Value of grain-growing sector within agro-industrial production: Structural changes and development trends

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Abstract. During the 20th and first quarter of the 21st century, there have been not only significant quantitative, but also structural changes in grain production close to some central applications of grain: food consumption, fodder consumption, industrial consumption, provision of seed production, foreign trade. Strategic planning of grain production in the country depends on many factors, including changes in grain production and processing technologies, widespread and accelerated integration of selective breeding results, multifactorial modeling of animal diets. The volume of consumption and the structure of cereals in the total volume of production is impacted by such processes as population growth, urbanization and changes in dietary preferences of modern people. One of the most important tasks in the development of the farming industry is to assess some possible prospects for the development of grain growing, with due account for new priorities to come up in the use of the entire biodiversity of cereals. Benchmark analysis of the ratio between the volumes of production, consumption and export-import of grain, rationale for the optimal characteristics of the grain-growing sector of the national economy, as an essential element of strategic potential, represent one of the fundamental interdisciplinary challenges facing modern science.

1. Introduction
Today, both in the developed countries of the world and in Russia, there are no uniform criteria for the rate of food supply for the population, subject to natural and climatic conditions and sophistication of agricultural production, as well as national living standards of the population. According to FAO experts, the two main indicators of the state of international food supply are the volume of carry-over stocks of grain in the world remaining in storage until the next harvest, as well as the level of grain production per capita [1]. Modernization of the grain economy in Russia, as well as state regulation of the production and market of grain and food should be guaranteed to meet the need for domestic products to provide the population with food.

Food security is largely determined by macroeconomic factors, the efficiency of social production, incomes of the population, the development of the agri-food sector of the economy and other impacts [2]. The “onset” of digital tools, including in the economy, dictates new economic conditions for agricultural producers concerning applications of modern information and management technologies, automation of business processes. The farming industry often sets a new direction for the development of the entire national economy. A scientifically grounded strategy for the country’s GDP growth, as one of paramount importance, should solve the problems of socio-economic development of rural areas.
2. Materials and methods
A theoretical and methodological toolkit rests on the publications of Russian and foreign authors on providing the population with food and developing the grain-growing sector. The information base is made up of state and departmental regulations, materials of the Federal State Statistics Service of the Russian Federation, data presented on the FAO website.

3. On classification of grain crop
Grains are responsible for providing modern human populations with cereals, grain derivatives and raw materials for other industries. The significance of the latter is confirmed by historians who assert about a 12-thousand-year history of grain cultivation, which is subdivided by modern science into grain and leguminous crops. Grain crops are grown in all continents of the planet (except Antarctica). The northern and southern boundaries of their range coincide with the planetary boundaries of agriculture. The geography of cereals cultivated all over the world has its own spatial distribution characteristics: rice is grown in Asia, wheat – in the Middle East, corn – in America, millet – in Africa. Subject to food requirements based on the degree of vital necessity, bread and potatoes rank first for some countries, while for others – rice is a staple food, vegetable crops predominate in some countries, as does marine food in others.

The most common grain crops include wheat, rice (especially in Asia), corn (especially popular in North America), rye (widely represented in Europe), oats, barley, buckwheat, triticale, millet and sorghum (in Asia, Africa). Some less common crops are also worth mentioning, including chumiza, paiza cultivated in China, African millet, teff – in Ethiopia, dagussa – in India, powdery amaranth – in Peru.

Nikolai Vavilov in his writings spoke about the evolutionary agroecological classification of grains, in addition to botanical systems, by ecological, physiological and economically valuable traits and properties [3].

