Czech University of Life Sciences Prague

Faculty of Economics and Management

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Diploma Thesis

Food self-sufficiency relation to the level of countries food security

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Food self-sufficiency relation to the level of countries food security

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Objectives of thesis

The main purpose of the dissertation is to study the current situation of food security in the world, to compare the indicators of food security and food self-sufficiency, to find out the relationship between these two characteristics. To achieve this goal, the solutions of the following tasks will be found:
– to study the basic theoretical aspects of food security,
– to study the basic theoretical aspects of food self-sufficiency,
– compare indicators of food security and food self-sufficiency in different countries
– find out if there is a relationship between these two indicators

Methodology

This dissertation is divided into three main parts. The theoretical part examines the definitions of food security and food self-sufficiency, examines the main methods and issues of assessing food security in the world. The practical part contains an analysis of the current indicators of food security and food self-sufficiency in different countries and regions of the world.

The theoretical and methodological basis of the dissertation is the work of foreign and domestic economists, financiers and political scientists, among them Revenko L.S., Balabanov V.S., Nazarenko V.I., Panteleeva O.I., Shagaida N.I., revealing various aspects of food security in different countries of the world, as well as theoretical and calculated data, taken from the official websites of international and national statistical agencies, including FAO, World Health Organization, United Nations, Federal Research Center for Nutrition, Biotechnology and Food Safety of the Russian Federation. FAO data were used for 2018 on the production and consumption of nutrients in various countries. Also, FSI methodologies and calculated data of the level of food security for 2019 were used in the work.

The proposed extent of the thesis

60 – 80 pages

Keywords

World, food security, food self-sufficiency, food independence

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Recommended information sources

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Declaration

I declare that I have worked on my diploma thesis titled “Food self-sufficiency relation to the level of countries food security” by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 30.03.2021 _____

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Food self-sufficiency relation to the level of countries food security

Abstract

The aim of the master's thesis is to study the concept of food security, to study the methods and processes of its provision, to compare the modern vision of food security with its classical understanding, to compare the indicators of food security and food self-sufficiency in some countries of the world.

In the theoretical part of the work, definitions and formulations concerning the topic of food security and food self-sufficiency of the country are presented, the advantages and disadvantages of each of the methods are considered, algorithms for calculating the parameters used are given.

In the practical part of the work, calculations of indicators of food self-sufficiency in 174 countries of the world were carried out using two methodologies. An analysis and comparison of assessments of food security and food self-sufficiency was carried out, explanations were given, and conclusions were drawn. The results of the study showed an almost non-existent relationship between food security and food self-sufficiency, the main reason for which, it was identified, was the assessment methodology.

Keywords: World, food security, food self-sufficiency, food independence.

Potravinová soběstačnost vztah k úrovni potravinové bezpečnosti zemí

Abstrakt

Cílem diplomové práce je studovat koncept potravinové bezpečnosti, studovat metody a procesy jejího zajišťování, porovnat moderní vizi potravinové bezpečnosti s jejím klasickým chápáním, porovnat ukazatele potravinové bezpečnosti a potravinové soběstačnosti v některých zemích světa.

V teoretické části práce jsou představeny definice a formulace týkající se zabezpečení potravin a potravinové soběstačnosti země, jsou zváženy výhody a nevýhody každé z metod, uvedeny algoritmy pro výpočet použitých parametrů.

V praktické části práce byly pomocí dvou metodik provedeny výpočty indikátorů potravinové soběstačnosti v 174 zemích světa. Byla provedena analýza a srovnání hodnocení potravinové bezpečnosti a potravinové soběstačnosti, bylo podáno vysvětlení a byly učiněny závěry. Výsledky studie ukázaly téměř neexistující vztah mezi zabezpečením potravin a potravinovou soběstačností, jehož hlavním důvodem, jak bylo zjištěno, byla metodika hodnocení.

Klíčová slova: Svět, potravinová bezpečnost, potravinová soběstačnost, potravinová nezávislost.

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List of abbreviations

FAO – Food and Agriculture Organization

WHO - World Health Organization

UN - United Nations

SSC - Self-Sufficiency Coefficient

CCP - The Cost of Consumed Products

CFC - the Cost of all Food Consumed

GLFSS - General Level of Food Self-Sufficiency

GLFI - General Level of Food Independence

TPS - Total Protein Supply

TFS - Total Fat Supply

TCS - Total Carbohydrates Supply

TES - Total Energy Supply

ESS - Energy Self-Sufficiency

PSS - Protein Self-Sufficiency

FSS - Fat Self-Sufficiency

CPA - Coefficient of Physical Activity

BMR - Basal Metabolic Rate

GFSI - Global Food Security Index

1 Introduction

The problem of food security is one of the most significant in the modern world economy. It affects the interests of various groups of countries, social and political forces, becoming more relevant as the international division of labor deepens, world trade in agricultural products and food develops, and globalization accelerates. However, the issue of food security remains one of the most controversial.

Food security reflects the ability of the agro-industrial complex to ensure a balanced and sustainable economic development. At the same time, ensuring the optimal ratio of domestic production and imported food supplies is essential for food security. Only under the condition of a stable situation in the domestic food market, the state is able to pursue an independent domestic and foreign policy. These circumstances determine the need for economic research in the field of food security and independence, an analysis of their economic nature and significance for the welfare of a state.

Ensuring national food security is a priority task of the state. Its solution depends on a number of factors, the main ones being the economic power of the state, its authority in the world arena and the competitiveness of agricultural products, raw materials and food supplied to the world market. These conditions determine one of two ways to ensure the food security of the state: active participation in the international division of labor, the world food market and import of the missing more competitive types of products or orientation towards maximum self-sufficiency in food, support for domestic production of agricultural products and protection of the domestic food market from external expansion. Over the past half century, the area of land per capita in the world has decreased from 0.24 to 0.12 hectares (FAO, 2019). All of this makes the food problem one of the most important global international problems. Its significance is determined by the fact that the solution of this problem, due to a number of objective and subjective reasons, cannot be carried out by isolated efforts of individual states: well-established cooperation of states with different climatic conditions, socio-political systems is required. Moreover, the food problem does not exist by itself, but in conjunction with other global problems of the planet - demographic, environmental, energy, and military. Its solution, like no other time, is influenced by the international situation.

2 Objectives and Methodology

2.1 Objectives

The main purpose of the dissertation is to study the current situation of food security in the world, to compare the indicators of food security and food self-sufficiency, to find out the relationship between these two characteristics. To achieve this goal, the solutions of the following tasks will be found:

- to study the basic theoretical aspects of food security,
- to study the basic theoretical aspects of food self-sufficiency,
- compare indicators of food security and food self-sufficiency in different countries
- find out if there is a relationship between these two indicators

2.2 Methodology

This dissertation is divided into three main parts. The theoretical part examines the definitions of food security and food self-sufficiency, examines the main methods and issues of assessing food security in the world. The practical part contains an analysis of the current indicators of food security and food self-sufficiency in different countries and regions of the world.

The theoretical and methodological basis of the dissertation is the work of foreign and domestic economists, financiers and political scientists, among them Revenko L.S., Balabanov V.S., Nazarenko V.I., Panteleeva O.I., Shagaida N.I., revealing various aspects of food security in different countries of the world, as well as theoretical and calculated data, taken from the official websites of international and national statistical agencies, including FAO, World Health Organization, United Nations, Federal Research Center for Nutrition, Biotechnology and Food Safety of the Russian Federation. FAO data were used for 2018 on the production and consumption of nutrients in various countries. Also, FSI methodologies and calculated data of the level of food security for 2019 were used in the work.

2.2.1 Data collection

At the beginning of the study, the data from the GFSI (Global Food Security Index) assessment are required as a starting point for the study. To assess food self-sufficiency using the classical import/export balance method, the data on the amount of food produced in each considered country and the amount of food consumed in each country by categories are required. The data was obtained from the FAO website. Using formula (2), 4170 parameters for 174 countries were analyzed.

Using the method of cluster analysis, the results of each methodology and conclusions about the similarities or differences between the methodologies were obtained.

To carry out calculations using the energy approach, the data on the amount of food produced, its nutritional value and the population of the country are required to estimate the amount of nutrients produced by each country per capita. These data were obtained from the official website of FAO. The database used contains 54097 parameters for 184 countries. Using formulas 4, 5, 6, Total Energy Supply, Total Protein Supply and Total Fat Supply were calculated. Further, to assess the sufficiency of the amount of products produced, it was necessary to calculate the rate of nutrient consumption per capita. This requires data on the average weight of a person, the average age of a person, data on the average level of physical activity. Having received these data, it became possible to estimate the average person's need for calories, proteins and fats. Having received these data, it became possible to assess the sufficiency of the country's production using formulas 7, 8, 9 (ESS, PSS, FSS) and draw conclusions about the country's food independence.

Note*

This study does not consider the amount of carbohydrates and the sufficiency of their own production by the country. There are several reasons for this. The first reason is a feature of the calorie calculation methodology. According to which, in the sum of calories (TES), the energy value is recorded only from two sources: fats (TFS) and carbohydrates (TCS), since according to human physiology, proteins are not used by the body as an energy source in the case of a balanced diet. (In the case of starvation and depletion, the body also uses proteins as a source of energy, but since the task of providing food is aimed at fighting hunger, in this regard, the caloric content of proteins should not be taken into account). That is, since the sum of calories (TES) is nothing more than the sum of calories

obtained from carbohydrates and fats, if we observe a sufficient level of supply of the country with calories and fats, the sufficiency of supply of carbohydrates is automatically guaranteed. Thus, the choice of analysis of only the sum (TES) and one of the categories included in it (TFS) is justified. The second reason, actually the reason for choosing fats and not carbohydrates, is also human physiology. In the case of an insufficient (or even complete exclusion) supply of carbohydrates to the body, the human body can completely switch to energy from fats, while a complete exclusion of fats from the diet is impossible. The reason for this is the use of fatty acids - a constituent part of some fats in the construction of hormones in the human body. Fatty acids are indispensable components of the human diet, while carbohydrates are used mainly as elements coupled with minerals and vitamins that support healthy cellular processes in the body.

2.2.2 Data processing

Using the capabilities of the Microsoft Excel program, all of the above data was processed.

The main hypothesis was the hypothesis of a direct relationship between the level of food self-sufficiency of the country and the level of its assessment by the GFSI method.

After the results of the number of self-sufficiency categories of countries were calculated and sorted, the countries were selected that are present simultaneously in the conclusions of both calculation methods. The number of countries for which both GFSI and GLFSS assessments were simultaneously obtained is 97.

The result of grouping the data showed the coincidence of estimates only in 23.71% of cases, which undoubtedly means that the main hypothesis is incorrect, and the alternative is true to it.

When calculating the level of food self-sufficiency of a country using the energy approach, countries with an assessment of the levels of ESS, PSS, FSS above 1 point simultaneously in all three categories were placed in the category of countries treated as countries with self-sufficiency in food. As a result of the study, 75 countries were rated as food self-sufficient.

3 Theoretical part

This chapter will provide an overview of the relevant theory with links to the works of well-known Russian and international researchers, will provide a description of modern methodologies and concepts of views on assessing food self-sufficiency and food security.

3.1 Theoretical concept of food self-sufficiency

This chapter will provide an overview of views on methodology for assessing food self-sufficiency.

Agriculture plays the leading role in solving the food self-sufficiency problem. It is this industry that provides the Earth's population with food products and raw materials of plant and animal origin. Until the middle of the 20th century, the increase in the volume of food production in the world and, first of all, grain was provided mainly in an extensive way due to the expansion of arable land and sown areas in almost all countries. This trend continued in the 1950s-1980s, but it was typical only for developing countries, while developed countries increased production volumes due to intensive factors.

Since the 1980s, there has been practically no increase in the area of productive land in the world. With an increase in the population, this means a decrease in land availability, which has only recently decreased from 0.28 to 0.24 ha (FAO, 2019). At the same time, countries with low land provision are characterized by the process of exceeding the withdrawal of land from agricultural use over the increase in arable land. In the United States and Western European countries, the possibilities for expanding arable land and sown areas are limited by the violation of the ecological balance, in the post-Soviet republics - by the shortcomings of agrarian transformations. All this points to different approaches to the problem of food supply and food security of each individual country in the world.

In the world economy, there are a number of classifications of countries according to the level of food security and the solution to the problem of food security. An example is the classification of countries into eight groups (Belkharoev, 2008):

- the first group - the main world exporters of food products (USA, Canada, Australia, some EU states, etc.),
- the second group - small countries actively exporting food (Hungary, Finland),

- the third group - states that are chronically experiencing food shortages, but are able to purchase it (Japan),
- the fourth group - countries that barely meet their food needs with their own production (India, South American countries),
- the fifth group - countries whose food supply has practically no effect on the global food situation (Iceland, Papua Guinea),
- the sixth group - countries experiencing food shortages and developing water and land resources to achieve self-sufficiency (Egypt, Indonesia, Pakistan, the Philippines),
- the seventh group - countries with a steadily deteriorating food supply (states of Africa south of the Sahara),
- the eighth group - countries with an emerging food crisis, in which population growth is outstripping resource opportunities for providing food (the former Union republics of Central Asia and the Caucasus).

It is necessary to emphasize the significant scatter of opinions in assessing the levels of self-sufficiency in domestic and foreign literature. For example, some authors (Nuraliev et al., 2009) note that food dependence can occur when the population is provided with food obtained from own production in the amount of less than 80%, while the presence of imported food products on the domestic market will be reach volumes of more than 20%. The critical volume of agricultural production as a whole at the national and regional levels, in their opinion, should be provided at the expense of own production by 60%. Otherwise, the state will lose food independence. It should be borne in mind that the recommended indicator cannot be universal and absolute. The choice of security indicators (food self-sufficiency) is determined by the specifics of agricultural production, the degree of economic development of the country, the level of dependence on the volume of food imports and other factors.

Important criteria for food security include the availability of strategic food supplies sufficient to provide the population with crisis standards for the period of mobilization measures to rebuild the country's life support system in order to overcome or compensate for damage caused by the crisis.

According to (Professor Revenko, 2003), strategic food reserves, occupying an intermediate role in the market mechanism, "*go to one of the first places in ensuring food security almost everywhere (at the global, regional and national levels).*". The professor explains this phenomenon by the fact that these stocks «*are both humanitarian and market in nature, and the procedure for their formation and use in order to ensure food security fully affects the commercial interests of various market entities*»

One of the main conditions for the country's food security is the country's sustainable self-sufficiency in grain, the rational formation and use of its resources. Factors such as a high share of grain consumption for food purposes, the ability of grain to maintain qualitative and quantitative parameters during transportation, and suitability for long-term storage create the possibility of forming insurance and reserve funds, which gives grain priority in the food self-sufficiency of the state, namely, determines its strategic position (Ravenko, 2014).

The modern theory of food independence is not limited to abstract conclusions, but increasingly relies on quantitative estimates and various methods of calculating optimal levels of food security. In particular, the sufficiency of the country's food self-sufficiency is periodically set in the form of parameters of the actually achievable share of the main types of domestic food in the total volume of its consumption and in the commodity resources of the domestic market. It should be emphasized that the quantitative parameters of the production of food and raw materials, sufficient to ensure domestic consumption, are calculated taking into account scientifically based physiological norms of consumption per capita.

In domestic literature, the level of self-sufficiency in food is proposed to be measured by general and particular coefficients. The general coefficient of self-sufficiency (SSC) is calculated by the formula:

$$SSC = \frac{CCP}{CFC} \times 100 \quad (1)$$

where

CCP - the cost of consumed products of own production in USA dallars,

CFC - the cost of all food consumed in USA dallars.

Accordingly, private self-sufficiency ratios are calculated by type of food in physical and value terms.

