

лирует рост совокупного ВВП объединения; повышении эффективности и конкурентоспособности производства; повышении инвестиционной привлекательности за счет объединения рынков, свободного перемещения четырех факторов, повышения производительности и роста доходов в каждом государстве; ускорении темпов экономического развития. Положительными факторами ЕАЭС и СНГ является институциональная интеграция и макроэкономическая конвергенция.

#### Список цитированных источников

1. Зазерская, В.В. Внешнеэкономическая деятельность регионов Республики Беларусь в условиях трансграничного сотрудничества / В.В. Зазерская // Тенденции развития науки, образования и экономики в эпоху цифровизации: мат. Междунар. науч.-практ. конф., Липецк, 28 апр. 2022 г. – Липецк: ЛГПУ имени П.П. Семенова-Тян-Шанского, 2022. – С.91–94.

2. Растворцева С.Н., Лебедев А.О. Развитие методов оценки факторов и форм межрегиональной экономической интеграции: Монография. – М.: Изд-во «Экон-Информ», 2016. – 213 с.

3. Департамент статистики. – Режим доступа: [https://eec.eaeunion.org/comission/-department/dep\\_stat/](https://eec.eaeunion.org/comission/-department/dep_stat/). Дата доступа: 2.12.2022.

4. База данных «Статистика СНГ». – Режим доступа: <http://new.cisstat.org/>. Дата доступа: 1.12.2022.

## ABOUT SOME INFLUENTIAL ASPECTS ON THE POTENTIAL AND EFFICIENCY OF AGRICULTURAL PRODUCTION IN BELARUS

Igor L. Kovalev<sup>1,\*</sup>

<sup>1</sup> *Institute of System Research in Agro-industrial Complex of the National Academy of Sciences of Belarus, 220108, Republic of Belarus, Minsk, Kazinets street, 103;*

*E-mail: olbosigor@mail.ru*

*\* Author to whom correspondence should be addressed; E-mail: olbosigor@mail.ru*

### Abstract

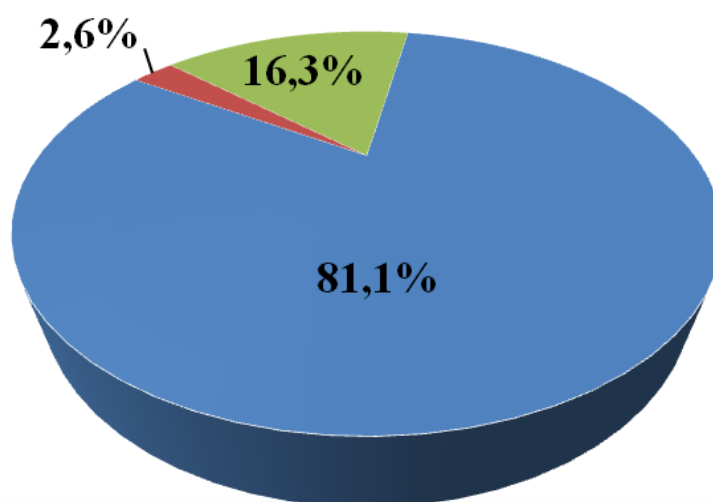
A number of important points and indicators that characterize the current state and potential of the Belarusian agricultural production are considered. The Republic of Belarus seriously lags behind the countries of Western Europe, North America, Japan, Israel and other developed countries in the innovative development of agriculture. The lag in innovative development was due to the underestimation over the past three decades of the progressive possibilities of new technologies and their insignificant introduction into agricultural production. Over the past decade, in the agricultural organizations of the republic, there has been a decrease in the indicator of energy capacity per 100 hectares of cultivated land for agricultural enterprises by 15%, and the indicator of energy capacity per employee of agricultural organizations during this time has increased by more than 1.4 times. Energy capacity indicators have a very significant and often decisive impact on the efficiency of agricultural production and the level of labor productivity in agricultural organizations. The agricultural production of Belarus lags behind developed countries in terms of equipping and using various elements of precision farming systems, satellite navigation and other multi-

functional modern flexible information systems. The main directions based on the innovative development of agriculture in the republic are presented.

**Key words:** Belarus, crop production, animal husbandry, production intensification, agricultural machinery, labor productivity, number of employees, costs, profitability, efficiency, digitalization.

### **Introduction**

To date, the basis of agricultural production in the Republic of Belarus is agricultural organizations of various forms of ownership. According to the National Statistical Committee of the Republic of Belarus, in the structure of all agricultural production in the country at the end of 2020, the share of agricultural organizations was 81.1%, farms – 2.6% and households – 16.3%, respectively (Figure 1).



