Assessment of food security in the regions of the Arctic zone of the Russian Federation

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Abstract. The article is devoted to improving the methodological tools for assessing food security threats to the constituent entities of the Russian Federation, taking into account the territorial specifics (for example, the Arctic regions). The need for a food security assessment procedure in the context of two approaches is indicated: 1) an assessment of the food security of the Arctic zone, as a set of territories of several regions belonging to different federal districts, but united by a single legal status; 2) an assessment of the food security of the Arctic zone, as a part of the constituent entity of the Russian Federation, the territories of which are fully or partially referred to the "Arctic” status. As a result of the comparative analysis of approaches to assessing food security in foreign and domestic practice, a system of indicators was formed, differentiated into 6 projections (criteria): physical availability of food; economic affordability of food; sufficiency of food consumption; food quality; transport accessibility; support for the functioning and development of the agro-industrial complex. Approbation of the proposed assessment toolkit was carried out on the example of the regions of the Arctic zone of the Russian Federation, the studied period is from 2012 to 2019. As a result of the assessment, food security threats have been identified both in the context of a separate Arctic entity and the Russian Arctic as a whole. The identified threats provide a basis for the development of specialized tools aimed at improving the regional economic policy in the food sector, taking into account the territorial specifics, as well as increasing the level of food security in the Arctic zone of the Russian Federation.

1. Introduction
The current state of the food supply system of the population of the Russian Federation until 2014 was characterized by a continuing decline in domestic food production with an increasing share of imports in the formation of food resources. The imposition of international sanctions in 2014 by a number of foreign countries, as well as the subsequent imposing food embargo on certain foreign-made food products by the Government of the Russian Federation made it possible to significantly correct the situation in the food sector. Over the past five years, a sharp increase in investment in the Russian agro-industrial complex has been recorded, which determines the technical and technological modernization of the industry.

As a result, there is an increase in the possibilities of agricultural producers to increase production volumes, and import food dependence is decreasing [1].
Nevertheless, there remains a need to supply imported food to Russia, which is primarily due to the natural and climatic conditions, as well as the still insufficient level of development of the domestic agro-industrial complex. Many regions are either unable to produce certain types of products, or cannot produce sufficient quantities to meet all the needs of the population [2]. In addition, the rise in prices for both domestic and imported food products has a negative impact on food security.

The regions of the Arctic zone differ from other regions of Russia primarily in that, due to their geographical location close to the Arctic Ocean, they have special harsh natural and climatic conditions for economic management. That is why the general approach to ensuring food security is inapplicable to them [3].

An extremely important aspect in matters of food security is the organization of monitoring of its current state, based on a system of criteria, indicators and their indicators, taking into account regional specifics. The assessment procedure focused on the identification of threats provides an opportunity in the future for the formation of management decisions aimed at improving the regional economic policy in the food sector, taking into account the territorial specifics, as well as increasing the level of food security of the Arctic zone of the Russian Federation (AZRF).

Based on the foregoing, the purpose of the study is to assess the level of food security in the regions of the Arctic zone of the Russian Federation, identify threats and develop measures to counter them.

2. Methods

Conducting a food security assessment procedure with subsequent identification of threats in the regions of the Arctic zone of the Russian Federation is based on the following approaches and methods:

1) world practice in the aspect of food security assessment based on the formation of a comprehensive assessment indicator taking into account the inclusion of private indicators [4]: the Global Food Security Index (GFSI), the Global Hunger Index (GHI), the Poverty and Hunger Index (PHI);

2) regulatory documents of the Russian Federation, regulating food security issues, including the format of the procedure for its assessment (Food Security Doctrine of the Russian Federation, approved by Presidential Decree No. 20 dated January 21, 2020; Order “On Approving the List of Indicators in the Sphere of Food Security of the Russian Federation ” No. 296-r dated February 10, 2021);

3) the results of foreign studies on the assessment of: the sustainability of the food component [4]; stability of food supplies, taking into account the transport accessibility of territories [5]; the state of health of the population [5]; the level of safety of food elements and / or pollutants [6];

4) the results of domestic studies of issues of assessing food security at the regional level [7-12]: the possibility of using a point assessment, differentiation of assessment results depending on the amount of points and establishment of an appropriate level of food security (high, acceptable, low, unacceptably low).