Russian researcher (Martynov, 2014) to assess the state of food self-sufficiency (general level of food self-sufficiency (GLFSS)), recommends using the calculation methodology according to the following formula, which is close to the previous one:

$$GLFSS = \frac{PPC}{PC} \times 100 \quad (2)$$

where

PPC - agricultural production plus changes in inventories (inventories at the beginning of the year minus inventories at the end of the year) in tones (FAOSTAT, 2018),

PC - the volume of industrial and personal consumption of agricultural products in tones (FAOSTAT, 2018).

The methodology for calculating the level of self-sufficiency in agricultural products, raw materials and food specified in formula (2) is the official methodology for calculating the Ministry of Agriculture of Russia, established by Order No. 582 of the Minister of Agriculture of the Russian Federation D. N. Patrushev of September 30, 2020. (Ministry of Agriculture of Russia, 2020)

Along with the indicator of food independence for certain types of products, it is advisable, to use the indicator of the general level of food independence (GLFI) according to the method proposed by Russian experts (Shagaida & Uzun, 2015).

$$GLFI = \frac{1-(PI-PE)}{PFE} \times 100 \quad (3)$$

where

PI - the value of imports in USA dollars,

PE - the value of export in USA dollars,

PFE - the expenditures of the population on food in USA dollars.

The meaning of the formula proposed by these experts consists in calculating the ratio of the balance of foreign trade to the total expenditure of the population on food. The result is subtracted from one. According to the results of calculations, we obtain a number either greater or less than unity, depending on whether the balance of foreign trade is a positive or negative value.

3.1.1 Methodologies of food self-sufficiency assessment

This chapter will describe two methodologies used to assess food self-sufficiency in countries.

First methodology is based on import-export balance.

The indicator of the general level of food self-sufficiency (GLFSS) will be calculated according to formula (2). Amount of imports, exports and domestic supply are taken from FAO (FAOSTAT, 2018).

Second methodology is based on nutritional value assessment (energetic approach).

The reason for using this approach in the study is the strong differences in the possibilities of producing specific products in different regions of the world due to factors such as climate, soil, technology, human capital, and so on. In practice, the inability of a particular country to produce a certain category of products is compensated by the production of some other product, nutritionally, completely replacing it. From this point of view, the approach to assessing food self-sufficiency based on the import-export balance is not entirely clear. Since the study compares the two approaches in agri-food policy, it makes sense to assess food self-sufficiency more accurately, namely in terms of the nutritional value of its products produced by the country.

To do this, the calculations of the amount of protein, fat and calories provided by home production for each person in the country will be done.

Total protein supply will be calculated using formula (4)

$$TPS = \frac{\sum_{i=1}^{n} Prot(Pc_i)}{P} \tag{4}$$

where

Pc_i - i category of product,

$Prot(Pc_i)$ - amount of protein from i product category in grams (FAOSTAT, 2018),

P – Population of j country,

Total fat supply will be calculated using formula (5)

$$TFS = \frac{\sum_{i=1}^{n} Fat(Pc_i)}{P} \tag{5}$$

where

Pc_i - i category of product,

$Fat(Pc_i)$ - amount of fats from i product category in grams (FAOSTAT, 2018),

P – Population of j country

Total energy supply will be calculated using formula (6)

$$TES = \frac{\sum_{i=1}^{n} Energy(Pc_i)}{P} \quad (6)$$

where

Pc_i - i category of product,

$Energy(Pc_i)$ - amount of energy from i product category in grams (FAOSTAT, 2018),

P – Population of j country

Formulas 4, 5, and 6 are used in the official FAO calculation methodology (FAOSTAT, 2018).

The indicator «level of energy self-sufficiency of the country» (ESS) will be calculated as

$$ESS = \frac{TES}{\text{Consumption rates}} \quad (7)$$

The indicator «level of protein self-sufficiency of the country» (PSS) will be calculated as

$$PSS = \frac{TPS}{\text{Consumption rates}} \quad (8)$$

The indicator «level of fat self-sufficiency of the country» (FSS) will be calculated as

$$FSS = \frac{TFS}{\text{Consumption rates}} \quad (9)$$

Formulas 7, 8, and 9 were used by Arkadiusz Sadowski and Agnieszka Beer-Nawrocka in their study of the energy approach to assessing food self-sufficiency (Sadowski, 2016).

3.1.2 Consumption rates

This chapter presents nutrient intakes and related definitions based on the physiological needs of the average active, healthy person. Nutrient intake rates will be used to assess the food self-sufficiency energy approach.

The physiological need for energy and nutrients is a necessary combination of nutritional factors to maintain a dynamic balance between a human, as a biological specie formed in the process of evolution, and the environment, and aimed at ensuring life, preservation and reproduction of the species and maintaining adaptive potential.

Norms of physiological needs for energy and nutrients are the average values of the required intake of food and biologically active substances, ensuring the optimal implementation of physiological and biochemical processes, fixed in the human genotype.

The norms of physiological needs for energy and nutrients differ depending on gender, age, profession, living conditions, etc. The norms are based on the main provisions of the Optimal Nutrition Concept.

The need for energy and nutrients depends on physical activity, characterized by the coefficient of physical activity (CPA), which is equal to the ratio of energy expenditure to perform a specific job to BMR.

Basal metabolic rate (BMR) (table 1) - the minimum amount of energy required for the implementation of vital processes, that is, energy consumption for the performance of all physiological, biochemical processes, for the functioning of organs and body systems in a state of temperature comfort (20C), complete physical and mental rest on an empty stomach.

The entire adult population, depending on the amount of energy consumption, is divided into 5 groups for men and 4 groups for women, taking into account industrial physical activity and other energy consumption:

- Group I (very low physical activity; men and women) - workers predominantly of mental work, the CPA is 1.4;
- Group II (low physical activity; men and women) - workers engaged in light labor, the CPA is 1.6;
- Group III (average physical activity; men and women) - workers of average severity of labor, the CPA is 1.9;

– Group IV (high physical activity; men and women) - workers of heavy physical labor, the CPA is 2.2 (construction workers, loaders, workers on maintenance of railway tracks and repair of highways, workers in forestry, hunting and agriculture, woodworkers, athletes, metallurgists, blast furnaces, foundry workers and other related activities);
– Group V (very high physical activity; men) - workers with particularly hard physical labor, the CPA is 2.5 (highly qualified athletes during the training period, machine operators and agricultural workers during the sowing and harvesting period, miners and tunnellers, miners, fellers forests, concrete workers, bricklayers, loaders of non-mechanized labor, reindeer herders and other related activities).

Table 1 – Average basal metabolic rate (BMR) of the adult population (kcal / day)

Men					Women				
Body weight, kg	18-29 years old	30-39 years old	40-59 years old	Over 60 years old	Body weight, kg	18-29 years old	30-39 years old	40-59 years old	Over 60 years old
50	1450	1370	1280	1180	40	1080	1050	1020	960
55	1520	1430	1350	1240	45	1150	1120	1080	1030
60	1590	1500	1410	1300	50	1230	1190	1160	1100
65	1670	1570	1480	1360	55	1300	1260	1220	1160
70	1750	1650	1550	1430	60	1380	1340	1300	1230
75	1830	1720	1620	1500	65	1450	1410	1370	1290
80	1920	1810	1700	1570	70	1530	1490	1440	1360
85	2010	1900	1780	1640	75	1600	1550	1510	1430
90	2110	1990	1870	1720	80	1680	1630	1580	1500

Source: Federal Research Center for Nutrition, Biotechnology and Food Safety of the Russian Federation and own analysis

Consumption rates in research are based on the average age of people, average weight and average physical activity.

3.2 Theoretical concept of food security

One of the objectives of this study is to demonstrate the differences between two assessments: assessing food security and assessing food self-sufficiency of the country. As a consequence, this chapter presents the theory that will be used in the analysis related to the modern methodology for assessing food security.

Jennifer Clapp mentions in her report that the term “food security” was first defined at the World Food Conference in 1974, amid a time of soaring food prices and widespread concern about the impact of market turmoil on world hunger. In that context, food security was defined as *“[the] availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices*” (Clapp, 2020).

Since its inception, the term "food security" has undergone numerous changes and in its modern and most relevant form it is used as "*Food Security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.*" (FAO, 2001).

According to the Russian researcher Lomakin (Lomakin, 2017), this definition of food security does not disclose the sources, factors of ensuring the physical and economic accessibility of food, "*whereas this aspect of the issue is the most important and essential for understanding the category of food security*". By these "factors", the author means a combination of internal and external factors, national agricultural production, the creation of food reserves, export-import supplies of food, international food aid, etc.

As noted by S.V. Kiselev (Kiselev, 2013): “*at present, approaches to the concept of food security in Russia and abroad differ. If the leading Western countries treat the problem of food security as the need to provide all segments of the population with food in the proper quantity and quality, then in Russia food security is considered primarily as food self-sufficiency and import substitution.*".

In other words, the approach to understanding the problem of food security differs in different countries of the modern world. According to this, currently, there are two main

concepts of food security. The first concept is “food security is a state when the market provides the required quantity of goods with the proper quality at an affordable price.” The second concept is “food security is the country's ability to independently fully provide itself with all the necessary food products. “

In developed countries (USA, Germany, France, Japan), the need to solve food security problems is attached great importance. However, in these countries this issue is considered from the point of view of the achieved high level of food self-sufficiency, although certain differences in approaches should be emphasized. For example, in Germany, food security is considered an important problem that arises only when the issue cannot be resolved through market regulation. In fact, in Germany the approach prevails in which this problem is analyzed from the point of view of the crisis situation in the country.

In the United States, food security is regarded, firstly, as supporting the stability of sales in the domestic food market (primarily national production), secondly, as a form of implementing food assistance programs for the poor, and thirdly, as stimulating agricultural exports and the use of food supplies in the interests of foreign policy (Food Security Act, 1985).

In the interpretation of the concept of “food security”, Russian economists attach key importance to the issue of eliminating the country's excessive dependence on food imports, mainly by providing the domestic market with domestic food products. In other words, despite the obvious advantages that the country is able to get from the international division of labor, priority in terms of food security is given to its own production, which can provide it with food sovereignty.

From this point of view, food security takes into account not only the consumer aspect, taking into account primarily the physiological norms of nutrition, but also the production factor, which means that food security is realized primarily by the development of our own national production, and only after that through the necessary imports. This view is shared by most famous Russian authors. (Balabanov, 2002), for example, by food security means “*a level of development of national agriculture at which a reliable supply of the country's population with domestic food is guaranteed*”. Another economist, (Nazarenko, 2011) mentions that the concept of food security includes two main aspects. Firstly, it is the level of food self-sufficiency and the availability of insurance stocks that

ensure the stability and independence of the state from changes in the world market conditions and weather conditions. Secondly, the author refers to the availability of food for all segments of the population, including its poorest part, considering food to be the most important and integral factor in the survival and existence of people.

It was previously believed (Popov, 2006) that the food situation in the world is stable if the ratio of carry-over stocks of grain to annual consumption is 17% (today this figure in the whole world is over 22% (International Council for Grains, 2015)). Assessing the situation in the world grain market, the UN Food and Agriculture Organization of the United Nations concluded that world carryover stocks should be at least 20% of annual consumption (Ravenko, 2003). A decrease in stocks below the indicated value indicates a critical state of world food security, since at the same time a sharp rise in world grain prices begins and it becomes inaccessible to many underdeveloped countries (Panteleeva & Myers, 2009).

In the concept of food security of the state, a special place is occupied by the problem of import, its influence on the food supply system of the population, on the development of the agro-industrial complex of each modern state. In the tradition of Western economic science, import is interpreted as an alternative to food self-sufficiency. Import limits are set by market laws, taking into account comparative advantages and the level of agricultural production and food achieved by the country. According to this approach, external (import) and domestic sources of food are equivalent. The problem of food independence in this case remains beyond the scope of analysis and discussion.

Such an assessment of food imports is inherent in a number of international organizations and UN programs that are aimed at combating hunger in developing countries. For example, FAO experts highlight the following food security features (Eurasian commission, 2013):

- food security does not mean food self-sufficiency,
- the country itself should strive to produce a sufficient number of products for its needs, if there are comparative advantages,
- The country should be able to import the necessary amount of food and provide food needs for its citizens.

A feature of the food sector is that it is highly vulnerable to economic shocks. The more a country is affected by crisis shocks, the worse its food supply becomes. Economic crises adversely affect the financial component of the food sector, leading to a destabilization of the credit system for agricultural producers, which, due to these constraining development factors, are forced to either refuse to expand or completely reduce production. For the consumer, this means a limited supply on the market and, as a consequence, an increase in food prices (Prokhozhev, 2005).

The term "food self-sufficiency" and the methodology for its assessment are given in paragraph 3.1, therefore, there is an interpretation of the term "food security" in accordance with the Global Food Security Index method (Global Food Security Index, 2019).

The Global Food Security Index is calculated based on the following indicators:

- Affordability,
- Availability,
- Quality & Safety,
- Natural Resources & Resilience,
- Output variables.

The Affordability indicator score is based on:

- Change in average food costs,
- Proportion of population under global poverty line,
- GDP per capita at PPP,
- Agricultural import tariffs,
- Presence of food safety-net programs,
- Access to financing for farmers.

The Availability indicator score is based on:

- Sufficiency of supply,
- Public expenditure on agricultural research and development,
- Agricultural infrastructure,
- Volatility of agricultural production,
- Political stability risk,

- Corruption,
- Urban absorption capacity,
- Food loss.

The Quality & Safety indicator score is based on:

- Dietary diversity,
- Nutritional standards,
- Micronutrient availability,
- Protein quality,
- Food safety.

The Natural Resources & Resilience indicator score is based on:

- Exposure - a composite indicator that measures exposure to and management of the impacts of climate change. Sub indicators include:
  - Temperature rise,
  - Drought,
  - Flooding,
  - Storm severity (AAL),
  - Sea level rise,
  - Commitment to managing exposure.
- Water - a composite indicator that measures the health of fresh-water resources and how depletion might impact agriculture. Sub indicators include:
  - Agricultural water risk – quantity,
  - Agricultural water risk – quality.
- Land - a composite indicator that measures the health of land, and how land degradation might impact agriculture. Sub indicators include:
  - Land degradation,
  - Grassland,
  - Forest change.
- Oceans - a composite indicator that measures the health of oceans, a crucial source of protein for many populations. Sub indicators include:
  - Ocean eutrophication,
  - Marine biodiversity,

    - Marine protected areas.
- Sensitivity - a composite indicator that measures how susceptible countries are to the depletion of natural resources and agricultural productivity. Sub indicators include:
    - Food import dependency,
    - Dependence on natural capital,
    - Disaster risk management.
- Adaptive capacity - a composite indicator that measures the degree to which countries are creating systems and adopting practices to manage the risk that exposure poses to the agricultural sector. Sub indicators include:
    - Early warning measures / climate smart agriculture,
    - National agricultural risk management system.
- Demographic stresses - a composite indicator that measures the degree to which demographic stresses might increase countries' sensitivity to agriculture-related climate exposure and natural resource risk. Subindicators include:
    - Population growth (2016-21),
    - Urbanisation (2016-21).

The Output variables indicator score is based on:

- Prevalence of undernourishment,
- Percentage of children stunted,
- Percentage of children underweight,
- Intensity of food deprivation,
- Human Development Index,
- Global Gender Gap Index,
- EIU Democracy Index,
- Prevalence of obesity.

3.3 The reasons why there are two methods for assessing food security.

Food security is understood differently in different countries. This is primarily due to the political course of these states. This chapter provides the rationale for this fact.

