

A model for assessment of agricultural products provision at the level of regional food systems

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Abstract. The article presents an overview of scientific publications on the provision of agricultural products, highlights the factors affecting the provision of food to the population. Emphasis is placed on studies devoted to the analysis of household resilience to food insecurity. A model for assessing the availability of agricultural products at the level of regional food systems is proposed. Based on the developed indicators, an assessment was made of the availability of agricultural products in the regions of the Southern Federal District (SFD) in 2020. The regions were ranked according to the level of provision with agricultural products. The leading regions of the SFD and the regions with the lowest level of provision of agricultural products were identified. The practical significance of the proposed assessment model lies in the use of the data obtained in determining the directions for the implementation of agri-food policy and the formation of measures to support the regions.

1 Introduction

The irrationality of the structure and norms of consumption that has developed in several regions of Russia largely does not meet the requirements and regulatory indicators of the current Food Security Doctrine of Russia. A number of studies on the regulation of food supply and food security have been devoted to the classification and analysis of factors that shape food supply at the level of regional food systems and individual households. Also, attention has been paid to the development trends of the global food system, and the formation of an international consumption model based on modern standards of food consumption typical for most countries of the world [1].

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Agricultural production, food security and food availability are affected by climatic factors and global climate change. Using specialized computer models, scientists are trying to predict how a further increase in greenhouse gas emissions, which occurs mainly as a result of anthropogenic activities and contributes to an increase in atmospheric temperature, melting glaciers, and rising world ocean level levels - will affect climate change. Already at this stage the consequences of such changes are becoming a serious problem for agricultural production and food systems, mainly in the developing countries of the world. There are global and regional changes in atmospheric temperature, a violation of the hydrological cycle including a change in the volume of water vapor in the atmosphere, which in turn affects the amount of precipitation. A number of case studies analyse the impact of climate variability on food provision and food availability [2]. With some researchers paying attention to food supply in the context of a reduction in agricultural land due to competition with non-agricultural usage.

Regions that both serve as major agro-ecological zones and coincide with the largest mineral deposits are often subject to the process of destruction of arable land which negatively affects agricultural productivity and threatens food security due to land use change when agricultural land is used for mining.

2 Materials and Methods

The analysis of the availability of food products can be carried out both at the state level and at the level of an individual family (household). Of particular interest are studies that analyse food security in relation to certain categories of the population. For example, J. S. Sin Wei and Le Q. McManamey analysed the factors affecting food security of migrants on the example of Tasmania. In a study by L. Bidiger-Friedman and B. Sanchez a buying food behaviour and food insecurity of students were studied [3-4].

P. Zidouemba analysed the conceptual foundations of food security and considered the influence of a number of factors on a global to household scale that determined the food security of households [5]. In the study of Ballairam, B. Lawrence, F. Henry, food security in the Caribbean countries is analysed through the prism of a conceptual model that links food, nutrition and public health [6]. A global trend is the growth of urban population. Jn. Crush and B. Frayne analysed the relationship between development of urban agriculture and the food supply of urban population [7-8]. A few studies analyse the food security of households in rural areas depending on their specialization in certain types of agricultural activities [9].

Of particular interest are studies on the resilience of households to food insecurity [5;10]. Using the concept of sustainability to analyse food security raises the question of what indicators to measure. One of the characteristics of sustainability is the complexity of its dynamics. In times of instability, individuals or households may experience changes in their standard of living in response to cyclical and seasonal changes, with direct implications for food security. Transitions from one state to another are often characterized by threshold effects or points of no return, when it is no longer possible to return the system to its previous state. For example, when crops die as a result of drought, or there is a sharp reduction in the herd of farm animals below the limit acceptable for recovery.

Sustainability has a multidimensional character, which makes it difficult to assess to a certain extent. T. Kebede, J. Haji, B. Legesse, G. Mammo made an attempt to conduct an econometric analysis of the resilience of rural households to the lack of sufficient agricultural products. In a study by C. Pemberton, M. Mgonja, H. Patterson-Andrews, the task was to develop a methodological approach for conducting interstate comparisons on food security [11]. As an effective method of comparative analysis, scientists propose the use of multivariate analysis of variance which will allow to establish the presence of

significant differences between countries in relation to a set of indicators characterizing food security. The methodology makes it possible to analyse a range of indicators - dependent variables characterizing four groups of food supply parameters (availability of food, its accessibility, safety and stability of food supply).

The advantage of using the multivariate analysis of variance methodology to compare the food provision indicators of several countries is that it allows you to establish whether there are differences in groups of indicators, taking into account (simultaneously) all analysed indicators without the need to create a composite indicator for evaluation. The complexity of the analysis lies in the fact that there is not always a full amount of comparable statistical data for comparison, thus, comparison can be made only for those indicators for which relevant data are available for all countries. This problem requires a development of new and adaptation of existing methods for assessing level of food supply, mathematical modeling and forecasting food security.

3 Results and Discussion

To assess availability of agricultural products at the level of regional food systems, self-sufficiency index of the region can be used (I_{FSS}):

$$I_{FSS} = \frac{\sum_{i=1}^n Cs_1 + Cs_2 + \dots + Cs_n}{n} \quad (1)$$

Where Cs_1, Cs_2, \dots, Cs_n are partial coefficients of self-sufficiency for certain types of food products; n is the number of types of food products for which self-sufficiency coefficients are calculated [12].