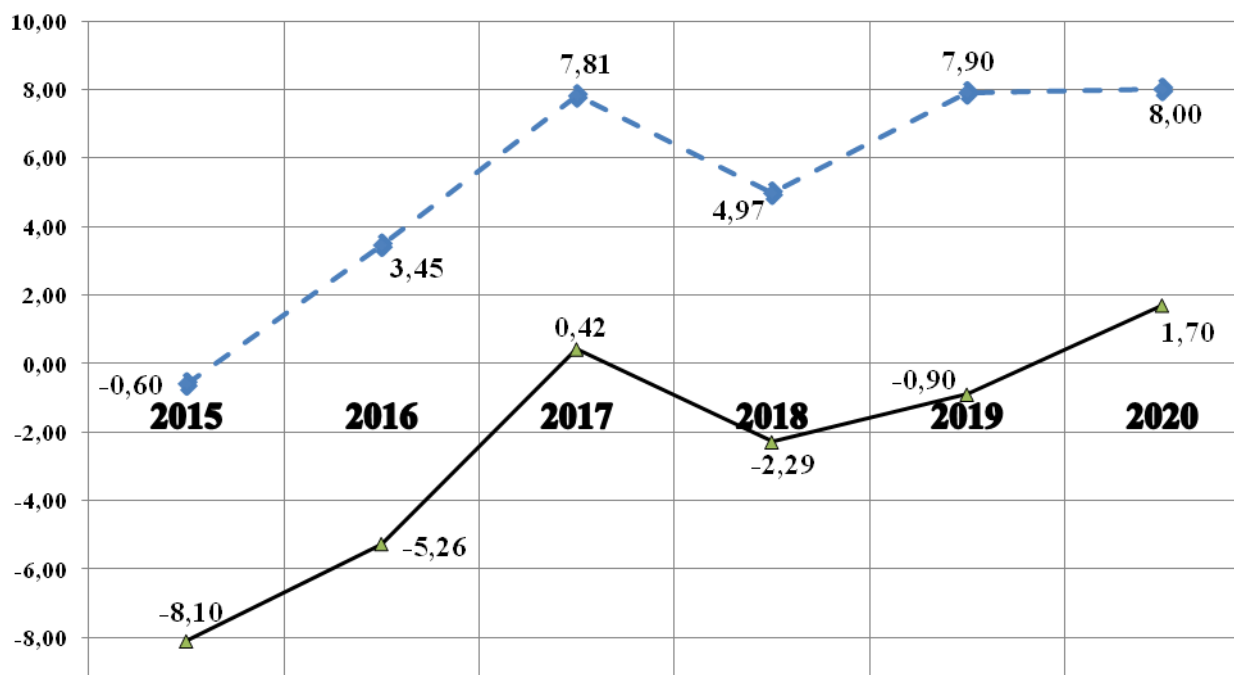
*Figure 1 – The structure of agricultural production in Belarus by categories of farms at the end of 2020 (as a percentage of total agricultural production; in current prices)*

Now, in the structure of all marketable agricultural products produced in the republic, the share of agricultural organizations can be estimated at up to 94-96%.

The agricultural production of Belarus is clearly dominated by an overwhelming majority, consisting of fully state-owned enterprises and organizations with a large share of state participation. According to the National Statistical Committee of the Republic of Belarus, at the beginning of 2021, the total number of agricultural enterprises with an area of agricultural land of 300 hectares or more and (or) the number of livestock and poultry in terms of a conditional livestock of 100 or more heads (except for micro-organizations and farms ) amounted to a total of 1382 enterprises in the republic, including organizations with state ownership and organizations with a share of state property – 887 (or 64.2% of the total), in turn, 968 (or 70% of the total number) enterprises are into the system of the Ministry of Agriculture and Food of the Republic of Belarus, most of these enterprises are either low-income or even unprofitable (52%), and without state support measures at the moment they are practically unviable.

Today, the most pressing problems of Belarusian agriculture still remain: extremely costly agricultural production and its very low efficiency. And despite the

constant and serious state support, in general, agricultural organizations of the republic still have a low level of profitability, which amounted to only 1.7% in 2020 (Figure 2).



*Figure 2 – Levels of profitability, taking into account state support (upper curve) and without it (lower curve) of all agricultural organizations included in the system of the Ministry of Agriculture and Food of the Republic of Belarus for 2015-2020 as of the end of each year*

The most important direction for the further development of Belarusian agriculture and the speedy achievement of an acceptable efficiency of agricultural production should be the intensification of this production based on the modernization of the production and technical base and the introduction of the latest achievements of scientific and technological progress.