Taking into account that complex indicators form a problem at the stage of synthesis and interpretation of the obtained evaluation results [13], it was concluded that it is necessary to form an aggregated system of evaluation parameters according to a certain set of criteria [3]: physical availability of food; economic affordability of food; sufficiency of food consumption; food quality; transport accessibility; support for the functioning and development of the agro-industrial complex. The possibility of using the scoring system of assessment [12] is indicated, provided that clear threshold values are formed for measuring criteria and estimated indicators.

The algorithm of the assessment methodology will include two stages: determining the level of food security and assessing food security threats. At the first stage, the following sequence of actions is provided:

1) the formation of a system of indicators, differentiated by 6 projections (criteria) [3];

2) formation of threshold values for each approved indicator for the purpose of threat identification [3];

3) the establishment of a certain number of points for each of the indicators (in terms of the imposed restrictions). If the indicator is characterized by a high level of assessment, then it is given 1 point, if it is acceptable, then 2 points, if it is low, then 3 points, respectively.
4) calculation of the level of food security (by summing up the points);
5) interpretation of the results obtained.

At the second stage, the following sequence of actions is envisaged:
1) carrying out a simple standardization procedure to bring the indicators to a comparable form; calculation of deviations of actual values from the established standard;
2) synthesis and interpretation of the results obtained taking into account the estimated level of food security;
3) making management decisions to counter the identified threats.

The details of the assessment procedure in terms of criteria, indicators, threshold values for the interpretation of the results obtained are presented in table 1. The threshold values (permissible standards) were proposed by the authors taking into account the Arctic specifics and can be changed depending on the territorial affiliation.

**Table 1.** The system of criteria and indicators for assessing the level of food security in the regions of the Arctic zone of the Russian Federation (compiled by the authors).

| Criterion                              | Indicator                                    | Threshold value                                                                 | Indicator assessment level |
|---------------------------------------|----------------------------------------------|--------------------------------------------------------------------------------|---------------------------|
| Physical food availability            | Self-sufficiency coefficient ($C_d$)          | No less than 0.5                                                             | low: $C_d \leq 0.5$;     |
|                                       |                                              |                                                                               | permissible: $0.5 < C_d \leq 0.7$; |
|                                       |                                              |                                                                               | high: $0.7 < C_d \leq 1$.  |
|                                       | Food import coverage ratio ($R_i$)            | No less than 1.0                                                             | low: $R_i \leq 1.0$;     |
|                                       |                                              |                                                                               | permissible: $1.0 < R_i \leq 2.0$; |
|                                       |                                              |                                                                               | high: $R_i > 2.0$.        |
| Economic affordability of food        | Poverty rate ($R_p$)                          | No more than 0.2                                                            | low: $R_p > 0.2$;        |
|                                       |                                              |                                                                               | permissible: $0.1 < R_p \leq 0.2$; |
|                                       |                                              |                                                                               | high: $R_p \leq 0.1$.    |
| Adequacy of food consumption          | Purchasing power ratio of household income ($R_i$) | No more than 0.7 | low: $R_i > 0.7$; | low: $R_i > 0.7$; |
|                                       |                                              |                                                                               | permissible: $0.1 < R_i \leq 0.2$; |
|                                       |                                              |                                                                               | high: $R_i \leq 0.4$.    |
|                                       | Gini coefficient (income concentration index) ($C_G$) | No more than 0.4 | low: $C_G > 0.4$; | low: $C_G > 0.4$; |
|                                       |                                              |                                                                               | permissible: $0.3 < C_G \leq 0.4$; |
|                                       |                                              |                                                                               | high: $C_G \leq 0.3$.    |
|                                       | Sufficiency ratio (calorie content) ($R_c$)   | No less than 2908-2916 kcal                                                  | low: $R_c \leq 2908$;    |
|                                       |                                              |                                                                               | permissible: $2908 < R_c \leq 3000$; |
|                                       |                                              |                                                                               | high: $R_c > 3000$.      |
|                                       | Food structure coefficient (diet) ($C_d$)     | No less than (-20)                                                          | low: $C_d \leq (-20)$;  |
|                                       |                                              |                                                                               | permissible: $(-20) < C_d \geq (-10)$; |
|                                       |                                              |                                                                               | high: $C_d > (-10)$.     |
| Food quality                          | Quality factor ($F_q$)                        | No more than 20                 | low: $F_q > 20$;         |
|                                       |                                              |                                                                               | permissible: $10 < F_q \leq 20$; |
|                                       |                                              |                                                                               | high: $F_q \leq 10$.     |
| Transport accessibility               | The ratio of the regional density of public railways to the average for the Russian Federation | No less than 0.5* | low: 0.5; | low: 0.5; |
|                                       |                                              |                                                                               | from 0.51 to 0.8: permissible; |
|                                       |                                              |                                                                               | over 0.81: high.         |
| Transport accessibility               | The ratio of the regional density of public roads to the average for the Russian Federation | No less than 0.5* | low: 0.5; | low: 0.5; |
|                                       |                                              |                                                                               | from 0.51 to 0.8: permissible; |
|                                       |                                              |                                                                               | over 0.81: high.         |
|                                       | The share of rural settlements connected by hard-surface roads with the network of public roads in the total number of rural settlements | Comparative analysis, % | below 60.0: low; | low: below 60.0; |
|                                       |                                              |                                                                               | from 60.1 to 80.0: permissible; |
|                                       |                                              |                                                                               | over 80.1: high.         |
| Support for the functioning and development of the | Share of investments in the development of transportation and storage of the region | No less than 10, | low: 10.0: low; | low: below 10.0; |
|                                       |                                              |                                                                               | from 10.1 to 30: permissible; |
|                                       | Share of investments in agriculture, fisheries and fish farming | No less than 5, | low: 5.0: low; | low: below 5.0; |
|                                       |                                              |                                                                               | from 5.1 to 10.0: permissible; |
agro-industrial complex – over 10.1: high.

