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Environmental issues and prospects of industrialization in the agricultural sector (Case study: The Russian Federation)

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ABSTRACT

The primary goals and guidelines of the state program for the development of agriculture and the regulation of markets for agricultural products, raw materials and food adopted by the government of the Russian Federation do not help to rapidly develop the process of industrialization of agriculture. As a result, the energy supply of agriculture in the context of the Federal Districts is decreasing. The situation is alarming when for a long time industrialization does not give significant changes in the factorial environment of labour productivity. In this regard, studies were carried out based on constructing the production function proceeding from the data of farms of the Ulyanovsk region for 2016; those data indicate the preservation of the leading role of the factors concerning the provision of fixed and circulating assets, as well as remuneration.

Keywords: Industrialization, Agricultural machinery, Agricultural holdings, Farming enterprises, Labour productivity, Professional qualifications, Environmental Issues.

INTRODUCTION

In this survey, the environmental issues and prospects of industrialization in the agricultural sector in the Russian Federation has been investigated in order to figure out a practical way to maintain a right balance between industrialization and Agriculture. To that end, a regression model of the relationship between the basic elements of a workplace and labour productivity in the primary production has been built. Correlation analysis showed that the closest relationship between the effective feature and the factorial features is observed between labour productivity and the availability of working capital (correlation coefficient = 0.733), crop area (0.528), and capital-labour ratio (0.497). The on-going changes in the factor base of labour productivity in recent years can be seen in agricultural organizations throughout the country. With the increase in the equipment capability of farms, the indicators of the capital-labour ratio and the expansion of sown areas began to change significantly. Therefore, the state is faced with the task of accelerating the transfer of agricultural production to an industrial base and advanced technologies, for which conditions are necessary to increase the volume of purchase of equipment by agricultural enterprises. The system for executing the arrangement of import replacement, as one of the instruments of the procedure of the new industrialization of the agro-modern complex of Russia, through the crystal of the contention of public exchange intrigues the agrarian market of the Eurasian economic union (EAEU) was investigated (Kovalev *et al.* 2019).

Horticulture, industry and administrations have a critical positive relationship with GDP. The Causality results show a bidirectional causal connection between GDP, agriculture (AR), industry (ID) and services sector (SV). (Isiksal & Chimezie 2016). Six standards of a characteristic idea of biomimicry were investigated and these standards were applied with regards to shrewd cultivating advancements (Blok & Gremmen 2018).

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The fourth mechanical insurgency, for example, hyper-network, hyper-knowledge and hyper-consistency contribute significantly to the sixth industrialization of horticulture, and in this manner it is basic to improve the seriousness of the rural area by utilizing the innovation of the fourth modern upset. Specifically, in light of examinations of the jewel model, the "request conditions" was the main factor for the initiation of the sixth Industrialization, and afterward "related and supporting fields", "factor conditions" and "business setting" were continued all together (Jung & Khoe 2018). The positive business climate has come through endeavor administrative changes that simplicity working together in Ghana (Sserunjogi 2020).

Industrialization of agricultural labour is the process of creating large-scale machine production in the sectors of agriculture and animal husbandry consisting in the use of modern means of complex mechanization and automation of basic production processes, the widespread introduction of scientific achievements, and technologies of industrial type. In this regard, agricultural labour turns into a kind of an industrial one (URL: http: // enciklopediya-tehniki.ru).

MATERIALS AND METHODS

Initially, we analysed and study the evolution of agriculture and industrialization in the Russian federation over time to help draw a comprehensive conclusion. Comprehensive mechanization of all sectors of agriculture is an essential condition for increasing labour productivity and the efficiency of the agricultural sector of the economy. The rapid development of industrial production in the twentieth century made it possible to carry out a real technical revolution in agriculture through equipping it with modern machinery in a historically short period of time. Instead of a million ploughs, scythes, wooden ploughs, and other primitive implements (Table 1), agricultural production received agricultural machines and the corresponding energy supply (Vodyannikov & Subaeva 2018; Jahanifar *et al.* 2018).

Table 1. The main tools for tillage in Russia at the beginning of the twentieth century.

Name of tools	Quantity, mln. units
Wooden plough and scythe	7.9
Wooden ploughs	3.0
Wooden harrows	5.7
Wooden harrows with iron teeth	15.9
Iron ploughs	6.0
Iron harrows	0.4

The mechanization of the main works in field cultivation was completed in the 50s of the last century (Table 2).