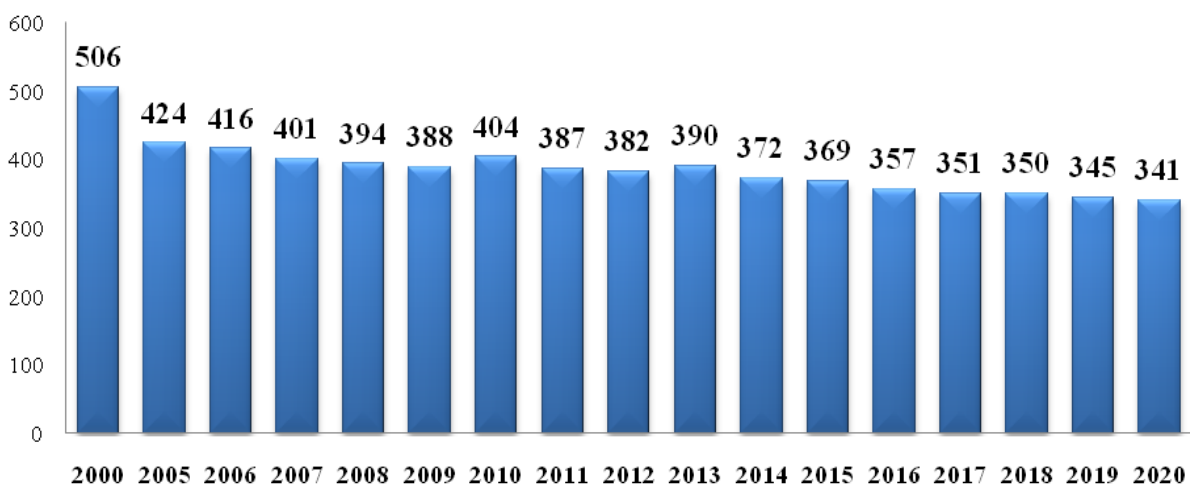
### **Formulation of the problem**

In the Belarusian agriculture over the past 20-25 years, various industrial large commodity forms of agricultural production have been actively developing. In general, during this period, the dominant directions and ways of intensifying domestic agricultural production were mainly associated with large agricultural production facilities.

One of the most important indicators that are used in the characterization and analysis of the processes of intensification of agriculture are indicators of the provision of agricultural enterprises with energy resources.

A universal indicator characterizing the provision of production with technical resources is the energy capacity in horsepower per 100 hectares of cultivated land. Its versatility lies in the fact that power capacities are understood as the totality of all technical resources of an enterprise with power: tractors, combines, other self-propelled equipment, power plants, milking machines, etc.

Figure 3 shows a diagram of the dynamics of energy capacities in horsepower per 100 hectares of cultivated land by agricultural enterprises in Belarus.



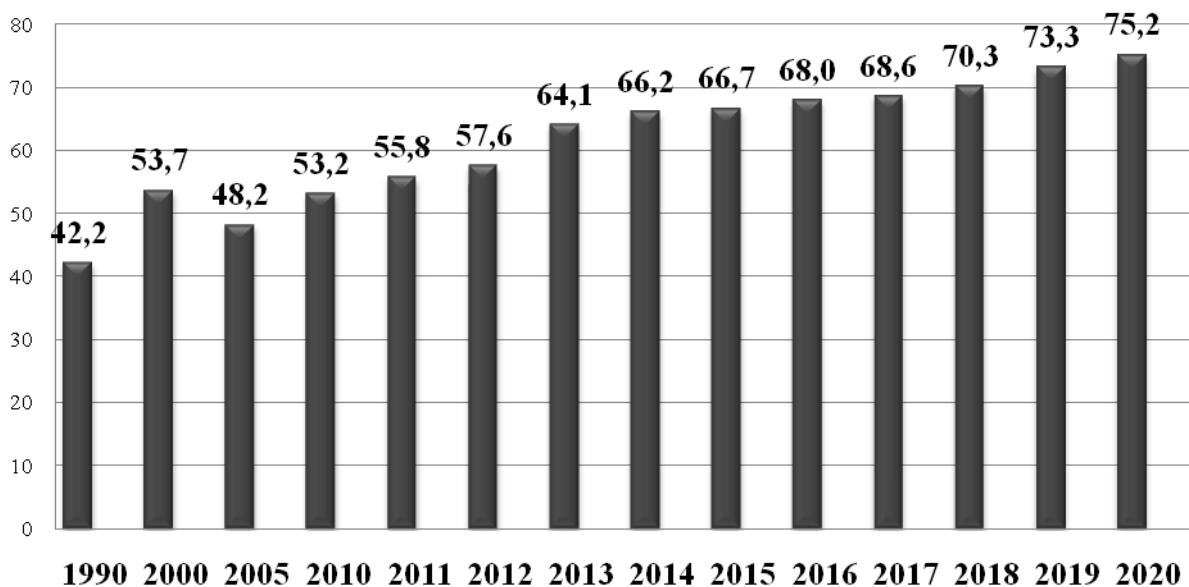
**Figure 3 – Energy supply of agricultural organizations of the Republic of Belarus as of the end of each year (compiled according to the data of the National Statistical Committee of the Republic of Belarus)**