An important feature of the problem raised is the possibility of ambiguous, often opposite, approaches to assessing the socio-economic consequences of import activity on the national economy. On the one hand, imports are a consequence of regular processes in the global economy, when the national markets of individual countries become part of the global market for goods and services, the international division of labor, and with it the system of interdependencies in all areas of the economy, including food and agricultural complexes. Import optimizes production costs, helps to meet the country's food needs, ensuring rapid saturation of the domestic market and saving social labor.

On the other hand, at a certain stage, due to the weakness of domestic producers, import activity can lead to a sharp and irrational increase in the share of foreign products in domestic consumption. This is accompanied by a decrease in employment in the field of material production, a deterioration in the financial condition of local enterprises, up to their bankruptcy. In accordance with the findings of Russian researchers, in particular, (Pleskachev & Kormanovskaya, 2008), "*the systematic increase in the total amount of food consumed in the share of imported food poses a very concrete direct threat to national economic security*".

3.4 The relationship between international trade and country security

As in the case of self-sufficiency, the basis for assessing food imports is a quantitative approach that includes certain criteria-based assessments of such imports from the point of view of maintaining food independence. In particular, world experience shows that a country maintains its independence if the ratio of imports to domestic consumption, expressed as a percentage (import quota), ranges from 20-25% (Senchagova, 1998).

The threshold of food dependence, according to the Russian scientist (Nikonov, 2015), should not exceed 10-15%.

After this level, the pre-crisis state of the food situation ensues when domestic production is insufficient and there is complete dependence on imports.

A high level of imports can cause the most adverse consequences for the entire economy of the country. As notes (Nazarenko, 2011), "*according to the calculations of the English economist J. M. Keynes, "the output of imports in any industry over the level of 30% leads to the cessation of the cumulative effect in it and in the industries associated*

with it, which leads to an imbalance of the entire mechanism of economic equilibrium and development'". As a result of exceeding this level, a food crisis arises, impoverishment, natural migration and depopulation of the population are growing. In this case, food security is restored only due to a decrease in import dependence in relation to goods for which such a reduction seems possible. At the same time, under the current conditions of increasing processes of globalization and the formation of international markets for agricultural products and food, export activity of agro-industrial complexes creates a very reliable support for food security. Food exports, for example, provide the flow of foreign exchange resources, which in turn can be invested in agriculture and the food industry.

Moreover, without expanded foreign markets in the current conditions of specialization and intensification of production, progress in the agricultural sector of most countries of the world becomes impossible. The close relationship between production and export activity is evidenced by the fact that the most prosperous countries in terms of food security are usually included in the list of net exporters of agricultural raw materials and foodstuffs (USA, EU countries, Canada, Brazil and others).

3.5 The main threats and risks to food security

There are four groups of factors that affect the global food system (FAO, 2019):

- geographical conditions and population distribution,
- world transport and communications,
- political situation in the world,
- world economy and trade.

The main threats and risks to food security in the world include the following (FAO, 2019):

- climatic factors (for example, in poor harvest conditions there is a threat of non-fulfillment of obligations under contracts for the supply of agricultural products),
- an increase in the population, as well as an increase in living standards in developing countries - an increase in solvent demand for food,
- decrease in investment growth in the agricultural sector of the economy,

– the cyclical nature of the economy (the optimal condition for achieving food security is stability, not only of the natural and climatic conditions, but also of economic development.

With regard to economic cycles, it can be noted that, according to the conclusions, made by (Revenko, 2003), even at the growth stage, an adequate reduction of poverty and an improvement in the food situation do not always occur. At the same time, during the recession stage, the adoption by the state of strict regulatory measures contributes to a sharp deterioration in food security indicators), price volatility, which plays a special role in destabilizing the food market, including in the conditions of coincidence of agri-food and general economic crises (volatility is an integral characteristic of food prices. The mechanism of food price volatility was identified back in the 1990s, and patterns of its distribution were found between food products, as well as a connection with oil prices, with exchange rates, stocks and productivity. Speculative transactions in the food and related products market play an increase in price volatility, with an average of up to 10% influencing the speculative factor in price changes in the market for basic food commodities.

The main reason that determines the possibility of solving the world food problem by the efforts of all states is the prevailing discrepancy between the distribution of the population and the production of agricultural products, raw materials and food in the countries of the world. At the end of the 20th century, the United States, for example, where only about 5% of the world's population lives, produced 12% of grain and 15% of meat and milk. In Europe, whose share in the population is 11%, wheat - 21%, milk - 32%, meat - 19% were produced. At the same time, the share of Africa with a 10% world population in grain production is only 5.4%, including wheat - 2.6%, meat - 4.3%, milk - 3.6%. In the United States, Canada and the European Union, one third of the world's wheat reserves are concentrated, with 4% of reserves in Africa. Population growth projections by country group suggest that this discrepancy will grow in the future (Belkharoev, 2008).

3.6 Food waste & food lost

An important component of any economic process is its efficiency. In terms of providing the country with food, an indicator of efficiency is the level of food waste and losses. This chapter provides information to demonstrate the importance of this component, demonstrate the scope of the problem, and enable the development of more effective ways to develop a food security strategy.

Food supply chains (also often referred to as food production and distribution networks), are an important component of food systems, and include all the stages and actors, including private sector businesses, from production to trade, processing, retail marketing, consumption and waste disposal (HLPE, 2017).

Agriculture is responsible for most of the risks to plants and animals monitored by the International Union for Conservation of Nature. Only a small percentage of food waste is composted - most end on landfills. Landfill methane emissions are one of the largest sources of emissions in the waste sector (FAO, 2015).

According to the Food and Agriculture Organization of the United Nations (FAO, 2015), the statistics for not consumed foods are as follows:

- The global volume of spoiled food is 1.5 billion tons in the original equivalent of the product, and the edible part of this is up to 1.3 billion tons.
- The hydrocarbon footprint from food produced and discarded reaches 3.3 billion tons of CO2 per year.
- The total amount of water spent on the production of unused food (250 km3) is equivalent to the annual runoff of the Russian Volga River or three times the volume of Lake Geneva.
- Likewise, 1.4 billion hectares of land (28% of global agricultural land) annually work to produce wasted food.
- There is quite enough food produced in the world to provide 4,000 calories per day for each eater. In fact, the table reaches only 2 thousand calories.

As much as 1.4 billion hectares of land are used to produce the total amount of food that is lost and wasted. This translates to more than 100 times the area of tropical rainforests that are being cleared every year, of which 80 per cent is cleared for agricultural expansion. Global food production amounts to more than 4 billion tones, or 4 600

kilocalories per capita per day. However, not all the food produced becomes available for human consumption since at least one third – over 1.3 billion tones – is lost or wasted annually. Food is lost and wasted for different reasons. In developing countries food is lost mainly during the first stages of the food supply chain – in the field, in storage or during transportation to markets. In sub-Saharan Africa alone, food worth US$4 billion is lost before reaching consumers, and this is enough to feed 48 million people for a year. In industrialized countries, an estimated 20 – 50 per cent of food that is bought is wasted by consumers, in addition to the losses between post-harvest and sale (Nellemann et. al., 2014).

The global economy is losing about one trillion dollars annually due to such waste. More than 90% of the discarded foodstuffs go to solid waste landfills and landfills - and this, in turn, pollutes the soil, water and air releasing toxins and greenhouse gases. The UN is concerned about this problem and is developing a global campaign to combat food loss. The purpose of this campaign is to inform people about the need to stop the senseless waste of food. This initiative concerns not only ordinary citizens with respect to food, not to get too much and not to throw away those products that can still be consumed, but also restaurateurs, farmers, wholesalers and owners of retail chains. According to statistics, about 4 billion tons of food are produced annually in the world, and this could be enough for all the inhabitants of the planet if food products were rationally used and distributed. However, approximately 1.3 billion tons are still in the trash, which is why the global economy is losing about one trillion dollars. (FAO, 2015)

A report by an independent commission of experts led by Professor Pierre Pinstrup-Andersen, concludes that the problem of increasing the efficiency of use and consumption of food, despite its global nature, can only be resolved locally. It is based on too many diverse reasons, and different countries have to solve this problem in different ways.

4 Practical Part

This chapter will present estimates of food self-sufficiency in 174 countries and their analysis. A comparative analysis of the results of the food security assessment methodology in accordance with the FSI methodology and classical methodology for calculating food self-sufficiency will be presented.

4.1 Hypothesis

For the purpose of setting course and research milestones, this chapter presents two hypotheses.

The main hypothesis is that the higher the food self-sufficiency of the country is, the higher is its food security.

Alternative hypothesis - the main hypothesis is not correct.

4.2 Global Food Security

This chapter provides information on assessing the food security of countries, according to the FSI. This information will be used as a basis for evaluating the two methodologies.

The 2019 ranking of 113 countries according to The Global Food Security Index is presented in the table 1 in appendix. Sorting occurs by index from highest to lowest.

The countries from the table 1 (appendix) were divided into 4 quantiles according to the points of the food security index (table 2):

Table 2 - Countries quartile deviation according to GFSI for 2019

Best environment	Good environment	Moderate environment	Needs environment
Singapore	Saudi Arabia	Dominican Republic	Nepal
Ireland	Greece	Botswana	Mali
United States	Czech Republic	Peru	Senegal
Switzerland	Uruguay	Ghana	Nicaragua
Finland	Hungary	Morocco	Bangladesh
Norway	China	Serbia	Cote d'Ivoire
Sweden	Belarus	Indonesia	Benin

Canada	Argentina	Ecuador	Kenya
Netherlands	Romania	Jordan	Burkina Faso
Austria	Brazil	Philippines	Cameroon
Germany	Costa Rica	Sri Lanka	Niger
Australia	Turkey	El Salvador	Cambodia
Qatar	Russia	Guatemala	Ethiopia
Denmark	Colombia	Tunisia	Laos
Belgium	Mexico	Algeria	Tajikistan
France	Panama	Uzbekistan	Nigeria
United Kingdom	Oman	India	Rwanda
Israel	Slovakia	Honduras	Tanzania
New Zealand	Kazakhstan	Paraguay	Guinea
Portugal	South Africa	Bolivia	Uganda
Japan	Bahrain	Ukraine	Sudan
United Arab Emirates	Bulgaria	Myanmar	Angola
Italy	Thailand	Pakistan	Zambia
Poland	Azerbaijan		Togo
Chile	Vietnam		Haiti
Spain	Egypt		Malawi
Kuwait			Mozambique
Malaysia			Sierra Leone
South Korea			Syria
			Madagascar
			Chad
			Congo (Dem. Rep.)
			Yemen
			Burundi
			Venezuela

Source: GFSI (2019) and own processing

The first quartile includes 29 countries, the second quartile includes 26 countries, the third quartile includes 23 countries, and the fourth quartile includes 35 countries. In Picture 1, you can see the illustration of this clustering.

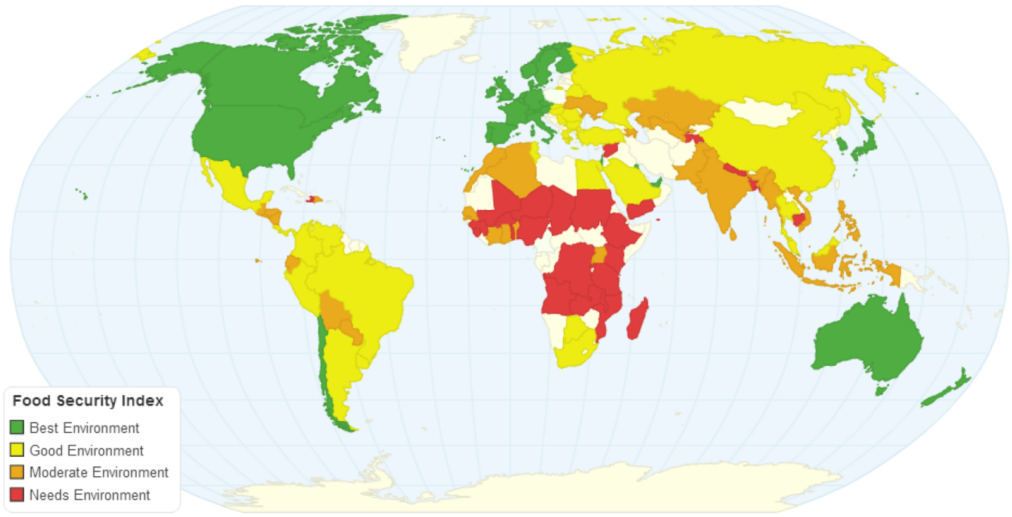

Figure 1 – Food Security Index clustering.
Source: The Economist Intelligence Unit 2020 and own analysis

4.3 Global Food Self-sufficiency rating

This chapter contains the calculations demonstration of the level of food self-sufficiency in 174 countries.

Country's food self-sufficiency was assessed according to formula 2 using FAOSTAT data of import/export balance for 2018 year. The food security assessment of countries is carried out in order to compare the results of two different approaches. By the number of coinciding values in each quartile, one can judge the similarity of methodologies. If countries, after calculations and subsequent clustering, find themselves in other quartiles, this will be a demonstration of difference in the applied approaches.

Below will be the results of calculations for all countries, but the examples of calculations will be done on a small representative sample of 20 countries to improve clarity and reduce bulkiness. Calculations are made for 174 countries. For each country, the number of categories was calculated, the self-sufficiency in which exceeds 90%. Countries were sorted in descending order and clustered.

Below is a demonstration of food self-sufficiency calculations for 20 countries by food category. For more representativeness, the results of the first five countries from each quartile from point 4.2 are presented (if there was no data for the country, the next one was taken).

Table 3 provides data on Ireland's food self-sufficiency scores by major categories.

Table 3 – Ireland's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	40,59
Barley and products	77,19
Maize and products	0,00
Rye and products	100,00
Oats	95,31
Cereals, Other	2,44
Sugar (Raw Equivalent)	6,06
Beans	84,00
Fruits, Other	16,81
Fats, Animals, Raw	386,36
Eggs	91,84
Milk - Excluding Butter	114,94

Source: FAO (2018) and own processing

From Table 3 it follows that Ireland has an adequate supply of Rye and products, Oats, Animal fats, Eggs and Milk. This means that food self-sufficiency is achieved in 5 points.

Table 4 provides data on Côte d'Ivoire's food self-sufficiency scores by major categories.

Table 4 – Côte d'Ivoire's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	0,00
Rice and products	67,23
Barley and products	No data
Maize and products	101,41
Rye and products	No data
Oats	0,00
Cereals, Other	52,50
Sugar (Raw Equivalent)	75,81
Beans	100,00
Fruits, Other	200,00
Fats, Animals, Raw	100,00
Eggs	95,35
Milk - Excluding Butter	96,77

Source: FAO (2018) and own processing

From Table 4 it follows that Côte d'Ivoire has an adequate supply of Maize, Beans, Fruits, Animal fats, Eggs and Milk. This means that food self-sufficiency is achieved in 6 points.

Table 5 provides data on Kenya's food self-sufficiency scores by major categories.

Table 5 – Kenya's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	15,52
Rice and products	9,68
Barley and products	111,43
Maize and products	94,36
Rye and products	0,00
Oats	66,67
Cereals, Other	No data
Sugar (Raw Equivalent)	56,76
Beans	99,22
Fruits, Other	106,78
Fats, Animals, Raw	108,00
Eggs	88,89
Milk - Excluding Butter	97,44

Source: FAO (2018) and own processing

From Table 5 it follows that Kenya has an adequate supply of Barley, Maize, Beans, Fruits, Animal fats and Milk. This means that food self-sufficiency is achieved in 6 points.

Table 6 provides data on Morocco's food self-sufficiency scores by major categories.