Table 2. Mechanization of the main field works (in% of the total volume).

Types of work and methods of performance	Years			
	1928	1932	1940	1956
Ploughing				
With ploughs	10	-	-	-
Horse-drawn ploughs	89	81	38	2
Tractor ploughs	1	18	62	98
Sowing of grains				
Manual	75,0	57	8	-
Horse-drawn seeders	24,8	28	36	3
Tractor seeders	0,2	20	56	97
Grain harvesting				
Scythes and sickles	77	35	20	8
Horse-drawn reapers	56	55	34	3
Combines	-	4	42	87

Already at an early stage of mechanization, the economic efficiency of the transition from horse-drawn vehicles to tractor vehicles was high. So, on average 2.4 man-days were spent on ploughing 1 hectare, and when using a 15 h.p. tractor STZ-KhTZ - 0.44 man-days, i.e. 5.5 times less. With manual sowing, 2 man-days per 1 hectare were spent, with machine sowing using horse-drawn seeders - 1 man-day, and when sowing with a tractor seeder, labour costs decreased to 0.14 man-days or in 7.14 times. The development of agricultural engineering until 1930 was characterized by the release of relatively simple horse-drawn and hand tools. Further, the formation of the material and technical base of the agrarian sector of the economy was associated with the mastering of production and the mass production of tractor equipment and high-performance tractor-driven agricultural machines for crop

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production. Energy-intensive processes in agriculture began to be carried out mainly by machines with tractor traction. The first period (1918–1930) of the Soviet tractor industry is characterized by the production of mainly wheeled petrol tractors intended for general agricultural work. The tractors used heavy fuel; the engine power was in the range of 25–48 hp and the speed was 3–6 km per hour. During these years, the first domestic diesel tractors S-65 were designed and tested. A total of 27.3 thousand wheeled and tracked tractors were produced (Vodyannikov & Subaeva 2018).

In the pre-war period (1931-1941), mass production of wheeled tractors SKHTZ-15/30 and "Universal", as well as tracked tractors SKHTZ-NATI, S-60 and S-65 was mastered; they were widely used in grain farming and this contributed to an increase in yield and gross grain harvest. During this period of the introduction of tractors, there was a significant saving in living labour. The engine power of the tractors ranged from 22 to 75 h.p. and their speed was 3.5–8 km per hour (Vodyannikov & Subaeva 2018; Ashouri 2020).

In pre-war times, agricultural work was carried out mainly with the help of manual labour or horse traction in all countries of the world. In 1939, there were only 36 thousand tractors in France, and 55 thousand in England. Only the USSR and the USA had a relatively powerful tractor fleet - 531 thousand and 1,370 thousand vehicles, respectively (Vodyannikov & Subaeva 2018). Harvesting machines were of great importance for increasing grain production in those years, reducing losses and contributing to the preservation of the quality of grain crops. For example, when harvesting grain with droppers and threshing with threshers, losses reached 20–25% of the yield. Replacing them with sheaf binders reduced losses by 5-7% and then harvesters keep these losses to a minimum.

It was characteristic for the initial stages of the mechanization of agricultural production that the machine and tractor fleet carried out only the basic operations of tillage and harvesting grain crops. Many other operations were performed manually and partially with horse-drawn equipment. Livestock raising remained practically non-mechanized. Therefore, the next stage in the creation and development of the material and technical base of the agrarian sector of the economy should be marked by a significant expansion of the fleet of available machines for performing work within the established agro-technical terms, as well as equipping agriculture with models of machines designed to mechanize manual operations. The fulfilment of these tasks was suspended by the Great Patriotic War that began in 1941. Agricultural engineering plants were switched to the production of military products, and the production of machines for the countryside actually ceased.

At the end of the Great Patriotic War, technical progress in the field of creating new and more efficient designs has significantly accelerated and proceeded in two main directions: by gradually improving the equipment produced without fundamental changes in its design, and the creation of fundamentally new machines with different working bodies based on a different technology, and on other engineering and economic ideas. The production of agricultural machinery was restored in its total volume already in 1948 and in the fleet of the main machinery in agriculture in 1950. As to the subsequent significant stages of technical progress in agriculture, it should be noted the creation and development of mass production of wheeled universal tractors on pneumatic wheels, as well as the transition to pneumatic wheels of most mobile agricultural machines. The most important direction of scientific and technological progress in the design of agricultural machinery is the steady increase in the power of tractors. So, tractors fit for tillage DT-54 with a 54 h.p. engine were replaced by tractors of the same class DT-75 with a 75 h.p. engine. Now tractors of this class are equipped with more powerful engines. A similar picture is observed for tractors of the “Belarus” series. Technological progress has led to the continued use in agriculture of powerful wheeled tractors of the “Kirovets” series.

