World practice of statistical evaluation food security of states

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Abstract. Food security is a problem of global importance, therefore, the methods and techniques for assessing it at the macroeconomic level are the most important components of the scientific study of the economies of countries. The paper provides a comparative analysis of aggregated indicators of food security in the Russian Federation with international established systems, assesses their advantages and disadvantages, as well as areas for improving the system in the Russian economy. Based on a statistical analysis of the global food security index covering 112 countries, generalizing conclusions are drawn about the importance of factors in the formation of food security at the present time, as well as about alarming trends in the world that require a timely solution at the level of a civilized world community.

1 Introduction

Food security is a problem of global importance, therefore, the leading international organization FAO (Food and Agriculture Organization) deals with it. The FAO motto - "For a world without hunger" was proclaimed at the first FAO Conference in Quebec (Canada) on 10/16/1945 and determined the role of the organization in the system of global regulation of the food problem. Modern digital technologies based on satellite systems allow the organization to monitor the state of food security in the countries of the world, provide operational information, and warn in a timely manner about emergencies and disasters that threaten the food supply of the countries of the world.

2 Methods

The study used a set of statistical methods to assess the current state of food security in the world, identify trends in food security after the COVID-19 pandemic, and determine the main cause-and-effect relationships of macroeconomic indicators.

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3 Results and discussion

In world practice, there are several methods for assessing the level of food security. At the international level, FAO indicators and the Global Food Security Index (GIFS) of the London group The Economist Intelligence Unit are determined.

FAO food security indicators are combined into four groups, each of which characterizes one of the aspects of the state of the country's socio-economic development: availability (availability) - five indicators; accessibility - eight indicators; stability (stability) - six indicators; use (utilization) - eleven indicators [1,2]. This system allows comparison across regions and over time, and information for calculating the indicators included in it is available for all countries.

The Global Food Security Index (GIFS) evaluates it according to three complex groups of indicators [3]:

- availability (affordabillity), which assesses the ability of the population to buy products, to resist uncontrolled price increases; availability of state programs to support low-income segments of the population to level out price increases;
- availability (availability), which assesses the ability of the national agro-industrial complex to provide food to the population of the country through the use of innovative developments, increased investment in R&D, development of transport infrastructure, guarantees of production stability;
- quality and safety of food products (access), which allows assessing the diversity of the population's diet, appearance, smell, taste, texture, nutrient content in foods; compliance with hygienic standards (biological objects, potentially hazardous chemical compounds, radionuclides, harmful plant impurities).

All indicators of food security, in fact, are integral, the calculation of which is based on the grouping of a large number of individual indicators. The complexity of building an integral indicator is due to the following reasons: indicators must be specific, measurable, achievable, relevant and time-limited; complex generalization in the index should be as reliable as possible, which is not always possible due to the low level of reliability of the initial information in developing countries. In this regard, the most acceptable option is a system of individual indicators, which each country develops in accordance with national characteristics.

The Global Food Security Index has been calculated since 2012 for 113 countries of the world based on 28 integral indicators. They are determined by grouping quantitative individual indicators. At the same time, each country develops its own system of individual indicators in accordance with national characteristics. In essence, this index is a “dynamic quantitative and qualitative reference model” [3], built on the basis of 59 individual indicators. The overall score is determined as a weighted average of four criteria: food availability; their presence; quality and safety; diversity of natural resources and their sustainability. At the same time, the score for each criterion is also a weighted average of the basic indicators and varies within 0…100. At the end of 2021, Russia ranked 24th among 112 countries in terms of food security (excluding Syria).

According to the British analytical company EIU (The Economist Intelligence Unit), in Russia “scientific research and development of agricultural infrastructure are poorly developed, and there are also political and social barriers” [4]. A fairly low score was given to the indicator "diversity of diet" - 58.2 points, which led to a low score for assessing the quality and safety of products. In terms of food availability for the population, Russia ranks 20th in the rating (87.2 points out of 100 possible). In this case, analysts assess the dynamics of average food expenses, which in Russia, according to the EIU, is at a “very good level”, although the dynamics of the indicator is negative. The income level of the population was also assessed as “good”, which also shows a negative trend.