Table 6 – Morocco's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	67,20
Rice and products	75,90
Barley and products	95,35
Maize and products	5,25
Rye and products	100,00
Oats	84,00
Cereals, Other	200,00
Sugar (Raw Equivalent)	51,32
Beans	0,00
Fruits, Other	104,83
Fats, Animals, Raw	40,00
Eggs	100,25
Milk - Excluding Butter	94,75

Source: FAO (2018) and own processing

From Table 6 it follows that Morocco has an adequate supply of Barley, Rye, Cereals, Fruits, Eggs and Milk. This means that food self-sufficiency is achieved in 6 points.

Table 7 provides data on Bangladesh's food self-sufficiency scores by major categories.

Table 7 – Bangladesh's Food Self-sufficiency scores

Category of comparison	Level of self sufficiency
Wheat and products	15,96
Rice and products	96,46
Barley and products	No data
Maize and products	67,92
Rye and products	0,00
Oats	0,00
Cereals, Other	No data
Sugar (Raw Equivalent)	5,31
Beans	116,38
Fruits, Other	102,01
Fats, Animals, Raw	100,00
Eggs	100,00
Milk - Excluding Butter	99,86

Source: FAO (2018) and own processing

From Table 7 it follows that Bangladesh has an adequate supply of Rice, Beans, Fruits, Fats, Eggs and Milk. This means that food self-sufficiency is achieved in 6 points.

Table 8 provides data on Czechia's food self-sufficiency scores by major categories.

Table 8 – Czechia's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	174,42
Rice and products	0,00
Barley and products	158,85
Maize and products	100,00
Rye and products	99,17
Oats	115,91
Cereals, Other	117,50
Sugar (Raw Equivalent)	187,09
Beans	0,00
Fruits, Other	40,54
Fats, Animals, Raw	54,29
Eggs	82,86

Milk - Excluding Butter	127,64

Source: FAO (2018) and own processing

From Table 8 it follows that Czechia has an adequate supply of wheat, barley, maize, rye, oats, cereals, sugar and milk. This means that food self-sufficiency is achieved in 8 points.

Table 9 provides data on Russian Federation's food self-sufficiency scores by major categories.

Table 9 – Russian Federation's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	222,53
Rice and products	88,34
Barley and products	145,87
Maize and products	177,12
Rye and products	108,07
Oats	99,28
Cereals, Other	113,33
Sugar (Raw Equivalent)	94,99
Beans	20,00
Fruits, Other	49,22
Fats, Animals, Raw	102,94
Eggs	97,75
Milk - Excluding Butter	93,98

Source: FAO (2018) and own processing

From Table 9 it follows that Russian Federation has an adequate supply of wheat, barley, maize, rye, oats, cereals, sugar, fats, eggs and milk. This means that food self-sufficiency is achieved in 10 points.

Table 10 provides data on Bolivia's food self-sufficiency scores by major categories.

Table 10 – Bolivia's (Plurinational State of) Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	42,66
Rice and products	103,24
Barley and products	45,19
Maize and products	131,22
Rye and products	No data
Oats	95,65
Cereals, Other	189,47
Sugar (Raw Equivalent)	131,76

Beans	192,86
Fruits, Other	85,92
Fats, Animals, Raw	123,53
Eggs	100,00
Milk - Excluding Butter	109,62

Source: FAO (2018) and own processing

From Table 10 it follows that Bolivia has an adequate supply of rye, maize, oats, cereals, sugar, beans, fats, eggs and milk. This means that food self-sufficiency is achieved in 9 points.

Table 11 provides data on Saudi Arabia's food self-sufficiency scores by major categories.

Table 11 – Saudi Arabia's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	14,13
Rice and products	0,00
Barley and products	6,21
Maize and products	1,42
Sugar (Raw Equivalent)	0,00
Fruits, Other	121,74
Fats, Animals, Raw	40,63
Eggs	88,82
Milk - Excluding Butter	112,15

Source: FAO (2018) and own processing

From Table 11 it follows that Saudi Arabia has an adequate supply fruits and milk. This means that food self-sufficiency is achieved in 2 points.

Table 12 provides data on Switzerland's food self-sufficiency scores by major categories.

Table 12 – Switzerland's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	44,53
Rice and products	0,00
Barley and products	65,00
Maize and products	47,20
Rye and products	90,91
Oats	11,59
Cereals, Other	80,33
Sugar (Raw Equivalent)	58,40
Beans	0,00

Fruits, Other	27,24
Fats, Animals, Raw	83,87
Eggs	63,54
Milk - Excluding Butter	100,94

Source: FAO (2018) and own processing

From Table 12 it follows that Switzerland has an adequate supply of rye and milk. This means that food self-sufficiency is achieved in 2 points.

Table 13 provides data on United Republic of Tanzania food self-sufficiency scores by major categories.

Table 13 – United Republic of Tanzania Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	5,79
Rice and products	104,03
Barley and products	29,85
Maize and products	120,50
Rye and products	No data
Cereals, Other	110,64
Sugar (Raw Equivalent)	61,83
Beans	120,81
Fruits, Other	100,56
Fats, Animals, Raw	100,00
Eggs	100,00
Milk - Excluding Butter	99,81

Source: FAO (2018) and own processing

From Table 13 it follows that Tanzania has an adequate supply of rice, maize, cereals, beans, fruits, fats, eggs and milk. This means that food self-sufficiency is achieved in 8 points.

Table 14 provides data on United States of America food self-sufficiency scores by major categories.

Table 14 – United States of America Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	151,90
Rice and products	184,47
Barley and products	93,62
Maize and products	124,37
Rye and products	43,32
Oats	27,67
Cereals, Other	108,68

Sugar (Raw Equivalent)	77,51
Beans	113,29
Fruits, Other	61,42
Fats, Animals, Raw	111,82
Eggs	103,29
Milk - Excluding Butter	102,18

Source: FAO (2018) and own processing

From Table 14 it follows that USA has an adequate supply of wheat, rice, barley, maize, cereals, beans, animal fats, eggs and milk. This means that food self-sufficiency is achieved in 9 points.

Table 15 provides data on Uruguay's food self-sufficiency scores by major categories.

Table 15 – Uruguay's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	92,44
Rice and products	1165,42
Barley and products	770,00
Maize and products	34,49
Oats	85,48
Cereals, Other	11,76
Sugar (Raw Equivalent)	17,36
Beans	75,00
Fruits, Other	68,85
Fats, Animals, Raw	284,62
Eggs	100,00
Milk - Excluding Butter	166,00

Source: FAO (2018) and own processing

From Table 15 it follows that Uruguay has an adequate supply of wheat, rice, barley, animal fats, eggs and milk. This means that food self-sufficiency is achieved in 6 points.

Table 16 provides data on Cameroon's food self-sufficiency scores by major categories.

Table 16 – Cameroon's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	0,16
Rice and products	24,88
Barley and products	No data
Maize and products	103,49

Rye and products	No data
Oats	No data
Cereals, Other	No data
Sugar (Raw Equivalent)	51,00
Beans	100,00
Fruits, Other	100,39
Fats, Animals, Raw	100,00
Eggs	90,00
Milk - Excluding Butter	99,19

Source: FAO (2018) and own processing

From Table 16 it follows that Cameroon has an adequate supply of maize, beans, fruits, animal fats, eggs and milk. This means that food self-sufficiency is achieved in 6 points.

Table 17 provides data on Dominican Republic food self-sufficiency scores by major categories.

Table 17 – Dominican Republic Food Self-sufficiency scores

Category of comparison	Level of self sufficiency
Wheat and products	0,00
Rice and products	108,55
Maize and products	2,99
Oats	0,00
Sugar (Raw Equivalent)	149,53
Beans	59,38
Fruits, Other	101,95
Fats, Animals, Raw	50,00
Eggs	102,01
Milk - Excluding Butter	85,65

Source: FAO (2018) and own processing

From Table 17 it follows that Dominican Republic has an adequate supply of rice, sugar, fruits, eggs. This means that food self-sufficiency is achieved in 4 points.

Table 18 provides data on Finland's food self-sufficiency scores by major categories.

Table 18 – Finland's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	65,13
Rice and products	0,00
Barley and products	87,38
Maize and products	0,00

Rye and products	28,57
Oats	135,66
Cereals, Other	120,00
Sugar (Raw Equivalent)	31,69
Fruits, Other	16,96
Fats, Animals, Raw	39,29
Eggs	113,64
Milk - Excluding Butter	81,07

Source: FAO (2018) and own processing

From Table 18 it follows that Finland has an adequate supply of oats, cereals and eggs. This means that food self-sufficiency is achieved in 3 points.

Table 19 provides data on Ghana's food self-sufficiency scores by major categories.

Table 19 – Ghana's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	0,00
Rice and products	58,97
Maize and products	102,08
Oats	0,00
Cereals, Other	8,33
Sugar (Raw Equivalent)	0,00
Beans	95,68
Fruits, Other	78,20
Fats, Animals, Raw	125,00
Eggs	100,00
Milk - Excluding Butter	68,18

Source: FAO (2018) and own processing

From Table 19 it follows that Ghana has an adequate supply of maize, beans, animal fats and eggs. This means that food self-sufficiency is achieved in 4 points.

Table 20 provides data on Austria food self-sufficiency scores by major categories.

Table 20 – Austria Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	82,14
Rice and products	0,00
Barley and products	81,76
Maize and products	93,42
Rye and products	97,25
Oats	89,29
Cereals, Other	107,03
Sugar (Raw Equivalent)	53,81

Beans	0,00
Fruits, Other	49,24
Fats, Animals, Raw	133,33
Eggs	87,07
Milk - Excluding Butter	119,99

Source: FAO (2018) and own processing

From Table 20 it follows that Austria has an adequate supply of maize, rye, cereals, animal fats and milk. This means that food self-sufficiency is achieved in 5 points.

Table 21 provides data on Argentina's food self-sufficiency scores by major categories.

Table 21 – Argentina's Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	331,29
Rice and products	181,67
Barley and products	548,32
Maize and products	225,93
Rye and products	100,00
Oats	99,60
Cereals, Other	302,38
Sugar (Raw Equivalent)	102,61
Beans	639,19
Fruits, Other	177,91
Fats, Animals, Raw	161,93
Eggs	100,24
Milk - Excluding Butter	119,88

Source: FAO (2018) and own processing

From Table 21 it follows that Argentina has an adequate supply of wheat, rice, barley, maize, rye, oats, cereals, sugar, beans, fruits, animal fats, eggs and milk. This means that food self-sufficiency is achieved in 13 points.

Table 22 provides data on Peru food self-sufficiency scores by major categories.

Table 22 – Peru Food Self-sufficiency scores for 2018

Category of comparison	Level of self sufficiency
Wheat and products	9,33
Rice and products	94,25
Barley and products	51,49
Maize and products	30,17
Rye and products	No data
Oats	32,26
Cereals, Other	184,31

Sugar (Raw Equivalent)	82,10
Beans	88,89
Fruits, Other	195,67
Fats, Animals, Raw	92,31
Eggs	100,00
Milk - Excluding Butter	107,85

Source: FAO (2018) and own processing

From Table 22 it follows that Peru has an adequate supply of rice, cereals, fruits, eggs and milk. This means that food self-sufficiency is achieved in 5 points.

According to calculations, the maximum number of categories - 13 received Argentina, the minimum number of categories of self-sufficiency - 0 - was found in a number of countries, among them the UAE, Saint Kitts and Nevis, Gabon, etc.

According to the results obtained, quartiles are divided by the number of categories 0-3, 4-6, 7-9, 10-13, respectively.

The quartile split results are presented below.

The first quartile includes:

- Argentina (with 13 self-sufficiency categories),
- Australia (with 12 self-sufficiency categories),
- Poland (with 12 self-sufficiency categories),
- Brazil (with 10 self-sufficiency categories),
- Bulgaria (with 10 self-sufficiency categories),
- Canada (with 10 self-sufficiency categories),
- China (with 10 self-sufficiency categories),
- China, mainland (with 10 self-sufficiency categories),
- France (with 10 self-sufficiency categories),
- India (with 10 self-sufficiency categories),
- Russian Federation (with 10 self-sufficiency categories),
- Serbia (with 10 self-sufficiency categories),
- Ukraine (with 10 self-sufficiency categories);

The second quartile includes:

- Belarus (with 9 self-sufficiency categories),
- Bolivia (Plurinational State of) (with 9 self-sufficiency categories),
- Ethiopia (with 9 self-sufficiency categories),
- Kazakhstan (with 9 self-sufficiency categories),

- Kyrgyzstan (with 9 self-sufficiency categories),
- Lithuania (with 9 self-sufficiency categories),
- Pakistan (with 9 self-sufficiency categories),
- United States of America (with 9 self-sufficiency categories),
- Chad (with 8 self-sufficiency categories),
- Czechia (with 8 self-sufficiency categories),
- Democratic People's Republic of Korea (with 8 self-sufficiency categories),
- Ecuador (with 8 self-sufficiency categories),
- Latvia (with 8 self-sufficiency categories),
- Malawi (with 8 self-sufficiency categories),
- Mali (with 8 self-sufficiency categories),
- Myanmar (with 8 self-sufficiency categories),
- Nepal (with 8 self-sufficiency categories),
- Slovakia (with 8 self-sufficiency categories),
- South Africa (with 8 self-sufficiency categories),
- Thailand (with 8 self-sufficiency categories),
- Turkey (with 8 self-sufficiency categories),
- United Republic of Tanzania (with 8 self-sufficiency categories),
- Zimbabwe (with 8 self-sufficiency categories),
- Albania (with 7 self-sufficiency categories),
- Chile (with 7 self-sufficiency categories),
- Croatia (with 7 self-sufficiency categories),
- Estonia (with 7 self-sufficiency categories),
- Germany (with 7 self-sufficiency categories),
- Hungary (with 7 self-sufficiency categories),
- Paraguay (with 7 self-sufficiency categories),
- Republic of Moldova (with 7 self-sufficiency categories),
- Romania (with 7 self-sufficiency categories),
- Spain (with 7 self-sufficiency categories),
- Uganda (with 7 self-sufficiency categories).

The third quartile includes:

- Azerbaijan (with 6 self-sufficiency categories),

- Bangladesh (with 6 self-sufficiency categories),
- Benin (with 6 self-sufficiency categories),
- Burkina Faso (with 6 self-sufficiency categories),
- Central African Republic (with 6 self-sufficiency categories),
- Côte d'Ivoire (with 6 self-sufficiency categories),
- Denmark (with 6 self-sufficiency categories),
- Egypt (with 6 self-sufficiency categories),
- Guinea (with 6 self-sufficiency categories),
- Kenya (with 6 self-sufficiency categories),
- Lao People's Democratic Republic (with 6 self-sufficiency categories),
- Madagascar (with 6 self-sufficiency categories),
- Morocco (with 6 self-sufficiency categories),
- Mozambique (with 6 self-sufficiency categories),
- Niger (with 6 self-sufficiency categories),
- Nigeria (with 6 self-sufficiency categories),
- Peru (with 6 self-sufficiency categories),
- Rwanda (with 6 self-sufficiency categories),
- Sweden (with 6 self-sufficiency categories),
- Tajikistan (with 6 self-sufficiency categories),
- Togo (with 6 self-sufficiency categories),
- Tunisia (with 6 self-sufficiency categories),
- United Kingdom of Great Britain and Northern Ireland (with 6 self-sufficiency categories),
- Algeria (with 5 self-sufficiency categories),
- Armenia (with 5 self-sufficiency categories),
- Austria (with 5 self-sufficiency categories),
- Bosnia and Herzegovina (with 5 self-sufficiency categories),
- Cambodia (with 5 self-sufficiency categories),
- Cameroon (with 5 self-sufficiency categories),
- Colombia (with 5 self-sufficiency categories),
- Costa Rica (with 5 self-sufficiency categories),
- Honduras (with 5 self-sufficiency categories),

- Indonesia (with 5 self-sufficiency categories),
- Iran (Islamic Republic of) (with 5 self-sufficiency categories),
- Ireland (with 5 self-sufficiency categories),
- Luxembourg (with 5 self-sufficiency categories),
- Mexico (with 5 self-sufficiency categories),
- Netherlands (with 5 self-sufficiency categories),
- New Zealand (with 5 self-sufficiency categories),
- Nicaragua (with 5 self-sufficiency categories),
- Sierra Leone (with 5 self-sufficiency categories),
- Sri Lanka (with 5 self-sufficiency categories),
- Uruguay (with 5 self-sufficiency categories),
- Viet Nam (with 5 self-sufficiency categories),
- Zambia (with 5 self-sufficiency categories),
- Angola (with 4 self-sufficiency categories),
- Belgium (with 4 self-sufficiency categories),
- Belize (with 4 self-sufficiency categories),
- Congo (with 4 self-sufficiency categories),
- Dominican Republic (with 4 self-sufficiency categories),
- Georgia (with 4 self-sufficiency categories),
- Ghana (with 4 self-sufficiency categories),
- Guatemala (with 4 self-sufficiency categories),
- Guinea-Bissau (with 4 self-sufficiency categories),
- Italy (with 4 self-sufficiency categories),
- Philippines (with 4 self-sufficiency categories),
- Senegal (with 4 self-sufficiency categories),
- Sudan (with 4 self-sufficiency categories),
- Turkmenistan (with 4 self-sufficiency categories),
- Uzbekistan (with 4 self-sufficiency categories),
- Yemen (with 4 self-sufficiency categories).