According to the data presented in Figure 3, one can see a decrease in the provision of energy resources for agricultural enterprises in Belarus. Thus, the decrease in this indicator over the past decade in the period 2010-2020 amounted to 63 horsepower per 100 hectares of crops, or decreased by more than 15%. That is, for the period 2010-2020 the provision of energy resources decreased by 15.6% or an average of almost 1.6% per year, while the load over this period increased by 30% per 1 tractor per 1 combine harvester by 20%. This fact indicates an increase in the share of more powerful equipment in the machine and tractor park of the agro-industrial complex of the Republic of Belarus. Soil cultivation is the most energy-intensive and expensive technological method in domestic agriculture. Currently, it accounts for up to 40% of energy and 25% of labor costs of the total volume of field work on growing and harvesting crops. More powerful equipment allows not only to perform energy-intensive operations (plowing, disking, cultivation, etc.), but also to use wide-cut combined units for other technological operations, which reduces fuel costs and labor intensity. The observed decrease in the provision of energy resources by an average of 1.6% per year is not a critical pace, but may be a completely natural reaction to the growth in the efficiency of using energy capacities and the renewal of the fleet of equipment. According to our calculations, only a sharp decline by 5% or more per year can alert and warn of the beginning of some degradation of the existing technical potential of agricultural production. So, in the period from 2000 to 2005, there was the largest drop in the provision of agricultural organizations with energy resources for the entire period of 2000-2020 we are considering by 82 horsepower per 100 hectares of crops, or by 16.2% in 5 years, or an average of 3.2% per year. Such a drop is explained by the start of deliveries at that time of more powerful and advanced new generation equipment to the machine and tractor fleet of the republic and the disposal of a large amount of old equipment that has already exhausted its resource.

This decrease occurred despite the implementation of a number of measures of state support for agricultural organizations of the republic. Such a decrease may indicate, quite obviously, both an increase in the efficiency of using energy capacities and the renewal of the fleet with the most modern, very powerful equipment that farmers are forced to purchase under the pressure of such a factor as a shortage of machine

operators and other technical workers in agricultural production. It can be reasonably stated that the current level of provision of the agro-industrial complex of the country with agricultural machinery makes it possible to produce agricultural products with acceptable efficiency. High competition in the market of agricultural products, which is getting tougher from year to year, requires a serious and qualitatively new technical and technological modernization and a significant increase in the energy efficiency of agricultural production [1-6].

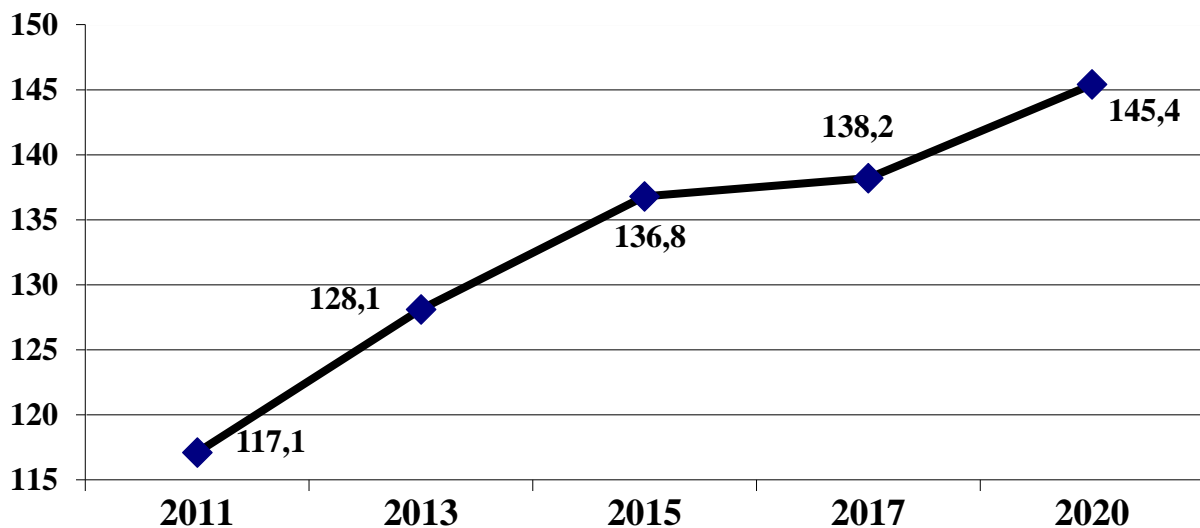
It is important to note that the indicator of the provision of energy resources very poorly takes into account the specifics of livestock production, which to a small extent depends on the area of agricultural land. In animal husbandry, the main technical resources are various stationary equipment (refrigeration, milking, transport, etc.) that operate on electric energy. The share of the capacities of electric motors and various electrical power equipment in the overall structure of the energy resources of the Belarusian agriculture with its developed livestock complex and especially the dairy sector today can be estimated at up to 25-30%. It is also advisable to evaluate another important indicator that takes into account the availability of labor resources in agriculture. There is definitely a constant increase in energy capacities in relation to the number of workers employed in agricultural production in agricultural organizations, at the end of 2020 this figure reached the level of 75.2 horsepower per employee and increased over the decade under review (2010-2020) by 22 horsepower or more than 1.4 times. Figure 4 shows the dynamics of the growth of energy capacities in relation to the number of employees in agricultural enterprises of the Republic of Belarus for the period from 1990 to 2020 as of the end of the year.



