]. When harvesting grain crops, harvesters with storage bins are used, necessitating vehicles' uninterrupted arrival. Therefore, the determination of the required number of vehicles for the transportation of grain from combines must be carried out, taking into account the performance of the technological machine [2].

Thus, the main results of grain transportation research are the development of software products based on which various compilations and modeling of transport and technological processes are possible.

Problem statement

Grain production, as one of the main directions in the agricultural production of Kazakhstan, requires sustainable modernization. The concept "from field to counter" is a complex multi-stage system that includes many factors that affect both the quality of the final product and its cost. One of these factors is the transportation of raw materials.

The aim

The purpose of the study is to consider the features and factors that affect the cost of transporting grain in the conditions of Northern Kazakhstan.

Research methodology

One of the fastest way to increase the efficiency of the use of vehicle transport in agriculture is to improve the system for transporting crops from the fields.

Transportation of agricultural goods has a number of features:

- the main feature is the seasonality of harvesting;
- due to seasonality - significant fluctuations in the volume of traffic, which in turn leads to a change in the need for the number of vehicles;
- high coefficient of repetition of transportations;
- fluctuations in yield;
- uneven distribution of the volume of agricultural production in the regions of the country;
- sometimes severe road conditions, especially in spring and autumn;
- short terms of harvesting and its removal from the fields, which leads to the hard work of road transport.

Cereal crops are transported mainly in bulk. Vehicles are loaded with grain directly at the place of harvesting from the bunkers of combines that move across the field within a particular rectangle.

There are several transportation schemes:

1) harvester–threshing-floor - grain-receiving enterprise (elevator);
2) harvester - threshing-floor- elevator;
3) harvester – threshing-floor.

The need to deliver grain to the threshing-floors is because the main grain receiving points could

be overloaded due to the short harvesting time.

The choice of crop transportation scheme depends on the geography of the harvesting site, the distance to the elevator, and the availability of transport and harvesting equipment.

Also should be considered a factor as the presence of many small non-commercial farms. About 200 thousand agro-formations operate in the agriculture of Kazakhstan, of which 94% are individual entrepreneurs and peasant (farm) enterprises. Small farms mainly produce a small volume of agricultural products. In the structure of gross output, they account for 31%; on average, one peasant farm accounts for 6.9 million tenge.

Further, using the example of one of these medium-sized agro-formations, how the costs of grain logistics are formed could be considered.

Pobeda Taiynsha LLP is located in the North Kazakhstan region, Taiynshinsky district, Chermoshnyanka village. The sown area of the enterprise is 9 thousand hectares. The yield at the enterprise varies on average from 13 to 15 q/ha. On this farm, wheat is subject to transportation.

AkZhar&Co LLP is a grain-receiving enterprise located in the North Kazakhstan region, Taiynshinsky district, the village of Bolshoy-Izyum. It is engaged in accepting, handling, drying, storing, and shipping grain.

1. The average transportation radius is calculated by Formula 1:

$$\pi R^2 = \frac{S_0}{0{,}8} \cdot 1{,}5 \quad (1)$$

where R is the average radius of cargo transportation;

S_0 is the area of agricultural land, m^2;

0.8 - the average share of agricultural land in the area of land use;

1.5 - increase in the average distance of on-farm transportation due to the inadequacy of the territory, the curvature of roads, and the location of crop rotation fields [5].

2. The average distance from the farm to the elevator is 25 - 30 km.

The route for the transportation of grain crops in the direction of the enterprise - grain-receiving enterprise is shown in Figure 2.