Currently, the prevailing trend is to create machines that combine the optimal working width with a sufficiently high working speed. The economic efficiency of this direction of technical progress in agricultural machinery is great, since the coverage of working machines, their speed and power are directly related to labour productivity (Vodyannikov & Subaeva 2018). Already in the 70-80s of the last century, the general trends in the creation of new agricultural machines were the following: the introduction of automation and control over working processes; the desire to create machines adapted to progressive technology; improving the technology of cultivation of agricultural crops; replacement of passive working bodies of machines with active ones; creation of combined machines and units for the simultaneous performance of several operations in one pass of a machine-tractor aggregate; creation of universal machines; increasing the reliability and durability of their structure. Equipping agriculture with machinery made it possible to strengthen its material and technical base, increase energy supply and power-to-labour ratio, and create the necessary conditions for increasing its productivity. The machine and tractor fleet of agricultural organizations in Russia retreats from year to year. Since 1995, only 22.2% of the tractor

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fleet, 17.4% of tractor ploughs, 20.5% of various seeders, and 11.0% of sugar beet harvesters, 19.9% of hay mowers, 12.7% of irrigation machines and installations, 16.0% of milking installations have remained (Table 3).

Table 3. Dynamics of technical equipment availability of agriculture in the Russian Federation, thousand units (http://www.gks.ru)

Types of equipment	1995	2000	2005	2012	2013	2014	2015	2015 in % to 1995
Tractors *	1052,1	746,7	480,3	276,2	259,7	247,3	233,6	22,2
Tractor ploughs	368,3	238,0	148,8	76,3	71,4	67,8	64,1	17,4
Cultivators	403,5	260,1	175,5	108,7	102,2	97,8	93,2	23,1
Seeders	457,5	314,8	218,9	115,4	107,5	100,7	93,6	20,5
Combine harvesters	291,8	198,7	129,2	72,3	67,9	64,6	61,4	21,0
Forage harvesters, pcs.	94,1	59,6	33,4	17,6	16,1	15,2	14,0	14,9
Potato harvesters, pcs.	20,6	10,0	4,5	2,7	2,6	2,4	2,3	11,2
Beet harvesters	20	12,5	7,2	2,8	2,5	2,4	2,2	11,0
Mowers	161,6	98,4	63,9	37,5	35,6	33,9	32,2	19,9
Sprinklers and sprinkling installations	46,3	19,2	8,6	5,2	5,2	5,7	5,9	12,7
Milking machines, pcs.	157,3	88,7	50,3	28,6	27,3	26,3	25,1	16,0

The energy resources of enterprises are represented by the power of tractors, motor vehicles, harvester motors, stationary engines, electric motors and electrical installations, and also live draft force expressed in mechanical horsepower. Indicators of energy supply and energy-to-labour ratio are determined on the basis of data on the total amount of energy resources. Energy supply characterizes the availability of energy capacities per 100 hectares of sown areas. Let us consider the dynamics of the energy supply of agricultural organizations in Russia in the context of the Federal Districts. To assess the dynamics of energy supply in agriculture, we have used data of Federal State Statistics Service for 1990-2015. In the context of the Federal Districts, there is a tendency to reduce the level of energy supply in agriculture. Data for 1990-2015 were used to assess the dynamics of energy supply in agriculture. There is a tendency to reduce the level of energy supply in agriculture in the context of the Federal Districts. Thus, the level of energy supply of agricultural enterprises in the Volga Federal District in recent years remains the lowest, while this decline over the past 25 years amounted to 47.2%. This decrease is a response to the increase in the efficiency of the use of energy capacities and the renewal of the equipment fleet.