**Figure 4 – Energy capacity per employee of agricultural organizations of the Republic of Belarus as of the end of each year (compiled according to the data of the National Statistical Committee of the Republic of Belarus)**

From the analysis of the technical support of agricultural production in Belarus over the past decade, it can be concluded that the emphasis in re-equipping agricultural enterprises with new equipment has shifted towards agricultural equipment with increased power. The average power of a tractor engine (including tractors on which

earth-moving, reclamation and other machines are mounted), taking into account the entire tractor fleet of agricultural organizations of the republic, over the past 10 years has grown by almost a quarter (more than 24%) from 117.1 horsepower in 2011 to 145.4 horsepower in 2020 (Figure 5). This trend is also confirmed by changes in the structure of the tractor fleet of the Republic of Belarus, where the share of tractors with increased power (power more than 181 horsepower) increased from 13.0% in 2011 to 20.2% in 2020 of the entire tractor fleet (table 1). Thus, in particular, during the period under review, the number of high-power tractors of the «Belarus-3522» model increased by almost 4.5 times, and tractors of the «Belarus-3022» model by 63 times, while the total number of tractors decreased by almost 17%. Also, it should be noted that the segment of tractors with a capacity of 33 to 65 horsepower has grown by almost 1.7 times – this is primarily due to the corresponding specialization of the farms that purchase them and the desire to profitably use a small economical tractor for certain jobs. The number of these tractors in the agriculture of the republic is quite insignificant (slightly more than 1 thousand tractors in 2020), but the growth over the period 2011-2020 the share of low-power tractors was noticeable: from 1.4% to 2.7% (almost 2 times).



*Figure 5 – Dynamics of changes in the average power of the tractor engine in horsepower, taking into account all agricultural organizations of the Republic of Belarus for 2011-2020 (as of January 1 of each year)*

The trend towards an increase in the number of tractors with increased power in the agricultural production of the republic will continue in the future, and in the next 3-5 years, the average power of a tractor engine, according to forecast estimates, will reach 160-165 horsepower. For comparison, for example in Germany, where the basis of agricultural production is small family businesses and farms with a total land use area of 2.5 to 5000 hectares, the average tractor engine power at the end of 2015 reached 155 horsepower.

In the future, the indicator of the availability of energy capacities per worker in agricultural organizations of the republic will only grow, it characterizes the relationship between the costs of human labor and the production consumption of mechanical and electrical energy and is calculated by the ratio of the total power of the engines of

technical equipment to the average payroll number of employees, i.e. the indicator characterizes the degree of replacement of the use of human physical force by technology.

Table 1 – The structure of the tractor fleet of agricultural organizations of the Republic of Belarus by power groups (as of January 1 of each year)

Year	Power (in horsepower)					
	до 65		66-180		более 181	
	%	number of tractors	%	number of tractors	%	number of tractors
2020	2,7	1069	77,1	30044	20,2	7856
2017	2,8	1173	79,4	32765	17,8	7329
2014	2,2	956	82,1	35852	15,7	6881
2011	1,4	640	85,6	40122	13,0	6089

From the analysis of the number of labor resources of agricultural enterprises of the republic, it is clearly visible that from year to year the number of people employed in agricultural production is steadily declining. Thus, the average annual payroll number of employees in agricultural organizations of the republic over the past decade (from 2010 to 2020) decreased by 101.6 thousand people, or more than a quarter (-27.5%), i.e. on average, the rate of decrease in the number of employed was more than 10 thousand people per year (Figure 6). At the same time, the capacity of newly arriving equipment to the country's agricultural enterprises is also steadily growing, although there is a general quantitative reduction in the machine and tractor fleet (an excess of the number of decommissioned equipment over newly received equipment).

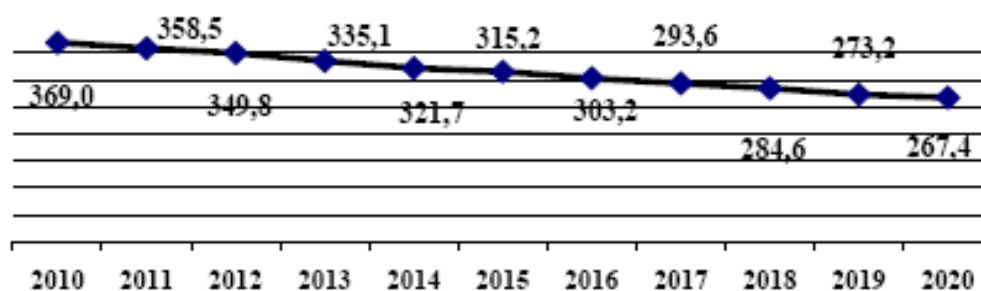


Figure 6 – The average annual payroll number of employees (in thousands) of agricultural organizations of the Republic of Belarus for 2010-2020 (according to the results of each year)