* threshold values (permissible standards) were proposed by the authors taking into account the Arctic specifics and can be changed depending on the territorial affiliation

The thresholds established for the indicators are limit values and characterize the normal course of development of various elements in the field of food security. If the indicators are approaching their maximum permissible value, then this indicates an increase in threats in the food sector.

The final level of food security ($I_{FS}$) in the regions of the Arctic zone will be determined by calculating the sum of assessments of the main criteria for food security. For further interpretation of the obtained evaluation results, we introduce the following characteristics:

- high level of food security: $I_{FS} = 13$ (as a result of high values of indicators);
- acceptable level of food security: $13 < I_{FS} \leq 24$ (scores for each of the indicators do not exceed 2);
- low level of food security: $24 < I_{FS} \leq 36$ (scores for each of the indicators do not exceed 3).

In addition, the need for a food security assessment procedure in the context of two approaches is indicated: 1) an assessment of the food security of the Arctic zone, as a set of territories of several regions belonging to different federal districts, but united by a single legal status; 2) an assessment of the food security of the Arctic zone, as a part of the constituent entity of the Russian Federation, the territories of which are fully or partially referred to the "Arctic" status.

3. Results

Approbation of the proposed assessment toolkit was carried out on the example of the regions of the Arctic zone of the Russian Federation, the list of which was approved by the Decree of the President of the Russian Federation "On the land territories of the Arctic zone of the Russian Federation". The study period is from 2012 to 2019; information base - open statistical data of the Federal State Statistics Service of the Russian Federation.

The results of the first stage of the assessment (determining the level of food security) are summarized in table 2.

Table 2. Values of integral indicators of food security in the regions of the Arctic zone, in points.

| Region                          | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---------------------------------|------|------|------|------|------|------|------|------|
| The Republic of Karelia         | 24   | 22   | 25   | 26   | 25   | 15   | 24   | 25   |
| Murmansk region                 | 27   | 26   | 26   | 26   | 26   | 27   | 23   | 26   |
| Yamalo-Nenets Autonomous District | 26  | 25   | 27   | 27   | 28   | 28   | 28   | 28   |
| Krasnoyarsk region             | 28   | 29   | 28   | 27   | 26   | 28   | 25   | 28   |
| The Komi Republic              | 28   | 28   | 27   | 27   | 27   | 29   | 29   | 28   |
| Chukotka Autonomous District   | 28   | 27   | 29   | 27   | 28   | 27   | 28   | 28   |
| Arkhangelsk region             | 29   | 31   | 29   | 31   | 28   | 29   | 28   | 28   |
| Nenets Autonomous District     | 30   | 30   | 30   | 30   | 31   | 30   | 28   | 28   |
| The Republic of Sakha (Yakutia) | 32  | 32   | 31   | 33   | 34   | 32   | 31   | 29   |
| Total for AZRF                 | 30   | 30   | 28   | 28   | 28   | 29   | 29   | 28   |

Thus, based on the scoring system that was introduced when developing a methodology for assessing the level of food security in the regions of the Arctic zone (13 points corresponds to a high level; 14-24 points - an acceptable level; 25-36 - a low level), it was concluded that there is a low level of food security. Moreover, this trend persists throughout the study period. The exception was the values of the integral indicator in the Republic of Karelia in 2013 and 2017, as well as in the Murmansk region in 2018 (the permissible level of food security).