Table 1. Comparability of international food security indicators

Category of indicator	Food security scorecards		
	FAO	**London group The Economist Intelligence Unit.**	**USA**
Availability	The average energy value of the diet; volume of food production; the share of cereals, root crops and tubers in the energy value of the diet; the average volume of proteins obtained; average volume of animal proteins	Nutritional standards; government spending on agricultural R&D; the adequacy of the food supply; the existence of food safety programs; food losses; protein quality; diet diversification	Average dietary energy supply; average calorie intake; share in the diet of dietary products, root crops and tubers; average protein content; average animal protein content -
Physical access	The share of paved roads in the total length of roads; GDP per capita (USD PPP); railway track density; road network density	Agricultural infrastructure; gross domestic product per capita (USD PPP); throughput of cities; unsustainable agricultural production	Share of paved roads in the total number of roads; railway density road density; domestic food price index
Economic access	Domestic food industry price index; access to improved sources of drinking water; access to improved sanitation facilities	Tariffs on imports of agricultural products	Access to improved water resources; access to improved cleaning services; share of arable land equipped with irrigation facilities;
Outcomes	The extent of malnutrition The share of food expenditures in the budget of poor families; the extent of the food shortage; the extent of food shortages; proportion of children under 5 who are malnourished; proportion of children under 5 who are underweight; prevalence of anemia among children under 5 years of age	Proportion of population below the global poverty line Food consumption as a share of household expenditure Political stability risk, corruption Access to finance for farmers	Low access to food; the extent of malnutrition; the share of spending on food by the poor; degree of nutritional deficiency; the proportion of children under 5 years of age suffering from atrophy and dystrophy and weighing below normal; proportion of adults with body weight below normal; the prevalence of anemia among pregnant women; the prevalence of vitamin A and iodine deficiency; volatility in domestic food prices; variability in per capita food production; political stability, absence of violence and terrorism; share of food imports; dependence on grain imports

Positive dynamics was noted in the indicator of the proportion of the population living below the poverty line, as well as tariffs on the import of agricultural products (the method of its calculation differs from the Russian one).

Much attention is paid to the problem of food security in the United States, which was one of the first to adopt the Law "On Food Security" [5]. The study of various food security assessment systems allowed us to conduct their comparative assessment (Table 1).

In the Russian system for assessing the country's food security, only five indicators are comparable with those of the FAO: the volume of production of agricultural and fish products, raw materials and food; daily caloric intake; the amount of proteins, fats, carbohydrates, vitamins, macro- and microelements consumed per day; consumer price index for food products; import of agricultural and fish products. There are no indicators of transport provision, the impact of external risks on food security and the negative impact of

a decrease in the level of food security on the quality of life of the population. At the same time, the Russian system contains indicators that are not in the FAO system: the volume of food reserves, the amount of state support for the population and producers, the provision of the population with retail space and space for catering [6].

The Russian system of food security indicators, outlined in the Doctrine-2020, reflects national priorities and features, and is incomparable with international systems in a number of indicators. Evaluating the methodological recommendations of the FAO, post-Soviet scientists believe that they are sufficient only for assessing food security at high levels of transnational and economic and political generalization - global (global), subregional (EU. APEC, G-7, G-20, EAEU, LAS etc.) and interstate. At lower levels - national, local, social groups and households - two indicators are not enough [7].

Food security indicators are calculated at various levels - global, national, household, individual. A number of Russian scientists, based on the study of the food security monitoring system in the Russian Federation, noted the following proposals for its improvement [6,7]:

- a number of target indicators should be excluded due to the problem of obtaining information for their determination;
- develop and adopt the format of the National report on the state of food security at the federal and regional levels;
- ensure comparability of Russian food security indicators with FAO indicators;
- supplement the calculation of food independence for individual products with a generalizing indicator of food independence;
- at the regional level, calculate the ratio of the actual volume of consumption in current prices of the reporting period to the recommended volume in the same prices;
- an assessment of the economic accessibility of food should be carried out using the ratio of the cost of the actual (recommended) set of products and the monthly consumer spending of the population.