### State and analysis of the problem

From the State Program for the Development of Agricultural Business in the Republic of Belarus for 2016-2020, approved by the Decree of the Council of Ministers of the Republic of Belarus No. 196 of March 11, 2016, the main target indicator of the subprogram: “Technical re-equipment and informatization of the agro-industrial complex” is an indicator of the provision of energy capacities for one working in the agricultural organizations of the republic. The implementation of this subprogram as-

sumed: the provision of energy capacities per employee in organizations operating in the field of agriculture at a level of at least 75 horsepower per employee. This task was eventually completed: this indicator at the end of 2020 amounted to 75.2 horsepower, or just over 100% of the target.

Labor productivity in agriculture is one of the most key indicators that takes into account the level of development of productive forces, the efficiency of all agricultural production and the degree of use of the labor potential of farmers [1-3, 5]. Labor productivity indicators in Belarusian agriculture are presented in Table 2.

Table 2 – Indicators of labor productivity in agriculture in Belarus

Indicators	Years						
	2015	2016	2017	2018	2019	2020	2020 / 2015, %
Labor productivity in agriculture per worker:							
in Belarusian rubles	35874	43103	52013	56146	64756	74688	208,2
in US dollars	22612	21676	26925	27568	30963	30674	135,7
The average official exchange rate of the Belarusian ruble against the US dollar, calculated as a geometric mean*	1,5865	1,9885	1,9318	2,0366	2,0914	2,4349	153,5

\* according to the National Bank of Belarus

Table 2 shows that labor productivity in agriculture per worker over a five-year period (2015-2020) in Belarusian rubles increased by more than 2 times, and in US dollars by 1.36 times. This is explained by the fact that the Belarusian ruble devalued against the US dollar by more than 1.5 times over the period under review.

According to the Federal State Statistics Service of Russia and the World Bank, at the end of 2018, labor productivity in agriculture in the Russian Federation amounted to 17.2 thousand US dollars of agricultural products per employee, and in the United States – 111.8 thousand dollars. It follows that at the end of 2018, Belarus was 1.6 times ahead of Russia in this indicator, and lagged behind the United States by 4 times.

One of the important directions for further development and improvement of the material and technical base of agricultural production is the introduction of innovations based on various navigation technologies, as the most important direction for the implementation of precision farming systems. Navigation technologies, systems and equipment are infrastructural elements and without them it is impossible to implement any precision farming systems and various types of remote monitoring. Today's realities are such that it is no longer possible to increase labor productivity in agricultural production without introducing high-intensity technologies with a comprehensive progressive modernization of all agriculture based on various information and communication systems. It is obvious that the widespread introduction of the latest information technologies, satellite navigation and monitoring systems into the machine and tractor fleet of the agro-industrial complex of the republic will effectively carry out operational and technological monitoring of units in the process of their



operation, positioning of mobile machines, monitoring the state of technical objects, progress and quality of technological operations, the amount of work performed [7-10].

With a general downward trend in the number of mobile machines in agriculture, it can be seen from the analysis of Table 3 that for some items (tractors, grain harvesters and trucks) over 7 years the number of agricultural machines decreased by (12.2 ÷ 26.6%), and the share of agricultural vehicles equipped with a navigation system for the period under review for these positions increased significantly (4 ÷ 8.2 times).

**Table 3** – Dynamics of availability of certain types of machines in agriculture of the Republic of Belarus for 2013-2020 as of the beginning of the year

#	Groups(types) of machines	2013	2015	2017	2020	CAGR*	2020 / 2013
		number				%	
1	Total tractors**	46131	43465	42669	40500	-1.8	87.8
	of which equipped with a navigation system	1325	1927	3275	6942	26.7	523.9
2	Total combine harvesters	12067	11122	9987	8856	-4.3	73.4
	of which equipped with a navigation system	71	118	179	583	35.1	821.1
3	Total freight road vehicles	23858	22107	20509	19012	-3.2	79.7
	of which equipped with a navigation system	933	1228	2235	3747	22.0	401.6

\* CAGR – Compound Annual Growth Rate

\*\*without tractors, on which earth-moving, reclamation and other machines are mounted

In terms of the share of agricultural machines equipped with a navigation system in the common machine and tractor fleet, Belarusian agricultural production lags behind the most developed in the agricultural sector: the EU countries, the USA, Canada, Israel, Japan, etc. By 2011, the active use of elements of satellite navigation systems in the USA up to 80% of farms were covered, and in the EU countries up to 60%. The share of agricultural vehicles equipped with a navigation system in these countries today already reaches 90% and above. Now in the advanced agricultural engineering of Western countries, only small tractors and cultivators for use in the household are not serially equipped with various types of navigation systems at manufacturing plants.