The fourth quartile includes:

- Afghanistan (with 3 self-sufficiency categories),
- China, Taiwan Province of (with 3 self-sufficiency categories),

- Cuba (with 3 self-sufficiency categories),
- Cyprus (with 3 self-sufficiency categories),
- Eswatini (with 3 self-sufficiency categories),
- Finland (with 3 self-sufficiency categories),
- Gambia (with 3 self-sufficiency categories),
- Greece (with 3 self-sufficiency categories),
- Guyana (with 3 self-sufficiency categories),
- Haiti (with 3 self-sufficiency categories),
- Iceland (with 3 self-sufficiency categories),
- Mongolia (with 3 self-sufficiency categories),
- North Macedonia (with 3 self-sufficiency categories),
- Slovenia (with 3 self-sufficiency categories),
- Timor-Leste (with 3 self-sufficiency categories),
- Venezuela (Bolivarian Republic of) (with 3 self-sufficiency categories),
- El Salvador (with 2 self-sufficiency categories),
- Fiji (with 2 self-sufficiency categories),
- Grenada (with 2 self-sufficiency categories),
- Israel (with 2 self-sufficiency categories),
- Jamaica (with 2 self-sufficiency categories),
- Japan (with 2 self-sufficiency categories),
- Jordan (with 2 self-sufficiency categories),
- Lebanon (with 2 self-sufficiency categories),
- Lesotho (with 2 self-sufficiency categories),
- Malaysia (with 2 self-sufficiency categories),
- Mauritania (with 2 self-sufficiency categories),
- Mauritius (with 2 self-sufficiency categories),
- Namibia (with 2 self-sufficiency categories),
- Norway (with 2 self-sufficiency categories),
- Panama (with 2 self-sufficiency categories),
- Papua New Guinea (with 2 self-sufficiency categories),
- Portugal (with 2 self-sufficiency categories),
- Republic of Korea (with 2 self-sufficiency categories),

- Saint Lucia (with 2 self-sufficiency categories),
- Saint Vincent and the Grenadines (with 2 self-sufficiency categories),
- Saudi Arabia (with 2 self-sufficiency categories),
- Solomon Islands (with 2 self-sufficiency categories),
- Suriname (with 2 self-sufficiency categories),
- Switzerland (with 2 self-sufficiency categories),
- Vanuatu (with 2 self-sufficiency categories),
- Botswana (with 1 self-sufficiency category),
- China, Macao SAR (with 1 self-sufficiency category),
- Djibouti (with 1 self-sufficiency category),
- Dominica (with 1 self-sufficiency category),
- Iraq (with 1 self-sufficiency category),
- Kiribati (with 1 self-sufficiency category),
- Kuwait (with 1 self-sufficiency category),
- Liberia (with 1 self-sufficiency category),
- Montenegro (with 1 self-sufficiency category),
- New Caledonia (with 1 self-sufficiency category),
- Oman (with 1 self-sufficiency category),
- Samoa (with 1 self-sufficiency category),
- Trinidad and Tobago (with 1 self-sufficiency category),
- Antigua and Barbuda (with 0 self-sufficiency categories),
- Bahamas (with 0 self-sufficiency categories),
- Barbados (with 0 self-sufficiency categories),
- Cabo Verde (with 0 self-sufficiency categories),
- China, Hong Kong SAR (with 0 self-sufficiency categories),
- French Polynesia (with 0 self-sufficiency categories),
- Gabon (with 0 self-sufficiency categories),
- Maldives (with 0 self-sufficiency categories),
- Malta (with 0 self-sufficiency categories),
- Saint Kitts and Nevis (with 0 self-sufficiency categories),
- Sao Tome and Principe (with 0 self-sufficiency categories),
- United Arab Emirates (with 0 self-sufficiency categories).

The first quartile includes 13 countries, the second quartile includes 34 countries, the third quartile includes 61 countries, and the fourth quartile includes 66 countries.

Complete data are presented in table 6 in the appendix.

4.4 Comparison the results from 4.2 and 4.3

The results of calculations of two methodologies: calculation of GFSI (4.2) and calculation of GLFSS (4.3) were taken, sorted and analyzed. The calculation results for each of them were divided into quartiles. The first quartile is light yellow, the second is darker, and so on. The first column of table 23 shows the value of the GFSI index, the second column - the corresponding country, the fourth column shows the number of categories in which the country is self-sufficient by at least 90%, the third column - the corresponding country.

The logic of this analysis lies in comparing the distribution of countries by quartiles, if a country in different methodologies occurs in different quartiles, this means a difference in estimates, and therefore in methodologies.

Since there is a task to test the hypothesis that the higher the self-sufficiency of the country is, the higher is its food security, we compare the results of assessments using these two methodologies, and if we see that the assessments do not coincide, it means that there is no supposed dependence (matches were achieved in 23% of cases). As a result, it turns out that a food-imports-independent country is not necessarily highly rated by the GFSI.

There are only 97 countries in Table 23, because it was possible to compare only those countries that were simultaneously in the 4.2 and 4.3 ratings.

Table 23 – GFSI & GLFSS quartiles comparison

With GFSI scores	Country	Country	With GLFSS categories
59,8	Algeria	Algeria	5
45,5	Angola	Angola	4
70,8	Argentina	Argentina	13
81,4	Australia	Australia	12
81,7	Austria	Austria	5
64,8	Azerbaijan	Azerbaijan	6
53,2	Bangladesh	Bangladesh	6
70,9	Belarus	Belarus	9
80,7	Belgium	Belgium	4

51	Benin	Benin	6
63,8	Botswana	Botswana	1
70,1	Brazil	Brazil	10
66,2	Bulgaria	Bulgaria	10
50,1	Burkina Faso	Burkina Faso	6
49,4	Cambodia	Cambodia	5
49,9	Cameroon	Cameroon	5
82,4	Canada	Canada	10
36,9	Chad	Chad	8
75,5	Chile	Chile	7
71	China	China	10
69,4	Colombia	Colombia	5
70,1	Costa Rica	Costa Rica	5
81	Denmark	Denmark	6
64,2	Dominican Republic	Dominican Republic	4
61,8	Ecuador	Ecuador	8
64,5	Egypt	Egypt	6
60,7	El Salvador	El Salvador	2
49,2	Ethiopia	Ethiopia	9
82,9	Finland	Finland	3
80,4	France	France	10
81,5	Germany	Germany	7
62,8	Ghana	Ghana	4
73,4	Greece	Greece	3
60,6	Guatemala	Guatemala	4
46,7	Guinea	Guinea	6
43,3	Haiti	Haiti	3
58	Honduras	Honduras	5
72,7	Hungary	Hungary	7
58,9	India	India	10
62,6	Indonesia	Indonesia	5
84	Ireland	Ireland	5
79	Israel	Israel	2
75,8	Italy	Italy	4
76,5	Japan	Japan	2
61	Jordan	Jordan	2
67,3	Kazakhstan	Kazakhstan	9
50,7	Kenya	Kenya	6
74,8	Kuwait	Kuwait	1
37,9	Madagascar	Madagascar	6
42,5	Malawi	Malawi	8
73,8	Malaysia	Malaysia	2
54,4	Mali	Mali	8
69,4	Mexico	Mexico	5
62,8	Morocco	Morocco	6
41,4	Mozambique	Mozambique	6
57	Myanmar	Myanmar	8
56,4	Nepal	Nepal	8
82	Netherlands	Netherlands	5
78,8	New Zealand	New Zealand	5
54,2	Nicaragua	Nicaragua	5
49,6	Niger	Niger	6
48,4	Nigeria	Nigeria	6
82,9	Norway	Norway	2
68,4	Oman	Oman	1
56,8	Pakistan	Pakistan	9
68,8	Panama	Panama	2

57,9	Paraguay	Paraguay	7
63,3	Peru	Peru	6
61	Philippines	Philippines	4
75,6	Poland	Poland	12
77,8	Portugal	Portugal	2
70,2	Romania	Romania	7
69,7	Russia	Russia	0
48,2	Rwanda	Rwanda	6
73,5	Saudi Arabia	Saudi Arabia	2
54,3	Senegal	Senegal	4
62,8	Serbia	Serbia	10
39	Sierra Leone	Sierra Leone	5
68,3	Slovakia	Slovakia	8
67,3	South Africa	South Africa	8
75,5	Spain	Spain	7
60,8	Sri Lanka	Sri Lanka	5
45,7	Sudan	Sudan	4
82,7	Sweden	Sweden	6
83,1	Switzerland	Switzerland	2
49	Tajikistan	Tajikistan	6
65,1	Thailand	Thailand	8
44	Togo	Togo	6
60,1	Tunisia	Tunisia	6
69,8	Turkey	Turkey	8
46,2	Uganda	Uganda	7
57,1	Ukraine	Ukraine	10
76,5	United Arab Emirates	United Arab Emirates	0
83,7	USA	USA	9
72,8	Uruguay	Uruguay	5
59	Uzbekistan	Uzbekistan	4
44,4	Zambia	Zambia	5

Source: Own processing

The total number of cases when the methodology for assessing food self-sufficiency and the methodology for assessing food security assigned the country to the coinciding quartile was 23.71%. What is the basis for rejecting the main hypothesis and accepting an alternative one.

4.4.1 USA GFSI & GLFSS discussion

Mohammad Gani, Professor at Independent University, Bangladesh (2006-present), when asked how the United States managed to achieve both high levels of food self-sufficiency and food self-sufficiency, answers the following:

"There is quite a lot of arable land in the United States (174.45 million hectares). The United States has invested heavily in modern agricultural technology for a long time. The yield per hectare is one of the highest in the world. At the U.S. yield rate, about 170 million hectares can feed a staggering 8,500 million people (10 tons per hectare can feed

50 people, and one person only needs 0.2 tons per year). That is, the United States can effectively feed the whole world. The actual world population is about 800 million less (in 2018).”

But there is a big problem. Food production is expensive and food supply far exceeds demand, so food prices are negative. In the US, there is a very severe penalty for overproduction of food. Although less than 2% of American workers are still in agriculture, they have traditionally wielded disproportionate political power. The US government is required by law to support farmers who cannot sell food domestically because there are usually 3 times more food than required. Thus, the government buys food and distributes it to foreign countries for free, and, even more strikingly, under Sections I, II, II, and IV of this Public Law 480, it usually also pays for delivery, local storage and transportation and distribution of donated food. also. In short, America pays the customer for the food (Quora, 2020).

The professor M. Gani comments on this problem as follows: *“This paradoxically hurts poor farmers from poor countries who receive free American food. Since the poor country's government gets free food from America, it tends to distribute food at low cost or even free, making it difficult for local farmers to compete. Food prices remain extremely low. This is the main cause of poverty around the world: more than 90% of the world's poor are smallholders, marginalized farmers, landless peasants, fishermen and animal hunters. They are poor because the price of what they sell is much lower than the cost of production. The crime of powerful American farms - overproduction - punishes the disenfranchised peasants of poor countries. Public Law 480 is a weapon that American farmers use to force the US government to buy food at a price much higher than the market would ever pay in an oversupply situation. The unintended advantage of this is that the US is gaining global leadership largely by buying diplomatic support from poor countries by providing them with free food.”*

America has long tried to dissuade farmers from overproduction. The US pays farmers not to use the land. The allocation of large agricultural subsidies has long been a financial headache for the US government (Gani, 2020).

4.5 Energetic approach of assessing food self-sufficiency

As was mentioned earlier, the assessment of the country's food security according to the GFSI methodology does not take into account the situation of the country's food crisis supply, which is its main drawback of GFSI methodology.

The assessment of the country's food security according to the GLFSS methodology, as the balance of food imports / exports, is not sufficiently representative. The main reasons are the following: achieving food independence in categories as themselves is not sufficient to guarantee the adequate supply of nutrients to meet the needs of the population in the event of an emergency situation; a country can achieve a self-sufficiency indicator in any category because either this category is not popular with consumers in the country, or if the country does not import this category of goods. In addition, there can be significant imbalances in nutrient production. For example, a situation when an excessive amount of fat is produced in a country and an insufficient amount of protein is produced, this methodology does not differ from a balanced one.

In this regard, for a more accurate assessment of the country's capacity for independent crisis supply, an energy-based approach to assessing food self-sufficiency is applied. The main advantage of this methodology is: this methodology allows to assess the country's own production of nutrients. That is, the ability, if necessary, to replace one category of food with another and assess the balance of the diet supplied to the market. For example, it is obvious that no matter how high fish production is, if this is the only category of food produced by the country, this will not be enough for a long-term supply of the country in the absence of the possibility of importing food.

4.5.1 Total Energy Supply (TES), Total Protein Supply (TPS), Total Fat Supply (TFS) calculations

This chapter will provide sample data and sample calculations of TES, TPS and TFS.

For the analysis, information was obtained from the FAO (FAO, 2018) website for 174 countries on the amount of protein, fat and calories received by its citizens from each of the food categories produced by the country. On average, information was obtained for each country for 101 food categories (57,096 data items).

According to the energetic methodology, for each country, the amount of protein, fat and calories should be summed for all food categories produced by the country. At the end of Table 24, the sums of protein, fat and calories for all Afghanistan-produced food categories are displayed.

Below is a demonstration of data, based on which, applying Formula (6), the Total Energy Supply (TES) of Afghanistan in 2018 was calculated.

Table 24 – Piece of data set for Afghanistan

Area	Element	Item	Year	Unit	Value
Afghanistan	Food supply (kcal/capita/day)	Wheat and products	2018	kcal/capita/day	1360
Afghanistan	Protein supply quantity (g/capita/day)	Wheat and products	2018	g/capita/day	36,64
Afghanistan	Fat supply quantity (g/capita/day)	Wheat and products	2018	g/capita/day	4,55
Afghanistan	Food supply (kcal/capita/day)	Rice and products	2018	kcal/capita/day	108
Afghanistan	Protein supply quantity (g/capita/day)	Rice and products	2018	g/capita/day	2,06
Afghanistan	Fat supply quantity (g/capita/day)	Rice and products	2018	g/capita/day	0,2
Afghanistan	Food supply (kcal/capita/day)	Barley and products	2018	kcal/capita/day	12
Afghanistan	Protein supply quantity (g/capita/day)	Barley and products	2018	g/capita/day	0,37
Afghanistan	Fat supply quantity (g/capita/day)	Barley and products	2018	g/capita/day	0,11
Afghanistan	Food supply (kcal/capita/day)	Maize and products	2018	kcal/capita/day	15
Afghanistan	Protein supply quantity (g/capita/day)	Maize and products	2018	g/capita/day	0,38
Afghanistan	Fat supply quantity (g/capita/day)	Maize and products	2018	g/capita/day	0,2
--//--	--//--	--//--	--//--	--//--	--//--
				Protein sum	55,5
				Fat sum	31,87
				Calories sum	2038

Source: FAO (2018) and own processing

According to calculations, Total Energy Supply (TES) of Afghanistan in 2018 was 2038 kcal/capita/day.