According to the classification adopted in Russia, grain crops, based on their principal values, are subdivided into white straw crops that include wheat, rye, triticale; cereal crops that include rice, millet, buckwheat; grain fodder including oats, barley and corn, sorghum, mogar, paiza, African millet, Sudanese grass, chumiza. A very widespread group of cereals that are becoming massively important, coming under the legume family of the papilionaceous subfamily, is leguminous cereals that include peas, green beans, soybeans, vetch, lentils, beans, etc. (Table 1)

| Group                  | Varieties                                                                 |
|-----------------------|---------------------------------------------------------------------------|
| Grain crops           | corn • oats • wheat • rye • sorghum • triticale • barley • quinoa         |
|                       | • finger millet • teff                                                    |
| Grain legumes         | broad bean • peas • guar • lupine • mung bean • chickpeas •              |
|                       | soybeans • green beans • pea vine • lentils                              |
| Cereal crops          | buckwheat • finger millet • mohar • millet • rice • sorghum • chumiza    |

According to FAO experts, those crops alone that are harvested for dry grains can be referred to as grain, including barley, buckwheat, canary seed, other cereals, fonio (small-grain millet), a mixture of cereals, corn, millet, oats, quinoa, rice (unhulled), rye, sorghum, triticale, wheat, while corn, sorghum, barley and oats – as the main fodder crops. Legumes involve beans, chickpeas, blackeyed pea, peas, pigeon peas, other legumes, lentils, horse beans, lupine, spring vetch, bambara beans (peanuts). Such essential crops as soybean, sunflower, sesame, mustard (seeds), poppy seeds fall within oilseeds. This group also includes rapeseed that is used in the food industry and very widely in the non-food industry.
4. Changes in the structure of cultivated areas

In support of the importance of grain growing in world agriculture, it is proposed to consider changes in the cultivated areas occupied by grain and leguminous crops for three significant periods that most vividly depict the economic and technological development of social production and national economies in a historical perspective. This is the pre-war period 1909-1913, also pre-war 1938-1939 and modern 2019-2020.

For 1909-1913, an average annual area for wheat production – a valuable grain commodity – amounted to 53,160 ths. ha in Europe, 31,325 ths. ha – in America, 16,063 ths. ha – in Asia, 3,427 ths. ha – in Africa, 3,174 ths. ha – in Oceania with Australia. All over the world (excluding Russia) – 77,778 ths. ha, and together with Russia – 107,149 ths. ha. Rye crops were sown over 14,679 ths. ha without Russia and 44,092 ths. ha with Russia, oats – 38,343 ths. ha without Russia and 56,996 ths. ha with Russia, maize – 68,621 ths. ha without Russia and 70,637 ths. ha together with Russian areas. Rice was grown on an area of 42,772 ths. ha [4] (Table 2).

| Grain crops | Average sown area in 1909-1913 | Average sown area in 1938-1939 | Harvested area in 2019, ths. ha |
|-------------|---------------------------------|---------------------------------|-------------------------------|
| Wheat       | 107 149                         | 160 000                         | 239 634                       |
| Rye         | 44 092                          | 40 000                          | 4 346                         |
| Barley      | 32 984                          | 37 000                          | 51 410                        |
| Oats        | 56 996                          | 55 000                          | 9 553                         |
| Maize       | 70 637                          | 85 000                          | 238 514                       |
| Rice        | 42 772                          | 78 000                          | 192 016                       |
| Cereal legumes | 11 280*                      | 47 000                          | 91 773                        |

* soybean [6]

Sources: [4]; website of the Food and Agriculture Organization of the United Nations (FAO), URL: http://www.fao.org/statistics/ru/ (date accessed: 11.04.2021).

According to Nikolai Vavilov, in 1938-1939 around the world, about 160 mln ha were already occupied by wheat, about 55 mln ha – by oats, about 40 mln ha – by rye, about 37 mln ha – by barley, about 47 mln ha – by cereal legumes (including peanuts), including chickpea – 9 mln ha, peas – 3.5 mln ha, beans – 2.3 mln ha, lentils – 2.1 mln ha; corn – 85 mln ha, rice – 78 mln ha [3].