As part of the implementation of the second stage of the assessment, food security threats were identified in the Russian Arctic as a whole (table 3) and in the context of a separate Arctic entity (table 4). Conclusions are drawn about the identification of the identified threats during the entire period under consideration.
Table 3. Threats to food security in the regions of the Arctic zone of the Russian Federation.

| Indicator | Identified threat |
|-----------|-------------------|
| Coefficient of self-sufficiency of regions in food products | The inability of regions to ensure food security through their own production of agricultural products, raw materials and food |
| Coverage ratio of food imports | High dependence on the import of imported food products |
| Poverty rate | Economic inaccessibility of food for the population at the current level of prices and incomes |
| Purchasing power ratio of household income | Deepening the property stratification of society |
| Gini coefficient (income concentration index) | Critical underconsumption of food products, as well as non-compliance of the food structure of residents of the regions of the Arctic zone with rational consumption standards |
| Sufficiency ratio (calorie content) | |
| Food structure coefficient (diet) | |
| Availability of railway networks and highways | Underdeveloped transport infrastructure in the regions of the Arctic zone |
| The proportion of rural settlements connected by hard-surface roads with the network of public roads in the total number of rural settlements | Lack of year-round transport links on paved roads, which determines the seasonality of food delivery |
| Share of investments in the development of transportation and storage | Lack of investment and, as a result, low technical condition and high wear and tear of rolling stock, unsatisfactory condition of the production base |
| Share of investments in the development of agriculture, fisheries and fish farming | Low investment attractiveness of the agro-industrial complex and, as a result, a shortage of investments necessary for the renewal of fixed assets and the further development of the industries |

Table 4. Specification of the identified threats to food security of the regions within the Arctic zone (assessment result based on 2019 data).

| Indicator | Murmansk region | Nenets Autonomous District | Chukotka Autonomous District | Yamalo-Nenets Autonomous District | The Republic of Karelia | The Komi Republic | The Republic of Sakha (Yakutia) | Krasnoyarsk region | Arkhangelsk region |
|-----------|----------------|-------------------------|--------------------------|-------------------------------|-----------------------|----------------|---------------------------|-------------------|----------------|
| The inability of regions to ensure food security through their own production of agricultural products, raw materials and food | + | + | + | + | + | + | + | + | - | + |
| High dependence on the import of imported food products | - | - | - | - | - | + | + | + | - | - |
| Economic inaccessibility of food for the population at the current level of prices and incomes | - | - | + | - | - | - | + | - | - | - |
| Deepening the property stratification of society | - | + | + | + | - | - | - | - | - | - |
| Critical underconsumption of food, as well as non-compliance of the population's dietary structure with rational consumption standards | + | + | + | + | + | + | + | + | + | + |
| Underdeveloped transport infrastructure | - | + | + | + | - | - | + | + | + | - |
| Lack of year-round transport links on paved roads, which determines the seasonality of food delivery | - | + | + | + | - | - | - | + | + | + |
| Lack of investment in the development of transportation and storage and, as a result, low technical condition and high wear and tear of rolling stock, | - | + | - | + | - | - | - | - | - | - |
The situation is most critical in the regions, the territories of which are fully included in the Arctic zone. In view of the Arctic specifics, these regions are characterized by an extremely low level of their own production of agricultural products, raw materials and food, which leads to a high degree of their dependence on imports from other entities. At the same time, the low level of development of the transport infrastructure or its absence at all limits the supply possibilities. As a result, northerners do not receive a lot of important nutrients and vitamins, which subsequently negatively affects the health of the population.