TES for all available data is presented in table 2 in Appendix.

According to calculations, using formula (4), Total Protein Supply (TPS) of Afghanistan in 2018 was 55,5 g/capita/day.

TPS for all available data are presented in table 2 in Appendix.

According to calculations, using formula (5), Total Fat Supply (TFS) of Afghanistan in 2018 was 31,9 g/capita/day.

TFS for all available data are presented in table 2 in Appendix.

The calculations provided data on the amount of produced protein, fat and calories per capita for 174 countries. The next step of the study will be the assessment of the produced resources for sufficiency. The database on the amount of nutrients used in the calculations of paragraph 4.5.1 contains 54,097 data items, therefore it will not be presented in the appendix of this work, but all the data used can be found on the FAOSTAT website.

4.5.2 Consumption rates calculations

In order to evaluate the data obtained in the previous step, it is necessary to obtain data on the required amount of nutrient production. This chapter will demonstrate the data and the algorithm for calculating them (for those data that need to be calculated).

According to the World Health Organization (WHO, 2020), average weight of human is 62 Kg.

Based on the United Nations data (UN, 2020), average age of human is 33 years.

According to the World Health Organization (WHO, 2020), 1 in 4 adults do not meet the global recommended levels of physical activity, adjusting for people exceeding recommended levels of physical activity, as an average coefficient of physical activity (CPA) 1,7 was taken.

Based on the above information and the norms specified in tables 3 and 4 in appendix, the average calorie intake per person should be estimated as 2500 calories per day, the average protein intake per person can be estimated as 75 grams per day, the average fats intake per person can be estimated as 85 grams per day.

The calculations of the indicator «level of energy self-sufficiency of the country» (ESS) was calculated using formula 7, the indicator «level of protein self-sufficiency of the country» (PSS) was calculated using formula 8, the indicator «level of fat self-sufficiency of the country» (FSS) was calculated using formula 9, based on all above-mentioned data.

Table 25 presents a fragment of energy self-sufficiency of countries rating calculations based on the energetic approach.

Table 25 - Energy self-sufficiency of countries rating for 2018

Country	ESS
Ireland	1,55
United States of America	1,51
Belgium	1,51
Turkey	1,48
Austria	1,48
Iceland	1,46
Romania	1,43
Canada	1,43
Germany	1,42

Source: FAO (2018) and own processing

Figure 2 shows the assessment of Energy Self-Sufficiency of countries. The dark-colored countries are energetically self-sufficient, the light-colored countries are not.

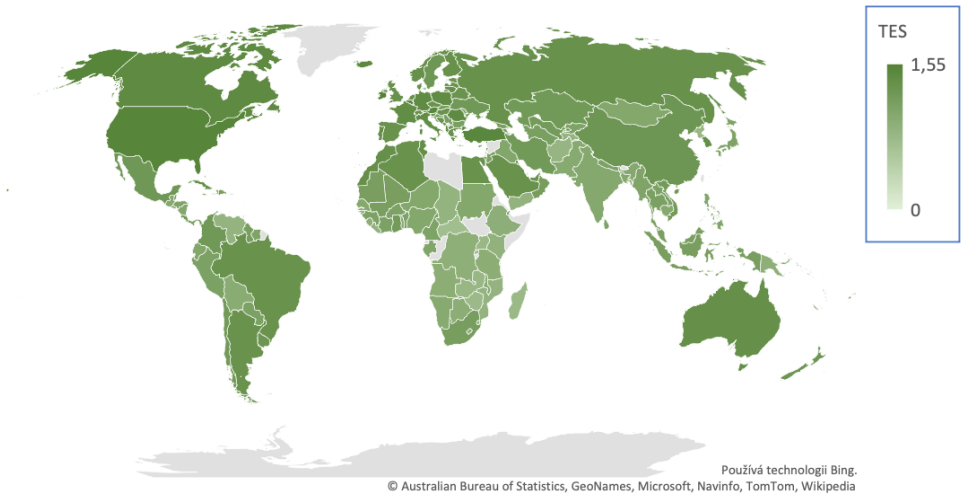

Figure 2 – Countries' ESS assessment map
Source: FAO (2018) and own processing

Table 26 presents a fragment of protein self-sufficiency of countries rating calculations based on the energetic approach.

Table 26 - Protein self-sufficiency of countries rating for 2018

Country	PSS
Iceland	1,95
China, Hong Kong SAR	1,71
Israel	1,69
Lithuania	1,69
Finland	1,57
Ireland	1,57
Denmark	1,56
Portugal	1,56
Malta	1,55

Source: FAO (2018) and own processing

Figure 3 shows the assessment of Protein Self-Sufficiency of countries. The dark-colored countries have protein self-sufficiency, the light-colored countries have not.

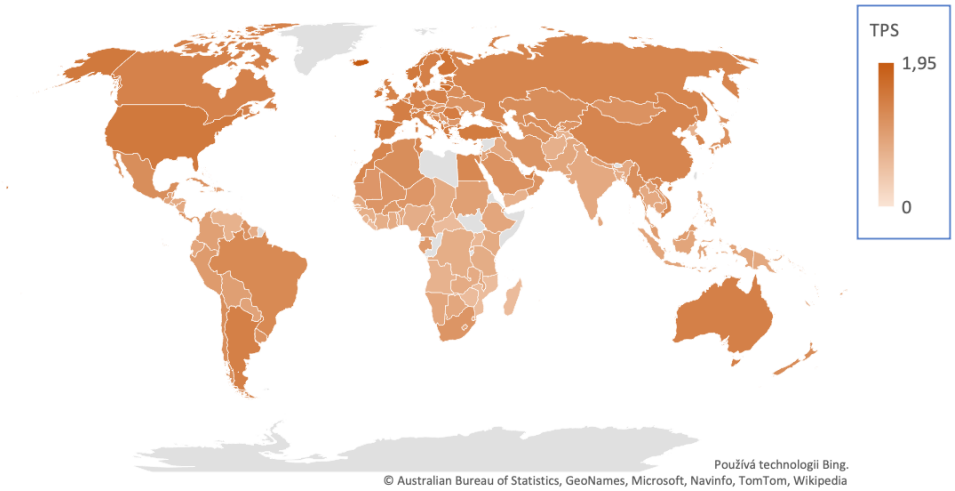

Figure 3 – Countries' PSS assessment map
Source: FAO (2018) and own processing

Table 27 presents a fragment of fat self-sufficiency of countries rating calculations based on the energetic approach.

Table 27 - Fat self-sufficiency of countries rating for 2018

Country	FSS
United States of America	2,01
Iceland	1,97
Austria	1,96
Canada	1,92
Belgium	1,90
Australia	1,86
Switzerland	1,80
Ireland	1,80

Source: FAO (2018) and own processing

Figure 4 shows the assessment of Fat Self-Sufficiency of countries. The dark-colored countries have fat self-sufficiency, the light-colored countries have not.

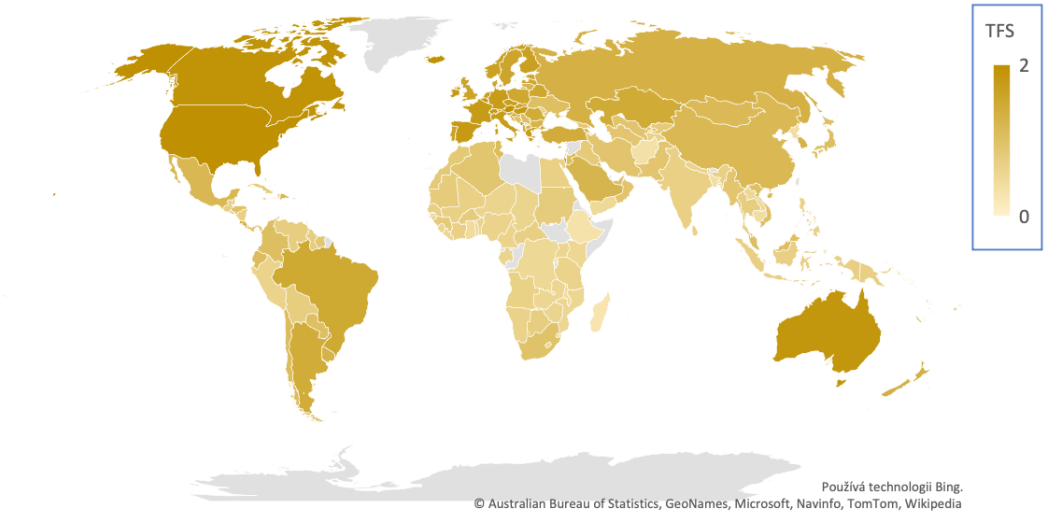

Figure 4 – Countries' FSS assessment map
Source: FAO (2018) and own processing

Full details of TES, TPS, TFS, ESS, PSS and FSS are given in table 2 in the appendix.

Having obtained the data sufficiency assessment from section 4.5.1, it makes sense to identify countries that have sufficient indicators in the production of proteins, fats and calories at the same time. In other words, these are those countries that score above 1 point in ESS, PSS and FSS at the same time (table 28).

Table 28 - Countries that score above 1 point in ESS, PSS and FSS at the same time

Country	ESS	PSS	FSS
Ireland	1,55	1,57	1,80
United States of America	1,51	1,51	2,00
Belgium	1,51	1,33	1,89
Turkey	1,48	1,48	1,43
Austria	1,48	1,45	1,96
Iceland	1,46	1,95	1,97
Romania	1,43	1,46	1,45
Canada	1,43	1,39	1,93
Germany	1,42	1,40	1,75
Poland	1,41	1,41	1,50
Israel	1,41	1,69	1,77
France	1,40	1,44	1,77
Italy	1,40	1,42	1,75
Montenegro	1,40	1,52	1,67
Portugal	1,39	1,56	1,64
Kuwait	1,39	1,38	1,31
Luxembourg	1,39	1,44	1,68
Tunisia	1,38	1,33	1,11
Malta	1,37	1,55	1,41
Republic of Korea	1,37	1,34	1,31
Lithuania	1,36	1,69	1,24

Denmark	1,36	1,56	1,62
Australia	1,36	1,41	1,86
Greece	1,35	1,44	1,76
Norway	1,35	1,51	1,65
Albania	1,34	1,54	1,37
Switzerland	1,34	1,27	1,80
United Kingdom of Great Britain and Northern Ireland	1,34	1,38	1,62
Russian Federation	1,34	1,35	1,32
Finland	1,34	1,57	1,68
China, Macao SAR	1,33	1,46	1,79
Spain	1,33	1,43	1,79
Hungary	1,33	1,19	1,80
United Arab Emirates	1,32	1,47	1,04
Argentina	1,32	1,42	1,45
Saudi Arabia	1,32	1,16	1,24
Bosnia and Herzegovina	1,32	1,32	1,01
Brazil	1,32	1,28	1,49
Netherlands	1,32	1,42	1,65
Czechia	1,31	1,16	1,71
Belarus	1,31	1,23	1,53
China, Hong Kong SAR	1,31	1,71	1,60
Estonia	1,30	1,40	1,50
Latvia	1,29	1,37	1,53
Uruguay	1,28	1,15	1,29
Slovenia	1,28	1,28	1,35
China	1,28	1,34	1,18
New Zealand	1,28	1,25	1,34
China, mainland	1,28	1,34	1,17
Sweden	1,27	1,41	1,57
Mexico	1,26	1,22	1,20
Ukraine	1,24	1,15	1,02
Croatia	1,23	1,21	1,37
North Macedonia	1,23	1,12	1,25
Kazakhstan	1,23	1,22	1,46
Mauritius	1,22	1,18	1,11
Chile	1,21	1,22	1,10
Samoa	1,21	1,17	1,61
Costa Rica	1,21	1,10	1,24
Viet Nam	1,21	1,31	1,03
Cyprus	1,21	1,22	1,34
Armenia	1,20	1,26	1,13
China, Taiwan Province of	1,19	1,15	1,54
Trinidad and Tobago	1,19	1,14	1,08
Saint Vincent and the Grenadines	1,19	1,20	1,00
Barbados	1,18	1,19	1,13
French Polynesia	1,16	1,28	1,47
Bulgaria	1,14	1,11	1,27
Malaysia	1,14	1,03	1,06
New Caledonia	1,13	1,13	1,31
Serbia	1,13	1,12	1,05
Japan	1,08	1,16	1,05
Bahamas	1,06	1,07	1,23
Saint Kitts and Nevis	1,03	1,03	1,14
Mongolia	1,03	1,16	1,16

Source: FAO (2018) and own processing

There is 75 such countries. Those countries that were not included in this list do not have complete self-sufficiency in food, which means their high dependence on food imports. Figure 5 shows the data in Table 28. The dark-colored countries are self-sufficient in food. The light-colored countries are highly dependent on food imports.

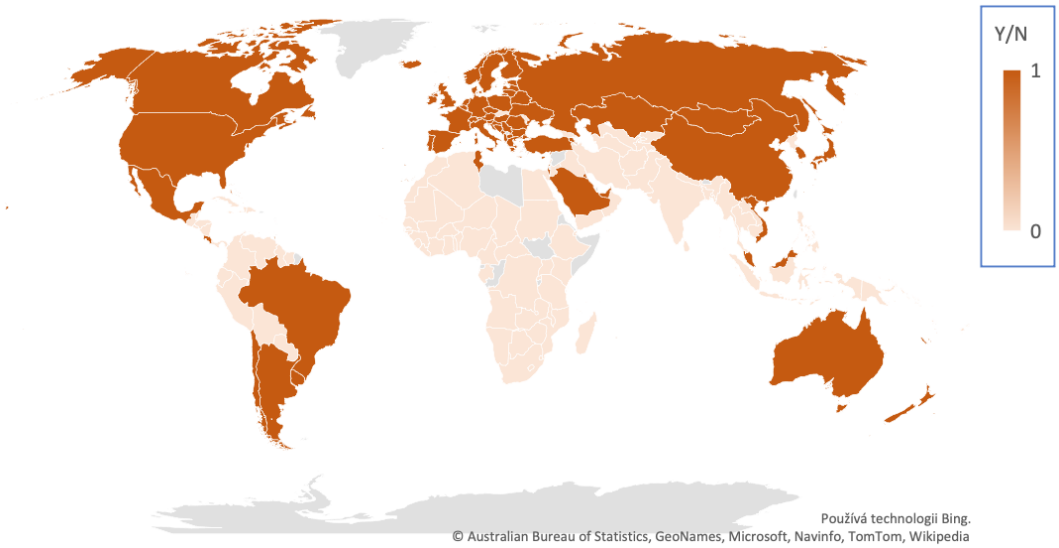

Figure 5 – Self-sufficient countries map
Source: FAO (2018) and own processing

5 Results and Discussion

It should be noted that the following situation has developed in the world: on the one hand, the world food (agri-food) system (MAPS) has been formed, on the other hand, ensuring food security is one of the most important tasks of any state, regardless of its socio-economic system. At the same time, the approaches to solving the problem of ensuring food security at the national level in each individual country are far from the same.