As of the beginning of 2020, the share of tractors equipped with satellite navigation systems is almost 7 thousand units or more than 17% of the total agricultural tractor fleet, the cumulative average annual growth rate for 7 years was almost 27%, but according to the calculations, with an annual growth rate of equipping the tractor fleet with navigation in 40% and with the receipt of new tractors in farms with already equipped satellite systems, it will take about 5 years.

The share of combine harvesters equipped with a navigation system from the entire fleet of combine harvesters at the beginning of 2020 is almost 6.6% the cumulative average annual growth rate from 2013 to 2020 for equipping with navigation systems was slightly more than 35%. However, considering that the fleet of grain har-

vesters of the republic is almost 9 thousand units, then with such an average annual growth rate in equipping this segment of machines with navigation, it will take about 9 years, which is completely unacceptable to achieve a serious level of modern of high-tech agricultural production in Belarus over the next five years (2021-2025). In a slightly different way, the situation with the fleet of trucks in the agro-industrial complex is developing. The share of cargo vehicles equipped with a navigation system from the entire freight transport fleet is almost 20%, with an average annual growth rate of 22% for equipping vehicles with navigation systems for the period 2013-2020. With this growth rate, the full equipment of the cargo fleet will be 8 years. According to our calculations, with a stable average annual growth rate of at least 38%, it will take no more than 5 years to fully equip the entire transport freight fleet of vehicles.

From the analysis of the data, it can be concluded that there is an active independent equipping of a fleet of tractors, combine harvesters and road freight vehicles with navigation systems directly by agricultural organizations on their own or at their own expense with the involvement of specialized third-party organizations. So, for example, in 2016, a rather significant year, in the Republic of Belarus, the total number of tractors equipped with a navigation system increased by almost 17%, and new ones with an already installed navigation system arrived at only 0.7% of the total number equipped with navigation at the end of the year. As of the beginning of 2020, the situation has improved dramatically, so out of all the new tractors received by the republic's agriculture, 8% have already been equipped with navigation systems at the manufacturing plants.

This indicates that the importance and necessity of equipping mobile machines with navigation equipment for the effective conduct of agricultural production has long been understood precisely at the level of the farmer, and here the urgent task of the state represented by the Ministry of Agriculture and Food, regional and district executive committees and manufacturers of agricultural machinery is, first of all, in creating favorable conditions, including financial ones, for equipping their machine and tractor fleet with modern systems and navigation aids, as well as other high-tech equipment [3, 8].

At the moment, the agricultural production of Belarus lags far behind Western countries in terms of equipping and using various elements of precision farming systems, satellite navigation and other multifunctional modern flexible information systems that are easily integrated into various navigation and monitoring systems, which significantly complements and expands their functionality. The introduction of satellite equipment monitoring systems at the enterprises of the agro-industrial complex using data from GPS/GLONASS systems justifies the cost of their installation and operation quite quickly: from 2 months to 1.5-2 years, depending on the cost and functionality of the selected system, and also reduces the total cost of maintaining the machine and tractor fleet is up to 20-25%. For the successful implementation of measures and the achievement of targets of the main current State programs in the field of the agro-industrial complex of Belarus, as well as to achieve the modern world level of high-tech agricultural production in the republic, all new and especially powerful and high-performance Belarusian equipment that enters the economy of the republic must be equipped with elements of navigation and on-board diagnostic

systems are already at the stage of serial assembly production of this agricultural machinery [3, 5, 8]. This will significantly reduce the cost and maximally unify the line of navigation equipment, the assembly of which can be organized at the enterprises of the Belarusian electronics industry, which will partially ensure the import substitution of these types of equipment. More than 70% of existing large agricultural enterprises in Belarus belong to the system of the Ministry of Agriculture and Food and are potential users of satellite navigation systems. The creation on the basis of the structures of the Ministry of Agriculture and Food of the Republic of Belarus of a unified system for monitoring and analyzing the fleet of agricultural machinery and controlling the parameters of its technical condition will seriously limit the possibility of fuel theft, mileage cheating, control the actual operating time of the equipment and identify the facts of equipment operation in emergency modes, etc. The creation of a unified center for monitoring and analysis of the machine and tractor fleet will allow the Ministry of Agriculture and Food of the Republic of Belarus and other interested organizations to have objective information on the actual readiness and operating time of mobile agricultural machinery, which will quickly identify, document, analyze, archive and store information on all facts inefficient use of equipment, as well as to conduct a comprehensive monitoring of agricultural work and the state of equipment during critical peak periods (sowing, harvesting, etc.). This will make it possible to quickly identify additional reserves for the efficient use of equipment, and use the data obtained on technical failures to search for the causes of these failures and select the most rational ways to eliminate them, as well as for strategic goals and objectives to improve the technical service of agricultural machinery and equipment produced by machine-building plants republics.