In accordance with the Food Security Doctrine of the Russian Federation, a constant assessment of its level is required, and, consequently, operational information. The Ministry of Agriculture of the Russian Federation conducts an annual monitoring of the state of the country's food security in the areas of production, processing, export-import of agricultural products, raw materials and food, the state of stocks and reserves, commodity circulation and consumption of food by the population, based on the results of which a report is submitted to the President. The Doctrine-2020 presents the legislative framework for monitoring, control, forecasting and the formation of an information base on this issue. Monitoring is centralized: at the federal level, a decision is made to conduct monitoring, and regional authorities ensure that it is carried out on the territory of the region. However, a comprehensive economic and statistical study of the state of food security in the Russian Federation has not yet been conducted, only certain aspects of this complex multifaceted problem are being studied: retail prices for basic types of food are being monitored, semi-annual and annual food balances are being built at various levels of government, and a sample budget survey of households is being conducted , on the basis of which incomes and expenditures of the population are investigated. In accordance with the recommendations of the Government of the Russian Federation dated November 18, 2013, to assess the level of food security, it is recommended to use three criteria - the physical availability of food throughout the country (the constant availability of food); economic accessibility (the level of retail prices is available to all buyers, regardless of income level and region of residence); food safety (absence of objects potentially hazardous to human health).

Based on our grouping of the countries of the world according to the global food security index, three typical groups were identified, which differ quite significantly both in terms of the level of the general index and the level of its constituent indices (Table 2).

Table 2. Grouping of countries of the world according to the level of the global food security index (GFSI), 2021

Indicators	Global Food Security Index (GFSI) groups, %			
	up to 50	51-70	more than 70	total
Number of countries	29	44	39	112
General global index	42	61	76	61
including: affordability index	37	69	87	67
natural resource availability index	43	56	68	57
quality and safety index	46	67	86	68
index of natural resources and sustainability	45	62	58	56
Average per capita: gross domestic product, thousand PPP dollars	4.2	11.3	34.9	18.9
area of agricultural land, ha	0.58	0.52	0.66	0.58

Note: without Siria

The food security of almost 26% of the countries of the world that are included in the lowest group is at an extremely low level, while 83% of this group are countries of the African continent, of which 28% of the countries, the population, especially children under 5 years old, suffer from chronic malnutrition (Angola, Burundi, Burkina Faso, Mozambique, Nigeria, Rwanda, Sierra Leone, Ethiopia).

This fact looks especially monstrous for the 21st century against the background of UN statistics that in the EU and the USA up to 40% of food produced is thrown into the trash. At the same time, it is these countries that provide a very high standard of living at the expense of developing countries. The group with the highest level of food security includes about 35% of the world's states - a rather modest figure both in terms of the index value and in terms of the share of countries. This group includes the countries of the Eurasian (18 EU countries, Great Britain, Israel, Qatar, Kuwait, South Korea, China, Norway, Bahrain, Singapore, Malaysia, Russia, UAE, Switzerland) and the American continents (USA, Canada, Costa Rica, Panama, Uruguay, Chile), Australia, New Zealand.

The degree of differentiation of the countries of the world according to the GISP is characterized by a structural grouping (Table 3). In the highest group 45% of page - x are concentrated. land with a population of 41.8% and a highly developed economy (68% of world income). In contrast, in the lowest group (26% of countries), with an area of 15.7% and a population of 15.8%, incomes are only 3.5%.

The coefficient of differentiation of countries by income indicates that the high level of the food security index, although associated with the presence of agricultural - x. land, but the average per capita provision of agricultural land is not a determining factor. The most significant differences by groups continue to be observed, as in previous periods, in the development of the economies of countries with an indicator of GDP (PPP) per capita.

Таблица 3. Structural grouping of countries of the world by the level of the global food security index (as a percentage of the total), 2021

Groups according to GFSI	Number of countries	The area of agricultural land, million ha	Population, mln. People	GDP (PPP) total, mln USD	GDP Differentiation Coefficient (PPP)
I-lowest	25.9	15.7	15.8	3.5	0.22
II-medium	39.3	40.6	38.4	28.1	0.73
III-highest	34.8	45.1	41.8	68.4	1.64
Average	100.0	100.0	100.0	100.0	1.00

The absence of a significant relationship between the GFSI and land availability is also confirmed by the correlation-regression analysis: the regression equation Y= 59.9 + 0.3x (Y-GFSI, X-land per capita) indicates a positive relationship, but the equation and its parameters do not statistically significant.

As already noted, the global food security index is formed as an integral indicator by averaging private indices that characterize certain aspects of food security. The basis of reasoned conclusions based on the results of the study is an integral mathematical assessment of the obtained indicators. The results of our correlation-regression analysis of the relationship between the studied characteristics reflect a high level of relationship between GDP and almost all parameters of food security, with the exception of land and natural resource endowment.