In 2019, all over the world, cereals were harvested from an area of 822,170,422 ha [FAO], which speaks of a special place taken by the grain-growing sector and the priorities of its development in agricultural production around the globe. It is important to highlight the relevant, multi-fold changes in crops such as corn and rice, a significant decrease in the acreage of barley and rye (Table 2).

5. On grain production per capita

Within a forecast balance of resources and use of grain and legumes, reflecting the expected volumes of production, domestic consumption, exports and volume of carry-over stocks of grain and legumes, the following blocks can be distinguished, namely: food consumption, fodder consumption, industrial consumption, seeds, foreign trade [7].

The issue of reasonable volumes of grain production under a growing demand and supply is especially relevant today – when globally growing population is increasingly coming into conflict with limited food production resources in quantities sufficient to meet the needs of a growing population. What is more, today a high percentage of the population is suffering food shortages and, unfortunately, starving, including children. In 2019, according to the World Health Organization (WHO), this was almost 690 million people. Over the past five years, the number of hungry people has grown by 60 million. In total, 8.9% of the world’s population are starving. The number of hungry people could rise to 840 million by 2030 if current trends persist [7].
Modern researchers discuss both the problems of food security of countries and the global level of food shortages and hunger on the planet.

For the most part, Russian researchers touch upon the problem of sufficient food supply for the population.

**Table 3.** Harvests of cereals, legumes, sunflowers, sugar beets and potatoes, kg per capita in Russia [8]

| Item                        | 2015 | 2016 | 2017 | 2018 | 2019 |
|-----------------------------|------|------|------|------|------|
| wheat, rye, barley, oats, grain maize, rice, cereal legumes | 715  | 823  | 923  | 771  | 826  |
| sugar beet                  | 266  | 350  | 354  | 266  | 346  |
| grain sunflower             | 63   | 75   | 71   | 87   | 105  |
| potatoes                    | 173  | 153  | 148  | 153  | 150  |

Source: [8].

Grain harvests in Russia are reaching record levels. According to the information provided by the Institute for Agricultural Market Studies (IKAR), in 2020 Russia harvested the second ever grain and wheat harvest in Russia – 133 MMT and 85.9 MMT, respectively. Record grain exports in the first half of the 2020/21 season amounted to 31.3 MMT of all grains and 25.5 MMT of wheat, which is 20% higher than last year (excluding informal export to the EAEU countries). However, there is no clear increase in the volume of cereals per capita (Table 3).

Today, the tasks of sustainable provision of the population with food and the growth of export supplies make it relevant to assess the level of food security, in the light of new technologies to facilitate livestock production, recommended consumption standards and high provision of the population with certain food items [18].

6. Conclusion
The grain-growing sector of the Russian Federation is not only interconnected with a significant number of branches of the national economy, but serves as their basis. It fosters the food supply of the population of not our country alone. According to Academician A. I. Altukhov, “insufficient regulation of the grain market and the monopoly of material and technical producers give an additional impetus to a rise in domestic prices, thereby increasing the disparity in prices for grain and industrial products used by grain-producing farms. It is in the grain farming and the grain market that almost all numerous challenges facing the grain-growing sector have intertwined and concentrated into a tight, complex knot” [9].

A “grain rate” used to calculate food supply (production of 1 ton of grain per capita [10]) today requires updating, with due account for new technologies for livestock production, recommended consumption rates and the provision of certain food items to the population of the country [11].

Besides, the use of digitalization technology, the development of ICT promotes a modern multi-level system towards updated rationale for grain production volumes and assessment of consumer demands for food. Agriculture and agrifood industry as a whole are being transformed, which leads to a change in the structure of production and management system, not only economic entity wise, but also across the agrarian sector as such. The development and strengthening of integration relations in agriculture requires special attention, sensitive regulation based on a scientific approach, and this will significantly reduce the impact of negative factors on the agricultural market, and, on the contrary, have a positive effect on the provision of the population with food, both in Russia and in partner countries.

Acknowledgments
The reported study was funded by RFBR and SC RA, project number 20-510-05020/20.

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