The threats to the food security of the Russian Arctic presented in accordance with tables 3 and 4 are supplemented by the threats identified on the basis of the content analysis of regulatory documents in the food sector. These include:

− insufficient participation of state and municipal authorities in organizing the supply and distribution of food in the Arctic zone;
− relatively low level of development of the business sector for food production in the Arctic zone;
− lack of a conceptual system for monitoring food security indicators specifically in the Arctic zone without reference to the rest of the region, if the zone is a constituent part of the constituent entity of the Russian Federation;
− lack of interaction of regional authorities of the subjects containing the Arctic territories in matters of improving food policy;
− lack of a unified strategy for ensuring food security for the Arctic regions as a single territorial zone of the Russian Federation.

Based on the results of the analysis, it can be concluded that the food policy of the regions is ineffective, since many criteria and indicators go beyond the established threshold values, which in turn indicates the presence of a number of threats to food security in the regions of the Arctic zone.

All of the above not only endangers food security, but also the overall achievement of a high quality of life for the population, which is Russia’s national priority in the Arctic.

4. Conclusion
The identified threats provide a basis for the development of specialized tools aimed at improving the regional economic policy in the food sector, taking into account the territorial specifics, namely:

− development of framework recommendations for improving the regulatory framework food security of the regions of the Arctic zone in accordance with the identified shortcomings;
− development of directions for the accelerated production of local food while reducing costs through the introduction of innovative technologies;
− development of proposals for expanding opportunities for population participation in food supply for the regions of the Arctic zone;
− development of measures aimed at increasing the availability of information on the directions and forms of state support, in order to increase the number of small forms of business and other subjects;
− improving the procedure for centralized import of food to the regions of the Arctic zone;
− developing proposals for regulating the price segment of the food market in the regions of the Arctic zone;

| Unsatisfactory condition of the production base | + | + | + | + | - | + | + | + | - |
| Total number of threats | 3 | 7 | 7 | 7 | 2 | 4 | 8 | 5 | 3 |
• adjusting the information and analytical mechanism for ensuring food security in the regions of the Arctic zone on the basis of improving methodological support, the quality of the formation of statistical material, as well as the apparatus for managing the monitoring system (improving the existing statistical database by introducing information on food security indicators in the regions of the Arctic zone).

As part of the implementation of the final paragraph of the recommendations, it is advisable:

• include in the general aggregate of statistical information data on the food security of the Arctic zone as a whole, on a par with other districts of the Russian Federation;
• provide statistical information on the food security indicators of the Arctic zone in the context of each constituent entity (for to the Arctic zone);
• provide statistical information on the food security indicators of the Arctic zone in the context of each constituent entity at the municipal level (for regions that are partially included in the Arctic zone).

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References
[1] Zinina O V and Olentsova J A 2020 Elements of sustainable development of agricultural enterprises IOP Conf. Ser.: Earth Environ. Sci. 421 022003
[2] Ruiga I R et al. 2020 Improvement of the methodological approaches to the evaluation of the agro-industrial clusters development potential in the regional economy IOP Conf. Ser.: Earth Environ. Sci. 421 032053
[3] Ruiga I R et al. 2019 Food security of the Arctic zone regions in the Russian Federation: formation of methodological principles and performance indicators IOP Conf. Ser.: Earth Environ. Sci. 315 022073
[4] Santeramo F 2014 On the Composite Indicators for Food Security: Decisions Matter! Food Reviews International pp 63-72
[5] Hwalla N 2016 Nutrition security is an integral component of food security Frontiers in Life Science 167-72
[6] King T 2017 Food safety for food security: Relationship between global megatrends and developments in food safety Elsevier 68 160-73
[7] Balatskiy E 2011 Qualitative component of food security in Russia Society and Economics 11-12 224-45
[8] Vartanova M 2016 The main directions of ensuring food security in the Russian Federation Food Policy and Security 5 29-39
[9] Kostyaev A I and Kotusenko I I 2012 Ensuring food security in Russia: a regional aspect Economy of Agricultural and Processing Enterprises 5 4-5
[10] Modebadze N 1997 Assessment of food security in the region AIC: Economy, Management 12 2-3
[11] Antamoshkina E 2013 Ensuring food security and agrarian policy in Russia Agrarian Science 8 2-3
[12] Olovyannikov D 2009 Methodology for assessing the state of food security in the region on the example of the Republic of Buryatia Izvestiya of Irkutsk State Economics Academy 3 60-3
[13] Santeramo F 2015 Food security composite indices: implications for policy and practice Development in Practice 4 594-600