After assessing the closeness of the relationship between the GFSI (Y) and the GDP (PPP) of the countries (X) (correlation coefficient 0.81 and coefficient of determination 0.65), a regression equation was constructed Y = 49.9 + 0.46 X. It can be concluded that the increase GDP (PPP) per capita by 1 thousand dollars on average across countries provides an increase in GFSI by 0.46 units.

In order to detail the relationship of income with individual indicators of food security, an analysis was made of the relationship of income with the parameters of the GFSI, the results of which are presented in Table 4.

Table 4. Indicators of pair regression relationship between GDP(PPP) and GFSI indicators, 2021

Food security indicator	**Affordability**	**Resource Availability**	**Quality and safety**
	У=-32,52+0,852X_1	**У= -58,89+1,469 X_2**	**У=- 49,352+1,0862 X_3**
Elasticity coefficient	2.32	3.39	3.00
Beta	0.73	0.72	0.78
Correlation coefficient	0.722	0.715	0.782
Determination coefficient	0.535	0.511	0.612
Standard error of the regression coefficient	0.0757	0.1369	0.0824
Criterion F (actual)	126.76	115.07	173.69

Comparative analysis of indicators of correlation and regression allows us to conclude that all indicators are highly responsive to the level of economic development of the country, but most strongly respond to the availability of resources, their quality and safety. Affordability is characterized by a lower coefficient of elasticity. The relationship indicators are significantly significant (the equations as a whole were evaluated by Fisher's test, regression coefficients by Student's test).

To assess trends in food security, an analysis was made of the dynamics of indicators and GFSI (Table 5).

Over a relatively short period of time, the indicator of the overall assessment of food security decreased from 63.1 to 62.4 points. However, the indicators that made it up had multidirectional development vectors: there is an increase in the affordability and quality of resources with a decrease in their availability. There is a clear, worrying upward trend in the variation of all indicators, especially in 2022. For 2019-2022 the variation of food security indicators in the world economy has increased by 2-3 times, which indicates an increase in the differentiation of countries according to the GFSI, and hence a deterioration in the food

supply of the countries of the lowest group. This, of course, is due to the deepening of variations in the economies of countries.

Table 5. Dynamics of food security criteria for the period of 2019-2022

Year	Total GFSI	Availability		Quality and safety	GDP (PPP) per capita*, thousand dollars, current estimate
		price	resources		
average level					
2019	63.1	67.9	59.6	61.2	17.9
2021	61.1	67.1	56.8	68.1	19.1
2022	62.4	69.3	58.1	66.0	20.8
variation coefficient					
2019	21.8	23.3	19.8	30.1	97.6
2021	22.6	31.4	21.0	26.0	100.3
2022	63.6	73.85	59.4	69.2	157.4

***** *calculation by weighted arithmetic average, countries with GFSI data*

In this regard, the question of changing rating positions in dynamics is of fundamental importance. The grouping of countries according to the change in rating positions from 2019 to 2022 made it possible to form a group with a strengthening position, a group without a change in position (0, + - 1 point) and with a decrease in the rating among the countries of the world according to the GISP (Table 6).

The first group included 53 countries (47.3% of the number of countries); in the second - 16 (14.3%); in the third - 43 (38.4%). Thus, most of the states of the world have improved their rating positions over a three-year period. These are, first of all, the underdeveloped states of the American continent (24.5%), African states (24.5%), EU states (17%). Among African countries whose population is chronically malnourished, Mozambique, Rwanda and Burundi have increased the rating, but lowered - Burkina Faso, Sierra Leone, Ethiopia, Nigeria Angola, therefore, the problem of hunger in these countries has worsened even more over the past three years. Among the upgraded EU members, 44% are the former socialist countries of Bulgaria, the Czech Republic, Slovakia and Poland.

The rich countries included in the TOP-10 - the United Arab Emirates, Sweden, Denmark, Ireland - have maintained their positions at the same level; Russia and EU countries - Hungary, Denmark, Ireland, Greece; poor countries in America and Asia - Mexico, Uruguay, Chile, Yemen, Indonesia and the poorest countries in Africa - Zambia and Madagascar. Thus, almost 44% of the countries that have not improved the food supply of the population are the poorest and poorest countries, which should worry all international organizations and, first of all, FAO.