The world food (agri-food) system has developed as a result of the intensification of international cooperation and division of labor, interaction and globalization of national commodity systems in the production and sale of agricultural products, raw materials and food. Its material basis is made up of diversified food complexes, which include three functional areas (Belkharoev, 2008):

- production of means of production,
- agriculture,

– processing and marketing of agricultural products, raw materials and food.

At the same time, the main elements of international trade, covering all areas of the food complex, are (Belkharoev, 2008):

– export of capital and technologies associated with the development of agribusiness,
– internationalization of scientific research, education and management training,
– organization and operation of international agreements and organizational structures affecting all aspects of the formation and functioning of the IAPC,
– global information that allows you to quickly and efficiently make management decisions in the field of agribusiness.

According to rough estimates, foreign trade channels receive about 12% of the world's agricultural products, including 27-29% of sugar production, 16-18% - wheat, 10-12% - corn, 12-15% - butter, 8– 8.5% - cheese, more than 3% pork and 10-12% each of other types of meat. In quantitative terms, this corresponds to 100 million tons of wheat, 65 million tons of corn, 34 million tons of sugar, 5.3 million tons of beef, more than 5 million tons of poultry meat (FAO, 2018).

When dealing with the world food market, it should be borne in mind that the world market is a market for export food products produced in the best natural and economic conditions by the most efficient producers and sold at prices that are acceptable to them. World prices are based on the cost of production in the best production conditions, obtained by the most efficient manufacturers. In doing so, it is also necessary to take into account export subsidies and other forms of stimulating the export of food and raw materials for its production. All other manufacturers in the world who work in worse conditions or in less efficient ways have a higher cost of agricultural products and cannot compete with world prices. They have, on the one hand, to improve production efficiency, on the other, to resort to protective measures, which is widely used by a number of economically developed countries, in which the protection of the domestic market and the equalization of production conditions are inevitable components of the state's economic policy. As protective measures, they use import tariffs, compensation taxes, excise taxes, various taxes and non-tax restrictions in the form of quotas and administrative regulation. These forces, with relatively low official customs duties, to erect impassable barriers to the import of certain types of food and raw materials for their production.

5.1 Impact of coronavirus infection on global food security

First of all, not only the lives of people are directly at risk of pandemic, but also the livelihoods of the importing countries and food producers. Its economic component is as dangerous as the threat it poses to human health. It affects farmers, processors, transporters and others who participate in the food supply chain. For countries that depend on food imports, the average annual grain consumption in the MENA region is currently 60 kg above the world average, at 200 kg per capita per year (OECD-FAO, 2018).

In terms of food consumption, wheat and its processed products, according to FAO Stat, provide 46% of food calories in Tunisia and Iraq, 43% in Algeria, 42% in Morocco, 35% in Jordan and Egypt, 26% - in Saudi Arabia. Considering that from 2017 to 2020 Egypt imported 65% of milling wheat and Saudi Arabia 95% (AMIS-Outlook, 2019), only imported cereals currently account for about 23% of all food calories in Egypt and 25% in Saudi Arabia. Of course, these two countries may experience the consequences of the rise in world prices for grain in different ways, especially in conditions when its supply will be limited for one reason or another.

While Asian countries rely on their own wheat and rice production, countries depend on imports of other crops such as soybeans. And they, in turn, are used, among other things, as feed for the already thinned pig population due to ASF. China buys soybeans from Brazil, USA, Argentina. And its shortage will directly affect the production of animal protein in China. Long-term quarantine primarily affects the agricultural sector of countries: previously, the media reported that the vegetable harvest is literally rotting in the fields and in greenhouses due to a catastrophic shortage of workers. Logistic chains have suffered due to emergency measures. In particular, the slowdown in the shipping industry. The UN Committee on World Food Security also warned that supply chain disruptions could be catastrophic (Meshcheryagina, 2020).

According to the news agency RIA News: "*At least 135 million people are in acute food insecurity or worse. According to the latest figures, more than half of the affected population is in Africa (73 million). In second place are Asia and the Middle East (43 million). 18.5 million are in the Latin America and the Caribbean region and 0.5 million in Europe.*

An estimated 183 million people in 47 countries are at moderate or borderline food insecurity, at risk of transition to a higher phase if faced with additional shocks or

stressors. These 183 million people living in acute food insecurity are the most vulnerable to the impact of the pandemic, as they have limited or no capacity to cope with the health and socioeconomic impact of the shock. In addition, countries dependent on food imports, oil exports, tourism and remittances will suffer. Small island developing states in particular. " (RIA News, 2020).

Labor shortages are becoming a common problem for global agricultural production. In the USA, Germany, Italy, workers of farms and livestock complexes worried about the fear of infection with coronavirus do not go to work. The authorities oblige employers to comply with increased measures to prevent infection among employees. The problem of the EU is that, having a single market for agricultural products, the participating countries are free to close their borders to prevent the spread of the pandemic. Today at border crossings there are delays in goods caused by additional checks. If the closure of individual countries increases, the entire market may collapse. Logistics problems like this do not only arise across the EU. In Italy, entire regions are in quarantine, problems with the movement of goods within the country arise when the state is divided into autonomous territorial units (India, Brazil). Controls in ports are being tightened. Delays in the port of Jeddah (Saudi Arabia) are reported by Brazilian exporters. Chinese ports are malfunctioning. To avoid disruptions in Brazilian ports and to ensure the movement of agricultural goods, the government is coordinating with state leaders on rules to ensure the safety of employees and smooth movement throughout the country. The surge in coronavirus infection coincided with a peak in Brazilian soybean exports. With China practically back to normal after the pandemic and in need of restocking, the ports' export program is overcrowded (InVenture, 2020).

According to FAO analysts, if there is a slowdown in the growth of grain yields in the Black Sea region by 9% over the next 10 years, the consequences for importing countries may be significant, because they will have to pay more for imports of products. For example, for a country like Egypt, the cost of importing food will increase by $ 170 million per year (FAO, 2020).

The Chinese authorities responded to the coronavirus pandemic by quietly stimulating the economy. The official interest rate set by the Central Bank for commercial lenders providing loans to rural areas, farms and agricultural firms, and other small businesses, was cut by a quarter percentage point to 2.5 percent. Regional banks that provide such loans at

a rate no higher than half a percent higher than the base interest rate were eligible to apply for new government funding (ROSSKONGRESS, 2020).

The most effective elements of the mobilization economy of China during the crisis were (ROSSKONGRESS, 2020):

- food supply. The state controlled both stores and online grocery delivery, which prevented a sharp increase in prices;
- control over the increase in the production of a number of materials: medical masks, essential products (to avoid panic);
- the state has launched a system of online services. China has significantly expanded its online government platforms where you can establish links with suppliers: for example, if some components are missing for production in one region, then you can find them through this platform.

However, all these measures were effectively implemented only thanks to China's readiness for such a situation, the availability of already created prototypes for online platforms, information about developed technologies, etc.

5.2 Recommendations for countries to deal with the negative effects of the pandemic

Of course, the consequences of the spread of the virus will have an extremely negative impact on the work of small and medium-sized farms, which may lose access to markets for selling their products or purchasing material and technical resources. Therefore, it is very important to maintain their liquidity and provide access to resources.

Maintaining the liquidity of the Health Promotion Program through food safety and zoonotic disease prevention projects is very important.

Regarding advice to governments what they can do in this situation. First of all - to abandon inappropriate subsidies to food consumers, direct them to support the livelihoods of the most vulnerable groups of the population and provide them with access to food. It is also possible to reduce import tariffs and other restrictions, which for many countries is an important regulation valve, a temporary reduction in taxes that affect the formation of the cost of food. In addition, countries need to provide food for their vulnerable populations and improve social protection programs.

According to experts Lomovtseva and Pyataeva (Lomovtseva, 2020), in modern conditions, it is advisable for the leadership of the regions to monitor the organization of the work of industries adjacent to the agro-industrial complex (for example, logistics of goods, since certain regions have already encountered difficulties in moving vehicles with seeds, fertilizers, spare parts and finished products). Also, the most important aspect of countering the spread of coronavirus infection is the timely disinfection of agricultural enterprises and the provision of personal protective equipment for all workers. Moreover, the key goal in the field of agriculture, of course, is to provide the population with products in the required volume, high-quality and complete sowing, as well as maintaining the continuity of the production cycle, which can only be achieved with the uninterrupted operation of agricultural enterprises, which also depends on the timeliness of payment of wages. workers in the industry. In order to ensure the smooth operation of agricultural enterprises, it is advisable for the executive authorities of the constituent entities, together with the management of agricultural enterprises, to take the following measures (Lomovtseva, 2020):

- to provide a reserve of labor resources of agricultural enterprises;
- provide employees with a place of temporary residence;
- organize corporate transport to deliver employees to the place of work;
- minimize contacts between employees (for example, allocate work areas);
- develop several options for employee work schedules, minimize the number of people in one shift, etc.

FAO comments on the development of coronavirus infection as follows (FAO, 2020): "*FAO is extremely concerned about the impact of the pandemic on both vulnerable countries and those struggling with hunger, as well as countries that are dependent on food imports. FAO is very concerned about how food imports will be secured. In terms of investment, increasing credit risk and tightening credit policies in developing countries will make it difficult to deliver large-scale macroeconomic support programs. In this area, FAO will work closely with partner banks. Thus, the European Bank for Reconstruction and Development announced an aid package of 1 billion euros, the World Bank - 14 billion dollars*.".

General recommendations to the governments of countries look like this:

- to take measures to stimulate the economy,
- rationalize government spending as much as possible by focusing on helping the least protected segments of economy,
- establish control over the observance of sanitary and hygienic standards at enterprises,
- to allocate subsidies to enterprises of the agro-industrial complex.

6 Conclusion

In conclusion, I would like to say that in spite of the seeming prosperity, security, satiety of the market today, the seemingly limitless possibilities that scientific and technological progress gives to the modern world, our world still remains fragile. Every year mankind is mastering new technologies, our achievements in automation and production efficiency make a new round of the spiral path to perfection every year. All this gives us the illusion of being in control of the situation. But in reality, this is only an illusion.

The complication of ongoing processes does not mean an increase in their reliability. Our world is still struggling with hunger, poverty, uneven distribution of resources, blatant illiteracy of human behavior, injustice, cruelty, crime and various cultural and social contradictions. The invention of penicillin at one time seemed like a panacea and the key to a brighter future, while now scientists are discovering the need for new antibiotics, because bacteria quickly adapted to penicillin and became more aggressive and dangerous. The main semantic message here is as follows: in view of the limitedness of any kind of resources, if we get a benefit in one, then somewhere we are inferior. The complication of processes and systems undoubtedly brings great benefits, but we should not forget about the side effects of these changes caused.

This pattern can be clearly traced in the topic of this research. The world community, trying to solve the problem of providing all segments of the population with food, uses all sorts of methods to increase yields, but this does not go unnoticed, such an active human agricultural activity destroys nature, chemicals used for pest control and fertilizers designed to increase the productivity of arable land that does not withstand the load, pollute the environment. The fact that human agricultural activities are the main source of

environmental pollution has been repeatedly noted by researchers around the world (Bauer, Tsigaridis, Miller, 2016).

6.1 Aims & Methodology

The set goals have been met. According to the developed methodology, the necessary information was collected: three databases, data on nutritional norms, data on average age, weight and activity of a person. The first database contained information of the GFSI. It contained information on the assessment of the GFSI index for 113 countries for 2019. The second database contained data on the amount of food consumed by countries and the possibilities of their own production. It contained 4170 parameters for 174 countries for 2018. The third database contained data on the amount of nutrients countries received from all food categories produced by those countries. This database contained 54,097 parameters for 184 countries for 2018. In accordance with the methodology, calculations were made, according to which the main hypothesis was rejected, the alternative was accepted, and 75 countries were assessed as countries with the possibility of self-sufficiency in food.

6.2 Summary of findings

Food security today is the most important element of the national security of any state. Food security is the basis of the life support system and demographic policy of the country, is the main factor in the formation of health, longevity, as well as a high quality of life of citizens. Of course, the main goal of food security at the moment is to provide the population with the necessary agricultural and fish products, as well as food and raw materials.

Food security is understood differently in different countries. This is primarily due to the political course of these states. An important feature of the problem raised is the possibility of ambiguous, often opposite, approaches to assessing the socio-economic consequences of import activity on the national economy.

On the one hand, imports are a consequence of regular processes in the global economy, when the national markets of individual countries become part of the global

market for goods and services, the international division of labour, and with it the system of interdependencies in all areas of the economy, including food and agricultural complexes. Import optimizes production costs, helps to meet the country's food needs, ensuring rapid saturation of the domestic market and saving social labour.

On the other hand, at a certain stage, due to the weakness of domestic producers, import activity can lead to a sharp and irrational increase in the share of foreign products in domestic consumption. This is accompanied by a decrease in employment in the field of material production, a deterioration in the financial condition of local enterprises, up to their bankruptcy.

In this case, food security is restored only due to a decrease in import dependence in relation to goods for which such a reduction seems possible. At the same time, under the current conditions of increasing processes of globalization and the formation of international markets for agricultural products and food, export activity of agro-industrial complexes creates a very reliable support for food security. Food exports, for example, provide the flow of foreign exchange resources, which in turn can be invested in agriculture and the food industry.

Moreover, without expanded foreign markets in the current conditions of specialization and intensification of production, progress in the agricultural sector of most countries of the world becomes impossible. The close relationship between production and export activity is evidenced by the fact that the most prosperous countries in terms of food security are usually included in the list of net exporters of agricultural raw materials and foodstuffs (USA, EU countries, Canada, Brazil and others).

The following results should be considered as the main results of the practical part of this work:

- The absence of a relationship between the level of self-sufficiency of the country with food calculated by the classical method of import / export balance (GLFSS) and its assessment of food security by the GFSI method has been demonstrated.
- As a result of calculations of the country's food self-sufficiency using the energetic approach, 75 countries were identified, as countries which are capable to independently provide their citizens with the necessary amount of food in accordance with generally accepted physiological consumption standards.

There are some reasons why countries with high food security scores lack adequate food self-sufficiency. In the modern world economy, the food security of an individual country is considered in conjunction with the development of world trade. From an economic point of view, interstate trade in agricultural products, raw materials and food is explained by the principle of comparative advantage. Its essence lies in the fact that each country has a certain resource base - land, labor, climate, the ability and experience of economic management, affecting to one degree or another the level of production costs. In conditions of competition and free trade, the country specializes in the production of those products that are most consistent with this base, that is, they are produced at the lowest cost, exports them and imports those products that other countries produce more efficiently. This trade exchange is called "indirect production". In this case, of course, it is necessary to take into account transport costs, which should be covered by the benefits of such trade. Resource efficiency gains result in more output and lower overall production costs, helping to raise the standard of living of its people worldwide. At the same time, in addition to benefits, interstate trade has certain disadvantages. One of them is associated with the displacement of domestic goods by imports, which leads to the curtailment of the production of the latter, which is aggravated by the fact that often the competitiveness of these goods is determined not so much by the true costs and prices prevailing in the exporting countries, as by subsidies and other measures of state support for their production. and sales. This can be clearly seen from the example of the processes that took place in Russia in the 90s of the last century.

However, the main disadvantage of interstate trade and country specialization is the loss of autonomy and the growing dependence of the importing country on other countries. Exporting countries, through an increase in product prices or the threat of an embargo, can create a critical situation in the importing country, which will entail serious negative not only economic, but also political consequences. In view of this, many states prefer to abandon the benefits of international trade, especially strategic types of agricultural products, raw materials and food, and develop domestic production.

The level of development of agro-industrial production and the solution of the food problem in individual countries to one degree or another is associated with the level of economic development of the country, the conduct of a general, agricultural, foreign policy, etc.