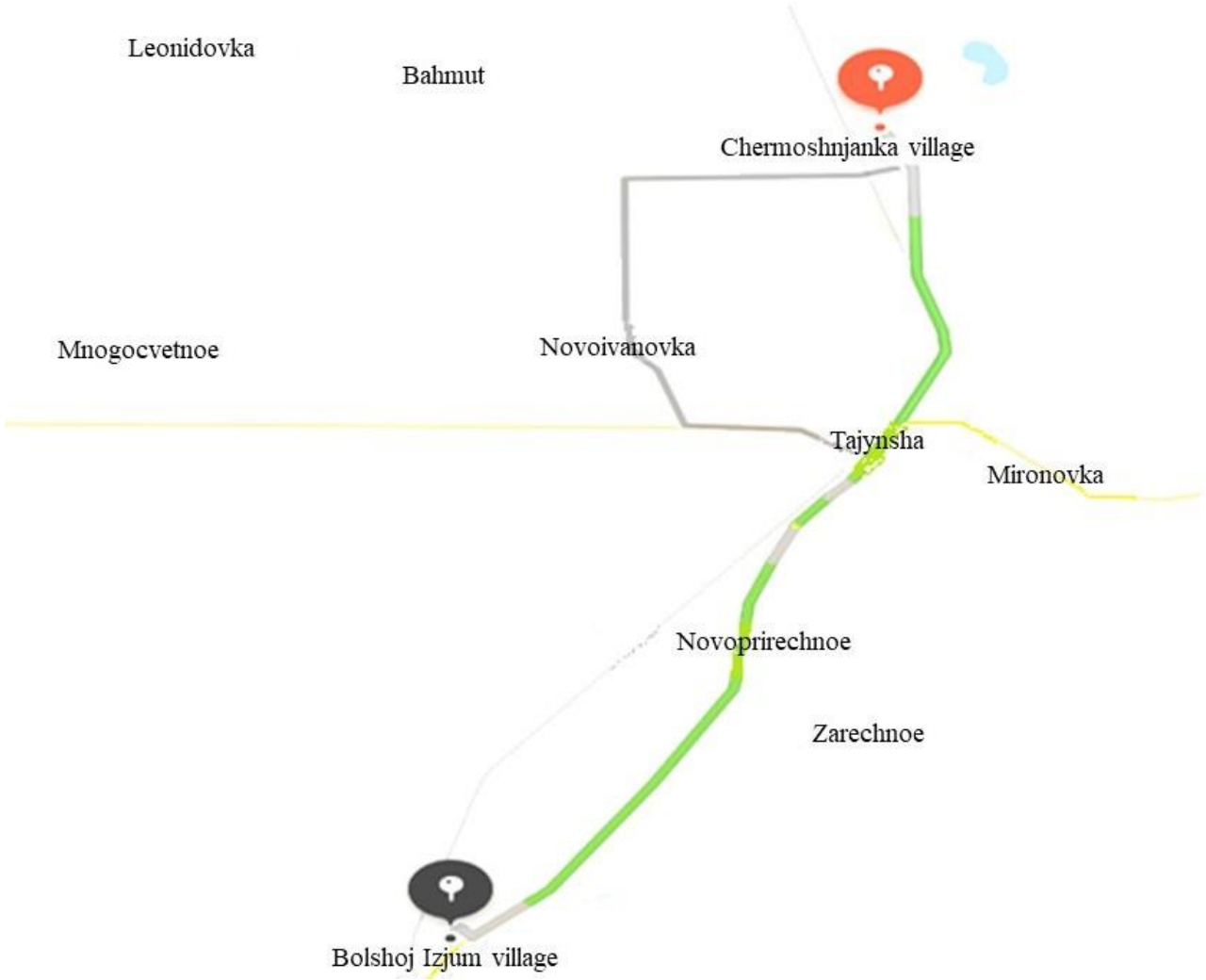

Figure 2. Wheat transportation route in the direction of grain-receiving enterprise in Tayynshinsky district

Compiled by the authors based on the source "Yandex maps".

3. Transport work could be carried out throughout the year, while from August to November and April-May, 60% of the total volume of transported wheat is produced.

4. There are three units of equipment for transporting grain on the farm: 1 dump truck Kamaz 45143-6012-50, carrying capacity of 22.4 tons; 2 dump trucks Kamaz 65115-6059-50 with a carrying capacity of 14.5 tons.

Transportation of grain in bulk from the enterprise is carried out by trucks of the Kamaz dump truck brand with an average service life of 8 years. However, since some vehicles have a carrying capacity of only 14.5 tons, this leads to an increase in the number of trips with a load.

According to the methodology used in the farms, the calculation uses the tariff for transporting one ton of grain per one kilometer of the distance traveled. The transportation tariff includes the costs of fuel and lubricants, drivers' salaries, and maintenance and repair of transport [6].

When transporting grain on the h-the model of a vehicle from the i-th field to the k-th temporary storage point, the economic costs are found by the Formula 2:

$$P_{ikh} = \mathrm{T}_{ikh} \cdot L \cdot Q_h, \text{tenge} \quad (2)$$

i=1,…;k=1,…; h=1,…,

where Tikh is the tariff for grain transportation in the unit of the h-th vehicle model from the i-th

field to the k-th temporary storage point, t/t·km;

L is the distance from the field to the storage point, km;

Qh is the carrying capacity of the h-th model of a vehicle, tonnes.

The tariff for the transportation of grain during the harvesting period in 2021 was 93 t/t·km, which is the average for the North Kazakhstan region, where it fluctuates between 80-100 t/t·km.

Results and discussion

Substituting the data in Formula 1, the following mathematical expression becomes:

$$R = \sqrt{\frac{1{,}25 \cdot S_0 \cdot 1{,}5}{3{,}14}} = \sqrt{\frac{1{,}25 \cdot 9000 \cdot 10000 \cdot 1{,}5}{3{,}14}} = 7330\ m$$

where 10,000 are square meters of 1 ha;

9000 - area of agricultural land, ha [5].

Thus, the average transportation radius of goods from the field: is r = 7.3 km.

The tariff for grain transportation in this case was equal to 96,1 t/t·km. For harvesting an area of 9000 hectares, the optimal number of combine harvesters for two weeks, considering the variation in yield, is 30 units.

$$P_1 = 96{,}1 \cdot 30 \cdot 14{,}5 = 41{,}803.5, \text{ tenge.}$$

$$P_2 = 96{,}1 \cdot 30 \cdot 22{,}4 = 64{,}579.2, \text{ tenge.}$$

Substituting these values into formula 2, we get that the economic costs of transportation from the farm to the grain-receiving enterprise amounted to 64,579.2 tenge when using Kamaz 45143-6012-50 (P_2) while using a Kamaz dump truck with a carrying capacity of 14.5, economic costs amount to 41,803.5 tenge (P_1). Thus, on average. The financial costs of transporting grain using all types of transport on the farm will be 53,000 tenge per 1 trip.