RESULTS

The developing process of industrialization of agriculture requires improving the forms of production setup, and the management system as a whole, accordingly. Here the most important role is played by large inter-farm and agro-industrial enterprises and associations created in various branches of agricultural production. According to the results of the All-Russian agricultural census, it is clear that the Russian agricultural sector at the present stage of its development is now in the process of mergers and acquisitions. So, according to the Federal State Statistics Service, the number of agricultural organizations in the country over the past 10 years has decreased by 1.6 times: from 59.2 thousand in 2006 to 36.4 thousand in 2016. At the same time, the number of peasant farm enterprises decreased in 1.6 times: from 285 thousand in 2006 to 174.6 thousand in 2016 (Vodyannikov & Sereda 2014). This form of production setup together with the growth of mechanization and automation of production level in the context of state support for large agricultural holdings leads to negative dynamics, i.e. to the growth of unemployment and monopoly pricing.

The industrialization of agriculture not only leads to a rapid increase in labour productivity, an increase in the efficiency of agricultural production, but also has the most important social consequences. Based on Federal State Statistics Service data, the average annual growth rate of labour productivity for 2005-2016 amounted to 0.9%. However, they provided an increase in agriculture production by 4 times and a decrease in the number of employees by 15.1%. The latter was literally a landslide decrease for agricultural organizations (Vodyannikov & Sereda 2014; Subaeva *et al.* 2017; Vodyannikov & Subaeva 2018). The situation is alarming when for a long time there are no significant changes in the factor environment of labour productivity (Vodyannikov & Sereda 2014; Vodyannikov & Subaeva 2018). Our studies used building the production function based on the data of the farms

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from the Ulyanovsk region for 2016; they indicate the preservation of the leading role of the factors reflecting the provision of fixed and circulating assets, as well as wages. The constructed regression model of the relationship between the basic elements of a workplace and labour productivity in the primary production of 175 agricultural organizations of the Ulyanovsk region showed that the capital-labour ratio (k2 = 0.171), the availability of working capital (k3 = 0.585), the level of wages (k4 = 1.461), the area of crops per 1 worker (k1.2 = 4.689) have the positive influence on total labour productivity. Correlation analysis showed that the closest relationship between the effective feature and the factor feature is observed between labour productivity and the availability of working capital (correlation coefficient = 0.733), crop area (0.528) and capital-labour ratio (0.497).

Some of the features occurring in the factor base of labour productivity in recent years can be seen in agricultural organizations throughout the country. With the increase in the technical equipment of farms, the indicators of capital-labour ratio and the expansion of cultivated areas began to change significantly (Kristensen *et al.* 2011).

However, the competitive ability of crop production is affected by lower wages, by the level of which (according to a 2012 UN report) Russia is in 37th place among 72 countries of the world. This is in general for the economy. Apparently, in agriculture this level is even lower (Philip 2010; Searchinger *et al*. 2013; Sejian *et al.* 2016).

SUMMARY

In order to make up for the losses in the agricultural sector as to its technical and technological support, and as to the level of mechanization, which occurred during the agrarian reform, it is necessary to overcome the disproportion, when the fall in wages in the sector was much ahead of the decline in labour productivity.

CONCLUSION

The industrialization of agriculture is aimed at increasing production efficiency and labour productivity of the sector. Thanks to this, the dependence of agricultural production on the spontaneous influence of natural conditions is gradually weakened and the seasonality of production is overcome.

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مسائل زیست‌محیطی و چشم اندازهای صنعتی سازی در بخش کشاورزی (مطالعه‌ی موردی: فدراسیون روسیه)

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چکیده

اهداف و دستورالعمل‌های اصلی برنامه‌ی دولتی برای توسعه‌ی کشاورزی و تنظیم بازار برای محصولات کشاورزی، مواد خام و مواد غذایی اتخاذ شده توسط دولت فدراسیون روسیه به توسعه‌ی سریع فرآیند صنعتی سازی کشاورزی کمکی نمی‌کند. درنتیجه، منبع عرضه‌ی انرژی‌بخش کشاورزی در مناطق فدرال، در حال کاهش است. این وضعیت هشداردهنده است زیرا صنعتی سازی بلندمدت منجر به تغییرات معنی‌دار در محیط بهره‌وری کار نمی‌شود. در این خصوص، مطالعات بر اساس ساخت داده‌های مربوط به مزارع منطقه‌ی الیانوسک برای ۲۰۱۶ انجام شده‌اند: این داده‌ها نشان‌دهنده‌ی نقش مهم عوامل مربوط به تأمین و ارائه‌ی دارایی‌های ثابت و در گردش و نیز مزایای مربوطه است.

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