Technologies for assessing food security in the transition to a circulating economy

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Abstract. The article discusses the main problems of ensuring food security, both at the state and municipal levels. In the course of the research, a number of hypotheses were put forward. Foreign examples of solutions to the problems of rural depopulation are given. Criteria and indicators of food security are proposed. The food sovereignty of Russia is analyzed and the main problems of the ineffectiveness of the food security policy are presented. The conclusion is made about the relationship between the environmental aspect and food security.

1. Introduction
Food sovereignty is a key component of a country's economic security and plays an important role in governance. In recent years, climatic and political challenges have complicated the activities of agricultural producers, damaging food security.

Unequal opportunities for food production and the lack of economic resources for their purchase contributed in 1974 to the creation of the concept of food security by the United Nations presented at the World Food Conference [1].

However, most of the world's population still suffers from the lack of adequate food security systems, which causes a shortage of food products necessary for a full life (in 2018, 821 million people suffered from chronic malnutrition) [2].

The production of large quantities of food does not in itself solve the problems of food sovereignty, which also relate to food availability and safety.

Moreover, food security analysis is rarely linked to soil management, which is important in the concept of a circular economy. The lack of strict control of the state of soils and their treatment with pesticides contributes to the infliction of negative harm to the environment and human health.

The food systems of countries every year experience more and more difficulties in achieving sustainable food security in conditions of limited resources, which leads to constant interaction with the economic, social and environmental aspects of life [3].

Within the framework of this study, the following hypotheses were put forward:

Hypothesis 1. What is the role of industrial agricultural organizations in the overall food security system?

Hypothesis 2. The balance of the ratio of organic agriculture and intensive farming using mineral fertilizers, chemical plant protection products, cultivation of GMO plants?
Hypothesis 3. What is the optimal ratio of peasant (farmer) households and large-scale production, taking into account the socio-cultural values and needs of the region?

Hypothesis 4. The influence of export potential on the quality of products for domestic consumption?

Hypothesis 5. Impact on food security of the existing and possible challenges of the global agricultural market?

Hypothesis 6. What criteria of food security are presented in agrarian and post-industrial countries?

Hypothesis 7. How do changes in the structure of food, new emerging diets in the context of globalization, consumer preferences affect imports?

2. Materials and methods

In the studies studied, special emphasis is placed on solving the problems of environmental safety and popularizing the transition to a green and bioeconomy, and pays special attention to the calculated indicators of food availability and to the delineation of the definitions of “food security”, “food independence”, “food self-sufficiency” [4].

The transition to a green and bioeconomy is associated with a transition to biofuels, which will promote rural development as the main supplier of raw materials for this product [5].

The problems of ensuring food security for coastal and island territories, described by foreign authors, contributed to the emergence of a new criterion for marine food security [6]. With regard to Russia, in terms of food security, the extraction of aquatic biological resources, the dynamics of the production of commercial aquaculture objects are practically not considered in the scientific literature.

In recent decades, the criteria and indicators of food security have been significantly expanded, but amid the constraints associated with the pandemic, local food crises and the contours of the global financial crisis, an ideal assessment system has not been achieved.

In addition to the standard cross-validity questions, Headey D. and Ecker O. include criteria that include intertemporal validity (the ability to identify trends and shocks) and nutritional relevance. Using a combination of literature review and recent empirical analysis, they compared four types of metrics (caloric intake, poverty, dietary diversity, and subjective metrics) with these metrics as a means of systematically identifying their relative strengths and weaknesses and comparing overall performance. Measures of dietary diversity are the most effective class of indicators: they are powerful predictors of economic status and malnutrition (both stunting and wasting), are sensitive to shocks, and are relatively cheap to measure [7].

The author's research is conducted on the basis of a systematic review of the food security sector using content analysis. A methodological approach based on a broad study of the problems of agricultural producers has identified specific development priorities to improve food security.

The ranking of food security of the countries of the world proposed by the British the Economist Intelligence Unit, which is a dynamic quantitative and qualitative reference model, built based on 34 indicators, allows comparisons between states to determine the strengths and weaknesses in the food security system. According to the global food security index, Russia ranks 42nd out of 113 countries in the ranking (figure 1).

The locality-specific food security criteria explored in Tanzania cover specific dimensions: three dimensions of sustainability (social, economic and environmental) while simultaneously representing four dimensions of food security (availability, access, use and sustainability), showing that rural communities think holistically and consider a variety of criteria and measurements related to food security. A methodological approach based on a broad understanding of the understanding of farmers and villagers is suitable for identifying specific development priorities that need to be addressed to improve food security in a specific area. Locality-specific food security criteria can be used to assess impacts, monitor and evaluate rural development measures [9].
3. Results
The main pillar of food sovereignty is the countryside, which is the main foundation, the producer of raw materials for the food industry. At the regional level, the functions of deep processing are carried out, and further redistribution through trade networks, including the return of already processed products back to the village at higher prices. At the country level, global monitoring and coordination of the entire food system of the country is carried out and the formation of a food security plan.

Graphically, an ideal food security model can be viewed in figure 2.

![Correct food security model](image)

**Figure 1.** Food security of Russia [8].

**Figure 2.** Correct food security model.

The modern provision of food security is faced with a wide variety of problems caused by population growth, poverty, and climate change. This is especially true in rural areas of developing countries, as they account for the majority of hungry and malnourished people.