Table 6. Grouping of countries according to the change in the rating positions of the GFSI from 2019 to 2022

GFSI Change Groups	Number of countries	Groups*
I Increased the rating	53	Argentina, Bulgaria, Bolivia, Costa Rica, Peru, Tajikistan, Jordan, Kazakhstan, Czech Republic, Ecuador, Japan, Honduras, Bahrain, Cambodia, Malawi, France, Laos, Mozambique, Oman, El Salvador, Slovakia, Guatemala, Portugal, China , United Kingdom, Vietnam, Venezuela, Netherlands, Rwanda, Tunisia, Spain, Congo (DR), Nicaragua, Tanzania, Chad, Myanmar, Nepal, Panama, Uganda,

		Ukraine, Burundi, Dominican Republic, Kenya, New Zealand, Paraguay, Togo, Finland, Bangladesh, India, Morocco, Norway, Poland, Algeria
II Without changes	16	Hungary, Greece, Denmark, Ireland, Yemen, Canada, Mexico, Serbia, Uruguay, Chile, Sweden, Zambia, Indonesia, Madagascar, United Arab Emirates, Russia
III Decreased the rating	43	Austria, Belgium, Burkina Faso, Guinea, Uzbekistan, Philippines, Italy, Sierra Leone, Mali, Senegal, Benin, Israel, Pakistan, Sudan, Romania, Switzerland, Germany, Cameroon, Nepal, Turkey, Haiti, Ethiopia, USA, South Korea, Ivory Coast, Saudi Arabia, Brazil, Thailand, Australia, Azerbaijan, Nigeria, Sri Lanka, Malaysia, Qatar, Belarus, Egypt, Colombia, Kuwait, Ghana, Singapore, Botswana, Angola

** Countries ranked in descending order of GFSI*

The aggravation of the world food problem is also confirmed by the rather high proportion of countries that have reduced the level of food security, 35% of which are the states of the African continent; 30% - rich countries of Europe (Austria, Belgium, Italy, Switzerland, Germany) and the world - USA, South Korea, Australia, Qatar, Singapore; 19% - the states of Asia.

The most significant increase in the rating is observed in the countries of the American continent - Argentina, Bolivia, Costa Rica and Peru. Positive dynamics is also noted in the steadily developing states of the post-Soviet space - members of the CSTO of Kazakhstan and Tajikistan. Kazakhstan has almost caught up with Russia in terms of economic development, Tajikistan is confidently leading among the CIS countries in terms of industrial development.

The food security rating was lowered as much as possible, first of all, by the richest and richest countries in the world - Qatar, Kuwait, Singapore, the USA, South Korea, Australia. The reason for this situation is largely the politicization of international trade relations. As scientists, heads of state have repeatedly said at all levels of politics, the world will never be the same. The global food market is transforming, the single market space is shrinking. If earlier crop failures in some regions of the world were compensated by harvests in others, and food was supplied to deficient regions through interstate exchange, now this mechanism does not work.

In this regard, countries with a developed agricultural sector turned out to be the most resilient in the difficult conditions of the pandemic and political sanctions. In particular, Singapore, Qatar and Kuwait have always been regions with a shortage of their own food, attractive markets for food suppliers from all over the world, allowing them to make high profits. The reason for the fall in the food rating of these countries was the lockdowns and related systematic disruptions in the supply of products.

The food problems of the United States, which have a highly developed agriculture, are systemic in nature, and, first of all, this is the monopoly nature of the American food market, divided between the Walmart, Kroger, Costco and Albertson's Companies, Smithfield Foods cartels. The second reason is the political turbulence of recent years, as a result of which not only international law and national political systems are being destroyed, but also international trade and economic ties. The pandemic has only exacerbated the accumulated problems and undermined the prevailing stereotype about the sustainability and efficiency of the American food system.

A feature of the agricultural sector in South Korea is its monopoly nature (rice production), as a result of which the country does not even provide half of its own needs. Over the past 15 years, the food taste preferences of the population have changed - the consumption of other types of grain and meat has increased, the production of which required an increase in the production of feed grains (corn, barley, wheat). High incomes allow the population to consume a lot of food, while preference was given to cheap imported products. As a result of the reduction in imports, prices have increased and the affordability of food has

decreased. Due to the limited arable resources in the country, a lot of fertilizers, pesticides, GMOs are used, which reduces the quality and safety of domestic food.