The traditional leader in terms of agricultural production among the regions of the Southern Federal District and Russia was the Krasnodar Territory; the volume of production amounted to 432,963 million rubles [13]. In terms of agricultural production in 2020, the SFD took 3rd place among other regions of Russia. However, in comparison with the volume of agricultural production for 2019, there is a decrease in production indicators by 8.6%. Also, in a number of regions of the SFD - the Republic of Kalmykia, Crimea, the Rostov Region, the city of Sevastopol, in 2020, a decrease in the volume of agricultural production was recorded, compared with the volume of output in 2019. Producers of agricultural products in the Astrakhan and Volgograd regions managed to ensure an insignificant increase at the level of 1.3 - 2.3%. Decreased volumes of agricultural output in the field of crop production in the republics of Kalmykia, Crimea, Rostov region, the city of Sevastopol (table 1).

Table 1. Indices of agricultural production in the Southern Federal District, %.

	Agricultural products		Crop products		Livestock products	
	2019	2020	2019	2020	2019	2020
Southern Federal District	107.7	95.1	112.0	92.9	98.6	100.2
Republic of Adygea	108.1	106.5	108.9	108.2	106.5	103.5
Republic of Kalmykia	98.3	89.7	131.8	86.6	91.3	90.7
Republic of Crimea	119.3	86.3	130.2	77.7	105.6	98.6
Krasnodar region	108.9	91.4	111.3	87.1	102.8	102.4
Astrakhan region	101.8	102.3	101.3	103.4	102.5	100.6
Volgograd region	108.0	101.3	110.6	101.6	102.9	100.7
Rostov region	105.8	97.1	112.5	96.6	88.1	98.8
Sevastopol city	116.4	90.3	118.7	89.4	99.2	100.1

In accordance with the assessment, the optimal indicators of food supply for agricultural products among the regions of the SFD in 2020 were demonstrated by the Krasnodar Territory, the Volgograd Region and the Republic of Adygea. The regions that have a low level of provision with agricultural products among other regions of the SFD are established - these are the republics of Kalmykia and Crimea. In 2020, the Republic of Kalmykia experienced a decrease in agricultural production by 10.3% compared to the level of 2019, which, among other things, contributed to the increase in prices for agricultural products. In the Republic of Crimea, in 2020, the volume of agricultural production also decreased; in the structure of consumer spending, 47.2% was the cost of purchasing food.

An increase in the level of provision with agricultural and food products can be realized through the development of the agricultural sector, as well as non-agricultural sectors, in particular, the processing industry and service sector.

Agriculture forms a significant part of GDP in many countries of the world, and growth in agricultural production can really improve living standards in rural areas. In addition, agriculture has a significant impact on the development of related industries, including the food, processing industry, and trade. Supporters of development of agriculture as an effective strategy for increasing the level of provision with agricultural products express the following arguments in favor of its development [14-15]:

- In a number of countries of the world, primarily developing countries, there is no alternative to agriculture: limited reserves of minerals do not allow development of the extractive and manufacturing sectors, and the service sector is limited by demand in domestic markets
- Achievements of modern science, new technologies open up additional opportunities for increasing productivity and developing agriculture, even in those countries and regions that previously had no opportunities for the active development of agricultural production
- Growth in agricultural production increases availability of food for farmers and population living in rural areas with personal subsidiary plots.

A strategy to increase the level of sufficiency in agricultural and food products based solely on development of the agricultural sector is also opposed by the following arguments:

- Trade liberalization and development of foreign direct investment have opened up new opportunities for developing countries to export manufactured goods and services and import cheap food products
- In many developing countries, low productivity of agriculture and, consequently, its low competitiveness in the international market, deter development
- The scale of agricultural growth is limited due to the natural limited resources for its development (for example, the area of agricultural land), and other fast-growing sectors may become a priority for developing countries
- Development opportunities for small farms and agricultural enterprises are limited, prices for their products often do not cover production costs.

On the basis of econometric analysis, a number of researchers tried to determine a potential for growth in the provision of food and agricultural products through development of various sectors - agriculture, industry, and service sector. Ravallion M. and Chen S. show that growth in agriculture has a greater impact than growth in the secondary and tertiary sectors [16]. In Latin America, an increase in agricultural GDP per agricultural worker is less effective in increasing the agricultural supply to the poor than an equivalent increase in non-agricultural GDP per agricultural worker. According to L. Christiansen [17]. In order to increase provision of agricultural products and foodstuffs in African countries, growth in agriculture is more favorable than growth in non-agricultural sectors. Accordingly, when choosing a strategy to increase the level of agricultural supply and identifying priority

development sectors, it is necessary to take into account specifics of each country, since this will be crucial for developing the most effective agricultural policy.

4. Conclusion

The most significant factors affecting food security are: natural and climatic (extreme weather events, climate, droughts, global climate change), production and technological factors (reduction of agricultural land area, alternative nature of land use, reorientation of agricultural production), political factors (military and civil conflicts, political instability in states and regions of the world, international sanctions and restrictions), a group of socio-economic factors (unequal distribution of income, poverty, unemployment, including seasonal unemployment in certain regions and countries of the world, rising prices for food, inefficient food distribution system).

The proposed methodology and methodological tools can be used when assessing availability of various types of agricultural products at the level of regional food systems. It is possible to conduct a comparative analysis for regions of Russia that have agro-food and agricultural specialization. The data obtained as a result of the analysis are necessary when planning the directions for implementation of agri-food policy and formation of measures to support the regions of Russia.

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