The development and further comprehensive implementation of this system at the enterprises of the Ministry of Agriculture and Food of the Republic of Belarus will make it possible to obtain a significant economic effect in the agricultural, machine-building and other related (electronics industry, etc.) production sectors of the country, which will eventually lead to a serious synergistic effect [3].

### **Conclusion**

An active role in solving the problems of reducing the cost of agricultural products, significant savings of all types of energy resources, in increasing the overall economic efficiency of agricultural production at this stage in the development of advanced world agriculture, now belongs to projects on automation, robotization, informatization, digitalization of agricultural production and processing of received agricultural products. In the context of a steady decline in the number of people employed in agriculture, an increase in the volume of cultivated areas and, in general, with an increase in the physical volumes of production in crop and livestock production, the role of modern powerful machines and equipment again entering the agricultural production of the republic and their rational use is greatly increased, the requirements to productivity, functionality, economy, reliability of agricultural machinery, machines and units. Only a reasonable comprehensive and systemic technical and technological re-equipment of agricultural production, saturation of it with high-tech, high-performance agricultural machines, complexes and equipment will be able to ensure a significant increase in labor productivity, minimize the costs of all types

of material, fuel and energy resources and, as a result, maximize the preservation of the country's food security [11-12].

Based on the analysis of the latest global market trends in agricultural machinery, now the special interest of agricultural producers in countries with advanced agriculture is directed specifically to flexible and intelligent solutions for various multifunctional agricultural machines, and not to a banal increase in the range, quantity or size of new purchased agricultural machinery, that is, the agricultural producer today requires, first of all, high-performance and at the same time economical, reliable, easy-to-use and equipped with the most modern digital electronic equipment, agricultural machines that meet the requirements of new advanced resource-saving agricultural production technologies.

### References

[1] Polukhin A.A. (2013): Features of the use of the technical potential of Russian agriculture at the regional level. *Education, science and production*, No. 2, pp. 16-21. ISSN: 2306-7047.

[2] Polukhin A.A. (2015): Formation of an economic mechanism of technical modernization of agriculture. *Biotika*, No. 1, pp. 19-23. ISSN: 2410-9290.

[3] Kovalev Igor L. (2018): Technical re-equipment of agricultural complex of Belarus: today's problems and new vectors of development. *Resources and Technology*, No. 15(1), pp. 39-64. ISSN: 2307-0048.

[4] Kovalev I.L. (2017): Modernization of tractors in the agricultural sector in Belarus. *Agricultural machinery: maintenance and repair*, No. 3, pp. 44-53. ISSN: 2222-8632.

[5] Saiganov A.S., Takun A.P., Kovalev, I.L. (2016): Guidelines for improving the system of agro-services for agricultural producers in the context of innovative development and modernization of the agro-industrial complex of the Republic of Belarus. Minsk, Institute for System Research in the Agro-industrial Complex of the National Academy of Sciences of Belarus, 141 p.

[6] Saiganov A.S., Takun A.P., Kovalev, I.L. (2017): Material and technical support of the agriculture of Belarus: state and prospects. *Agricultural machinery: maintenance and repair*, No. 9, pp. 33-44. ISSN: 2222-8632.

[7] Kovalev I.L. (2020): World trends in agricultural engineering and the direction of technical and technological modernization of crop production in the Republic of Belarus. *Agricultural machinery: maintenance and repair*, No. 3, pp. 28-44. ISSN: 2222-8632.

[8] Kovalev I.L., Kostomakhin M.N. (2019): On the prerequisites for the creation of a single republican center for remote monitoring and park management of agricultural equipment. *Agricultural machinery: maintenance and repair*, No. 4, pp. 62-76. ISSN: 2222-8632.

[9] Kostomakhin M.N., Voronov A.V., Kovalev L.I., Kovalev I.L. (2015): Monitoring the reliability parameters of agricultural machinery using GPS/GLONASS systems. *Proceedings of GOS-NITI*, Vol. 118, pp. 26-30. ISSN: 2587-6864.

[10] Kovalev I.L. (2015): Programs preferential leasing of equipment for farmers – direct state support of domestic engineering // *Russian Journal of Agricultural and Socio-Economic Sciences*, No. 10, pp.18-31. ISSN: 2226-1184.

[11] Kovalev I.L., Takun A.P., Efremov A.A., Takun S.P. (2021): The role of automated information systems in increasing the efficiency of agricultural business. *Agricultural machinery: maintenance and repair*, No. 1, pp. 56-69. ISSN: 2222-8632.

[12] Kovalev I.L., Takun A.P., Efremov A.A., Takun S.P., Kostomakhin M.N. (2020): The systems of corporate management in the field of agro-industrial complex with the use of information technologies and their modernization. *Chief livestock specialist*, No. 2, pp. 51-63. ISSN: 2074-7454.