In Australia, the food crisis is associated with interruptions in the supply of perishable products. The decrease in the country's food security is also due to the low level of employment and housing problems of the population, the lack of access to safe and high-quality products in sufficient quantities. Australia's agriculture is a highly developed industry, producing vegetables, fruits and livestock products known throughout the world, a huge amount of seafood is caught. At the same time, Australia is one of the states with the highest food prices, which is associated with huge transport costs, rising fertilizer prices due to the Russian-Ukrainian conflict, and harsh climatic conditions for growing crops. The events in Ukraine, from where grain was imported, significantly complicated the food supply of the country, and three large shipping lines refused to do business with Russia.

The food security of Africa's poorest countries has historically been low and dependent on food imports. As a result of the global economic and food crisis of recent years, the situation has only worsened. Chronic poverty, malnutrition and hunger in African countries are caused by periodic natural disasters, wars, civil conflicts. The volume of food produced by the countries themselves does not meet the needs of the population, so the shortage came from the international food market: imports account for up to 40% in the food balance of African countries, grain and its processed products, sugar, meat and dairy products predominate. Rising prices in the world food market, associated with political events and economic sanctions, led to a decrease in the already low level of physical and economic access to food in African countries. The problem is aggravated by a poorly developed transport network, a poorly developed mechanism for the exchange of products between the city and the countryside: on the one hand - agricultural products, on the other - fertilizers, machinery, inventory [8,9,10].

4 Conclusion

To assess the food security of various countries in world practice, two methods are used - FAO and the global index of the London group The Economist Intelligence Unit. The FAO methodology is quite cumbersome and requires the collection of a large amount of primary information, the quality of which does not meet the requirements in all surveyed countries due to differences in the methods of collecting primary information. In this regard, in our opinion, the method of calculating the global food security index seems to be more acceptable. This index fairly objectively assesses the state of the food problem in countries of different levels of economic development, allows you to establish the factors of its formation, assess trends in dynamics. The grouping of countries according to the GISP made it possible to establish that the richest countries of Europe, Asia and America are characterized by the highest level of food security, and the lowest are the states of Africa, whose population suffers from chronic malnutrition and real hunger. In this regard, it seems obvious that the FAO, in principle, does not fulfill its main function of resolving the food problem in the world and does not take any measures, at least to mitigate it.

In recent years, the situation on the global food market has changed dramatically due to the pandemic, political events, and economic sanctions. There is a redistribution of the market, as a result of which the old ones are torn and new trade and economic ties are formed. Many states, not only poor, but also quite rich, began to experience problems due to food shortages. In this regard, most countries of the world in the coming years will focus on providing food, first of all, to their own citizens, for which measures will be taken to develop their own agricultural production and its infrastructure, as well as to protect the domestic market. As never before, the problem of ensuring national food security and even food

independence has become acute. For these reasons, the global food market in the coming years will be subject to segmentation by consumers, suppliers and geographic areas.

References

1. A.A. Lichman, Nikon Readings **19** 68-71 (2014).
2. S. Rosen, K. Thome, B. Meade, International Food Security Assessment, 2016–2026, GFA-27, U.S. Department of Agriculture, Economic Research Service, June 2016.
3. E.V. Memetova, Food Security Scorecard: International, National and Regional Levels *Materials of the international scientific-practical conference* (M.: REU n.a. G.V. Plekhanov, 2019).
4. The Economist Intelligence Unit. Global Food Security Index 2019-2022 Measuring Food Security and the Impact of Resource Risks. a report. 2022.
5. O.G. Ovchinnikov, USA and Canada: economics, politics, culture **8(560)** 21-41 (2016).
6. E.V. Zhiryaeva, Administrative Consulting **12** 49–67 (2020).
7. M.A. Kvitchuk, E.A. Ivshin, Science and the world **11-2(39)** 20-22 (2016).
8. T.E. Migaleva, V.I. Epifanov, Vestnik of REA n.a. G.V. Plekhanov **4 (34)** 120-125 (2010).
9. R. Capone, H.E. Bilali, P. Debs, et al., Journal of Food Security **2(1)** 1-12 (2014).
10. B. Meade, S. Rosen, Measuring Access to Food in Developing Countries: The Case of Latin America. Economic Research Service (ERS) of the U.S. Department of Agriculture, Market and Trade Economics Division (MTED, 2002). http://ageconsearch.umn.edu/bitstream/19716/1/sp02me01.pdf