In the studies of many scientists, ways to improve the efficiency of grain production are analyzed. For example, some offer timely and high-quality fieldwork [6], and others reduce crop losses during the harvesting period, choosing the optimal plan for harvesting and transporting grain [5].

Since grain crops are distributed throughout the territory of Northern Kazakhstan, it is necessary to make zoning of the territory to identify the required costs and time for moving combine harvesters to the harvested fields, evenly load all available granaries, harvest various crops as they ripen [6].

As the main grain-growing regions, Akmola, North-Kazakhstan, and Kostanay regions need to be equipped with modern agricultural equipment, most of which is obsolete.

According to the Ministry of Agriculture of the Republic of Kazakhstan, agricultural machinery in Kazakhstan is outdated and worn out by 70%. The percentage of equipment renewal in this sector is 2-4%. At the same time, to ensure the industry's normal functioning, at least 8-10% of machines must be updated annually, depending on the types of equipment.

In turn, using worn-out and obsolete equipment increases the cost of repairs and fuels and lubricants by an average of 20%, which ultimately leads to an increase in the price of production. Furthermore, the depreciation of agricultural machinery also leads to severe crop losses and mechanical damage to grain during harvesting. Also, it prevents the use of innovative technologies in the grain industry of agriculture in modern Kazakhstan [8].

Conclusion

Ensuring sustainable and balanced development of agriculture is one of the priority areas of food security in Kazakhstan. Crop production is the basis of agriculture; in turn, grain production is Kazakhstan's leading branch of agriculture. Occupying 80% of the cultivated area of crops, the grain industry has large production volumes, requiring a large amount of service, particularly transportation

and, accordingly, the cost of it. The impact of transport costs on the competitiveness and sustainable development of agriculture is clear.

The transportation of agricultural goods has several features: seasonality of harvesting, a high recurrence rate of transport, fluctuations in yield, uneven distribution of the agrarian production volume across the regions of the country, sometimes difficult road conditions, short harvesting time, and its removal from the fields, which leads to hard work of transport.

Grain transportation also includes many variable factors that affect its cost, in addition to the following features: transportation volume, distance (average transportation radius), transport turnover, condition, number and carrying capacity of vehicles, grain transportation tariff, fuel and lubricants cost, methods and time loading-unloading.

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Солтүстік Қазақстан жағдайында астық тасымалдау құнына әсер ететін факторлар

Аңдатпа.Мақалада Солтүстік Қазақстан жағдайында астық тасымалдау кезінде көлік

шығындарын есептеуге әсер ететін факторлар қарастырылған. Астық өндіру Қазақстанның ауылшаруашылығының жетекші саласы болып табылады және мемлекеттің АӨК салаларын және ауылдық өңірлерді дамытуға бағытталған басым бағдарламаларын іске асыру мәселесінде стратегиялық маңызы бар. Өз кезегінде ауылшаруашылығын тұрақты дамыту Қазақстанның азық-түлік қауіпсіздігі стратегиясын қамтамасыз ету болып табылады.

Астық саласы өндірістің үлкен көлеміне, адам ресурстарының көп мөлшерін пайдалануға және техникалық қамтамасыз етуге байланысты, сондай-ақ тасымалдау қымбат болып табылады.

Астықты тасымалдау кезінде оларға әсер ететін факторларды анықтау есебінен көлік шығыстарын барынша азайту бәсекеге қабілеттілікті арттыруға және көлік логистикасын дамытуды жеделдетуге мүмкіндік береді. Астықты жинау және тасымалдау жоспарын жасау кезінде ауылшаруашылығы жүктерін тасымалдау ерекшеліктерін ескеру қажет.

Түйін сөздер: көлік шығындары, астық тасымалдау, жүк көтергіштігі, жүк айналымы, бидай, тасымалдау маршруты.

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Факторы, влияющие на стоимость перевозки зерна в условиях Северного Казахстана

Аннотация: В статье рассмотрены факторы, влияющие на расчет транспортных расходов при перевозке зерна в условиях Северного Казахстана. Производство зерна является ведущей отраслью сельского хозяйства Казахстана и имеет важное стратегическое значение в вопросе реализации приоритетных программ государства, нацеленных на развитие отраслей АПК и сельских регионов. В свою очередь устойчивое развитие сельского хозяйства является обеспечением стратегии продовольственной безопасности Казахстана.

Зерновая отрасль является затратной в силу огромных объемов производства, задействования большого количества человеческих ресурсов и технического обеспечения, а также транспортировки.

Минимизация транспортных расходов при перевозке зерна за счет выявления факторов, влияющих на них позволит повысить конкурентоспособность и ускорить развитие транспортной логистики. При составлении плана уборки и транспортировки зерна необходимо учитывать особенности перевозок сельскохозяйственных грузов.

Ключевые слова: транспортные расходы, перевозка зерна, грузоподъемность, грузооборот, пшеница, транспортировка, маршрут.

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