Key challenges for ineffective food security policies:

- Reduction in the number of rural residents, which does not allow maintaining a high level of organic farming and eco-farming;
- Suboptimal stimulation of the export of agricultural products;
- Measures of sanctions / countersanctions, including those on political, phytosanitary, veterinary or other grounds;
- Changing of the climate;
- Insufficient investment in agriculture;
- Lack of qualified personnel in the agro-industrial complex;
- Lack of a balanced policy in relation to agricultural producers;
- Weak base of Russian domestic selection and seed production, breeding.
Despite all this, Russian agriculture, among the developed countries, is one of the most efficient in the world. Receiving insignificant state support in the form of subsidies and subsidies (in the EU, subsidies in the cost of agricultural products are 30%, in Russia 3%); the agro-industrial complex is not only able to provide the population with food, but also to export abroad [10].

4. Discussion

Agriculture has been able to advance food security to a new level in public administration. Unfortunately, the role of agriculture is limited by the internal conflict arising from the achievement of food sovereignty. Many countries, in the process of forming criteria for ensuring food security, overlook the criterion of marine food security and ocean security in general, as an important supplier of eco-resources.

Coastal ecosystem problems associated with ocean pollution and warming could deprive 10% of the world's population of micronutrient sources and employment.

Rapid deforestation and soil depletion in all countries threaten the entire ecosystem of the planet and food security. Unsustainable land use practices that provoke land degradation and slow the global transition to a green and bioeconomy not only deprive the accumulation of biomass reserves, but also destroy existing ones.

To solve problems related to environmental safety and promote the development of rural areas, it is necessary to create a program to stimulate third-generation biofuels, which does not reduce the availability of food [11].

The vulnerability of food security lies in its belonging to the agricultural sector, which has been experiencing degradation in recent decades [12]. The mass extinction of villages due to low wages and the lack of comfortable living conditions deprives the agricultural sector of its labor force and further development prospects. The growing dynamics of depopulation of villages must be eradicated by a balanced agricultural policy developed for each individual subject of the country, taking into account its individual characteristics and problems. An example of a successful targeted agrarian policy are the agricultural projects in Spain, which are developed for specific villages with their inherent problems [13]. This allows for an individual approach to the problem of the village, rather than building a common policy for all, which in most cases does not yield results.

The massive urbanization of the population that began in the 21st century has changed the entire structure of the consumer market, causing the vulnerability and fragility of the food system. Over 19 years, the rural population in Russia, which is the main labor force in the agricultural sector, has decreased by 2 million people.

In 1800, only 2% of the world's population was affected by urbanization; in 2008, urbanization reached 50%, while the increase in the number of the world's population must also be taken into account. If the trend continues to increase, then by 2030 urbanization will be 60% [14]. This will undoubtedly lead to a shortage of quality food products, making entire countries dependent on food importing countries.

The food systems of countries and regions fall short of global sustainability expectations. Most countries of the world are experiencing problems with quality food supply [15]. Figure 3 shows the regions that are undernourished.

The main problem of Russia's food sovereignty is the lack of a sufficient amount of domestic seeds. At the end of 2019, the share of domestic seeds in the domestic market is less than 62.7%, which does not correspond to the Doctrine of Food Security of Russia, which displays an indicator of at least 75% [17]. In terms of agriculture, Russia is fully provided only with seeds of domestic breeding: winter wheat 90.5%, spring wheat 82.2%, barley 63.5%. In the rest of the cultures traditional for Russia, a catastrophic situation is observed. The country is provided with seeds of sugar beet and potatoes by only 0.6% and 9.7%, respectively, sunflower by 26.5%, spring rape by 31.7%, corn by 46% and soybeans by 41.8% [18].

An equally urgent problem of modern agriculture in Russia is the training of personnel for the agro-industrial complex. Today in Russia there are 54 agricultural universities of the Ministry of
Agriculture of Russia in which 350 thousand people are trained [19]. Nevertheless, of the entire mass of graduates of the relevant specialties, only 20% remain to work in agriculture [20].

Figure 3. The region of the earth experiencing malnutrition [16].

Studying agricultural policy through a retrospective prism, it can be seen that market interventions in the agricultural sector (grants, subsidies, duty restrictions) are mainly aimed at stimulating food producers (purchase of equipment, incentives for fuels and lubricants, tax preferences). However, the implementation of such a policy, if no additional measures are taken, does not give the desired result since the main factors of cost growth, such as storage, processing, transportation, losses from food waste, redistribution and marketing are not taken into account [21].

5. Conclusion
Agriculture is the main guarantor of food security in the region and the country, which is facing restrictions. All restrictions are systematic and institutional in nature, which makes them difficult to solve.

The elements of occupational safety, covering the entire value chain of crop and livestock products, dictate the selection criteria for personnel for agricultural producers.

Food security research should be undertaken in a holistic and interdisciplinary approach, covering all interrelated areas.

Food security is characterized by physical and economic accessibility, food safety for consumers. Among the criteria: stability of the agro-industrial complex; level of manufacturability, environmental policy and agricultural policy market, product competitiveness, volume of grain carryover stocks, etc.

In the modern world, food security is increasingly viewed in the context of environmental impact, which indicates a gradual transition to a circular economy (closed type).

Achieving food and nutritional security is inherent in four aspects: food availability, access to food (economic and physical), use of safe food (meeting sanitary and health standards), food stability (security of supply, unlimited time and quantity of receipt).

On the scale of post-industrial development, the creative economy has recently emerged, including creative rural areas, the digital economy in relation to the field of digital agriculture, a green economy, including organic agriculture and non-traditional forms of energy, as well as the circulation economy that has appeared in recent years.

Despite the seemingly trite scientific problem of food security, in addition to unsteady opinions on regional criteria for food security, it should be noted that aspects such as the preservation of the
traditional dietary structure, for example, the provision of fish species from local water bodies, should be noted.

Among the new aspects, one should highlight the balance between foreign exchange earnings from the export of agricultural products and the preservation of high-quality bakery grain and flour on the Russian domestic market.

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