In this regard, such groups are used in the world economy (Belkharoev, 2008):

- developed countries with market economies,
- countries with economies in transition and developing countries,
- large and small countries,
- countries with low, middle and high income per capita,
- import-oriented, export-oriented and countries with protectionist food self-sufficiency policies.

Considering all of the above, it would be logical to propose using the names "successful trade balance", "convenient trade balance", "favorable exchange conditions" instead of the name "food security".

There are some reasons why high self-sufficiency countries don't perform well in Food Security Index. In addition to the fact that this is due to the fact that the assessment of these two parameters assesses different indicators, the country's ability to produce the required amount of products does not guarantee the lowest price in comparison with foreign analogue goods. In assessing the food security index, the range of products on the market has a great influence. For example, the United States, Brazil and Russia are net exporters of food, show high rates of self-sufficiency, but the level of food security in Russia and Brazil is estimated to be significantly lower than in the United States. This is due to the fact that the United States, despite the fact that it sells a lot, buys a lot, and greatly expands the range of goods on the market. Brazil and Russia, in turn, import, as a rule, those goods that they cannot produce themselves. That is, the logic is: "Why should we buy what we ourselves produce?" As a result, the range of goods in the markets of Russia and Brazil is much less than in the USA, and this significantly reduces the food security index. "

6.3 Possible limitations

The method of assessing food security as a country's ability to independently provide its citizens with the necessary food is currently losing its relevance due to the high development of the transport system, the positive effect of market globalization and the increased frequency of exchange of goods between countries around the world, as a way to increase economic efficiency and a way to fight hunger.

This methodology does not address the issue of economic efficiency, which is its main drawback.

The methodology for assessing food security as the ability of the market to provide the required quantity of goods with the required quality at an acceptable price, in my opinion, is not correct, because it weakly correlates with the classical understanding of the term “security”. I believe that what this methodology describes would be much more correct to call "favorable trade balance" or "favorable conditions for food imports", but not "security".

This methodology does not consider the problem of the crisis supply of the country with food and the issue of the formation of strategic reserves.

6.4 Proposed future steps for further analysis

First of all, one should take into account and take into account in calculations the probability of a crop failure in a particular region for various, but primarily climatic reasons. In this study, those countries that were able to independently produce all the necessary nutrients in 2018 were classified as food self-sufficient countries, however, as practice shows, in order to increase the probability that self-sufficiency will remain in the future, the parameters of self-sufficiency (ESS, PSS, FSS, CSS) of countries should be required to exceed 1.1 points.

Since this study was aimed at evaluating and comparing methodologies, rigorous assessment of ESS, PSS, FSS, CSS parameters is completely enough for settled aim, although to make the study more significant in practice, the parameters should be made more stringent.

In addition, extra requirements for adjusting the diet according to the climatic conditions of the countries could be introduced. That is, nutritional norms in countries with cold climates exceed those in equatorial countries, and this can be taken into account in future studies. The amount of minerals, vitamins, animal and vegetable proteins, saturated and unsaturated fatty acids could be added to make research more detailed.

All of the above clarifications can significantly narrow the list of countries classified as food-self-sufficient countries.

Also, in view of the above-mentioned problem of environmental pollution due to agricultural activities of people, it makes sense to consider the problem of the efficiency of

production, distribution and use of produced food products, in order to increase the efficiency of the agro-industrial complex of countries.

Among other things, based on the theoretical conclusions of this study, the methodology for assessing the country's food independence can be slightly improved.

This methodology can be based on some universal key parameters like:

- Percentage of land used in agricultural production,
- Percentage of people employed in agricultural production,
- The cost of the food basket in purchasing power parity.

The parameter "Percentage of land used in agricultural production" is necessary for assessing the country's potential to independently provide its population with food. The parameter "Percentage of people employed in agricultural production" is necessary to assess the production efficiency in the production of agricultural products. The parameter "Cost of the food basket in purchasing power parity", seems to be sufficient to assess the availability of the required amount of food to the population of the country and to assess the ability of the economy to provide the required amount of food.

It is a proposal, and that idea could be the topic of next research.

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Appendix

Apendix Table 1 - Global Food Security Index rating for 2019

Rank	Country	Overall score	Affordability	Availability	Quality & Safety
1st	Singapore	87.4	95.4	83.0	79.4
2nd	Ireland	84.0	90.5	76.8	87.7
3rd	United States	83.7	87.4	78.3	89.1
4th	Switzerland	83.1	83.8	84.3	78.2
5th	Finland	82.9	84.1	78.6	91.8
5th	Norway	82.9	81.9	81.0	90.5
6th	Sweden	82.7	85.0	78.1	89.4
7th	Canada	82.4	83.3	80.0	86.7
8th	Netherlands	82.0	85.6	76.2	88.9
9th	Austria	81.7	85.4	78.6	81.1
10th	Germany	81.5	84.9	79.1	79.8
11th	Australia	81.4	86.6	77.1	79.9
12th	Qatar	81.2	98.9	64.0	84.1
13th	Denmark	81.0	85.4	74.8	87.2
14th	Belgium	80.7	84.4	76.2	83.9
15h	France	80.4	83.8	74.8	87.1
16th	United Kingdom	79.1	83.6	74.4	80.9
17th	Israel	79.0	83.0	73.6	83.8
18th	New Zealand	78.8	84.6	75.5	73.5
19th	Portugal	77.8	81.3	70.9	88.0
20th	Japan	76.5	82.4	71.0	76.7

20th	United Arab Emirates	76.5	89.8	63.7	78.5
21st	Italy	75.8	82.5	68.3	79.7
22nd	Poland	75.6	81.1	69.3	79.5
23rd	Chile	75.5	80.5	71.3	74.7
23rd	Spain	75.5	82.3	65.9	84.7
24th	Kuwait	74.8	88.1	62.3	75.9
25th	Malaysia	73.8	81.7	67.7	70.6
26th	South Korea	73.6	75.8	71.2	74.9
27th	Saudi Arabia	73.5	86.3	61.8	73.5
28th	Greece	73.4	77.8	64.9	86.0
29th	Czech Republic	73.1	82.6	66.3	68.1
30th	Uruguay	72.8	79.3	66.7	73.3
31st	Hungary	72.7	80.8	66.1	70.5
32nd	China	71.0	74.8	66.9	72.6
33rd	Belarus	70.9	76.0	62.9	80.2
34th	Argentin a	70.8	78.9	60.2	79.5
35th	Romania	70.2	79.3	64.3	64.1
36th	Brazil	70.1	77.0	58.8	84.0
36th	Costa Rica	70.1	75.6	63.1	75.6
37th	Turkey	69.8	74.7	64.8	71.1
38th	Russia	69.7	79.8	60.1	70.9
39th	Colombia	69.4	73.7	65.6	69.3
39th	Mexico	69.4	74.9	62.3	75.2
40th	Panama	68.8	73.8	63.1	71.8
41st	Oman	68.4	77.8	57.6	74.4

42nd	Slovakia	68.3	78.6	62.1	59.4
43rd	Kazakhstan	67.3	77.5	57.7	68.3
44th	South Africa	67.3	70.8	64.5	66.2
45th	Bahrain	66.6	81.9	56.3	56.9
46th	Bulgaria	66.2	79.0	54.2	66.8
47th	Thailand	65.1	77.1	58.7	52.6
48th	Azerbaijan	64.8	75.3	59.2	54.0
49th	Vietnam	64.6	75.1	59.7	51.7
50th	Egypt	64.5	57.6	70.2	65.9
51st	Dominican Republic	64.2	68.4	61.0	62.3
52nd	Botswana	63.8	69.5	61.3	56.6
53rd	Peru	63.3	69.1	59.0	60.4
54th	Ghana	62.8	66.3	61.7	57.1
55th	Morocco	62.8	61.5	64.2	61.9
55th	Serbia	62.8	73.9	53.0	61.8
56th	Indonesia	62.6	70.4	61.3	47.1
57th	Ecuador	61.8	69.4	56.1	58.4
58th	Jordan	61.0	70.5	54.8	54.2
58th	Philippines	61.0	68.9	57.7	50.3
59th	Sri Lanka	60.8	65.0	60.0	52.4
60th	El Salvador	60.7	63.8	58.6	58.9
61st	Guatemala	60.6	65.3	57.6	57.5
62nd	Tunisia	60.1	61.5	58.0	62.2
63rd	Algeria	59.8	66.9	55.8	53.0
64th	Uzbekist	59.0	65.6	55.1	53.4

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65th	India	58.9	64.2	58.4	47.0
66th	Honduras	58.0	57.2	57.8	60.6
67th	Paraguay	57.9	72.0	42.4	65.4
68th	Bolivia	57.7	65.8	50.0	58.3
69th	Ukraine	57.1	63.9	50.0	59.6
70th	Myanmar	57.0	59.1	57.2	51.3
71st	Pakistan	56.8	63.2	55.7	43.6
72nd	Nepal	56.4	58.5	55.4	53.7
73rd	Mali	54.4	45.9	60.1	59.9
74th	Senegal	54.3	51.6	56.1	56.1
75th	Nicaragua	54.2	63.5	47.9	48.2
76th	Bangladesh	53.2	60.4	54.8	30.6
77th	Cote d'Ivoire	52.3	53.5	58.1	33.1
78th	Benin	51.0	48.6	54.9	46.4
79th	Kenya	50.7	56.7	48.0	43.2
80th	Burkina Faso	50.1	47.0	55.9	41.6
81st	Cameroon	49.9	53.7	47.6	47.0
82nd	Niger	49.6	50.2	53.6	37.4
83th	Cambodia	49.4	56.7	48.1	34.6
84th	Ethiopia	49.2	49.7	52.6	39.0
85th	Laos	49.1	55.5	47.6	37.4
86th	Tajikistan	49.0	58.8	41.1	46.6
87th	Nigeria	48.4	50.4	45.8	50.7
88th	Rwanda	48.2	43.8	52.0	48.5

89th	Tanzania	47.6	45.1	50.4	45.9
90th	Guinea	46.7	47.4	52.4	29.0
91st	Uganda	46.2	45.8	45.5	49.1
92nd	Sudan	45.7	47.1	44.4	46.0
93rd	Angola	45.5	51.3	40.5	44.9
94th	Zambia	44.4	41.8	50.7	33.6
95th	Togo	44.0	45.6	47.2	31.0
96th	Haiti	43.3	50.3	39.6	35.9
97th	Malawi	42.5	39.4	48.6	33.1
98th	Mozambique	41.4	42.5	47.9	20.6
99th	Sierra Leone	39.0	40.8	40.3	30.6
100th	Syria	38.4	34.6	38.9	46.4
101st	Madagascar	37.9	35.7	45.7	22.1
102nd	Chad	36.9	40.3	34.9	33.5
103rd	Congo (Dem. Rep.)	35.7	37.3	40.0	19.8
104th	Yemen	35.6	45.5	28.6	30.2
105th	Burundi	34.3	36.6	32.2	34.5
106th	Venezuela	31.2	15.8	32.2	66.9

Source: GFSI (2019) and own processing

Apendix Table 2 – Energetic approach countries rating for 2018

Rairing	Country	TES	ESS	Country	TPS	PSS	Country	TFS	FSS
1	Ireland	3885,0	1,55	Iceland	146,5	1,95	United States of America	170,3	2,00
2	United States of Americ	3777,0	1,51	China, Hong Kong SAR	128,5	1,71	Iceland	167,8	1,97

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3	Belgium	3764,0	1,51	Israel	126,8	1,69	Austria	166,4	1,96
4	Turkey	3708,0	1,48	Lithuania	126,5	1,69	Canada	163,7	1,93
5	Austria	3694,0	1,48	Finland	118,0	1,57	Belgium	160,9	1,89
6	Iceland	3656,0	1,46	Ireland	117,5	1,57	Australia	157,8	1,86
7	Romania	3578,0	1,43	Denmark	117,0	1,56	Switzerland	153,2	1,80
8	Canada	3567,0	1,43	Portugal	116,9	1,56	Ireland	152,8	1,80
9	Germany	3554,0	1,42	Malta	116,3	1,55	Hungary	152,6	1,80
10	Poland	3536,0	1,41	Albania	115,7	1,54	China, Macao SAR	152,3	1,79
11	Israel	3527,0	1,41	Montenegro	114,3	1,52	Spain	151,9	1,79
12	France	3501,0	1,40	United States of America	113,6	1,51	Israel	150,4	1,77
13	Italy	3500,0	1,40	Norway	113,2	1,51	France	150,1	1,77
14	Montenegro	3499,0	1,40	Turkey	110,7	1,48	Greece	149,8	1,76
15	Portugal	3479,0	1,39	United Arab Emirates	110,1	1,47	Italy	149,0	1,75
16	Kuwait	3471,0	1,39	China, Macao SAR	109,4	1,46	Germany	148,8	1,75
17	Luxembourg	3470,0	1,39	Romania	109,2	1,46	Czechia	145,5	1,71
18	Tunisia	3452,0	1,38	Austria	109,1	1,45	Finland	143,2	1,68
19	Malta	3419,0	1,37	Luxembourg	108,3	1,44	Luxembourg	143,1	1,68
20	Republic of Korea	3417,0	1,37	France	108,2	1,44	Montenegro	142,0	1,67
21	Lithuania	3410,0	1,36	Greece	108,1	1,44	Norway	140,5	1,65
22	Morocco	3410,0	1,36	Spain	107,3	1,43	Netherlands	139,9	1,65
23	Denmark	3399,0	1,36	Argentina	106,8	1,42	Portugal	139,0	1,64
24	Australia	3391,0	1,36	Netherlands	106,5	1,42	United Kingdom of Great Britain and Northern Ireland	138,1	1,62

25	Greece	3381,0	1,35	Italy	106,5	1,42	Denmark	138,0	1,62
26	Norway	3366,0	1,35	Australia	105,9	1,41	Samoa	136,6	1,61
27	Albania	3361,0	1,34	Sweden	105,5	1,41	China, Hong Kong SAR	135,6	1,60
28	Switzerland	3355,0	1,34	Poland	105,4	1,41	Sweden	133,8	1,57
29	United Kingdom of Great Britain and Northern Ireland	3343,0	1,34	Estonia	105,2	1,40	Slovakia	132,4	1,56
30	Cuba	3342,0	1,34	Germany	105,2	1,40	China, Taiwan Province of	130,8	1,54
31	Russian Federation	3342,0	1,34	Canada	104,4	1,39	Latvia	130,5	1,53
32	Finland	3340,0	1,34	United Kingdom of Great Britain and Northern Ireland	103,8	1,38	Belarus	130,4	1,53
33	China, Macao SAR	3326,0	1,33	Kuwait	103,2	1,38	Poland	127,7	1,50
34	Spain	3324,0	1,33	Latvia	102,7	1,37	Estonia	127,1	1,50
35	Algeria	3321,0	1,33	Russian Federation	101,4	1,35	Brazil	126,3	1,49
36	Hungary	3317,0	1,33	Morocco	101,0	1,35	French Polynesia	124,8	1,47
37	United Arab Emirates	3312,0	1,32	China, mainland	100,7	1,34	Kazakhstan	124,3	1,46
38	Argentina	3308,0	1,32	China	100,6	1,34	Romania	123,6	1,45
39	Saudi Arabia	3307,0	1,32	Republic of Korea	100,1	1,34	Argentina	123,1	1,45
40	Bosnia and Herzegovina	3302,0	1,32	Tunisia	99,7	1,33	Turkey	121,6	1,43
41	Brazil	3300,0	1,32	Belgiu	99,7	1,33	Malta	119,8	1,41

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42	Netherlands	3297,0	1,32	Bosnia and Herzegovina	98,7	1,32	Albania	116,7	1,37
43	Egypt	3288,0	1,32	Viet Nam	98,6	1,31	Croatia	116,7	1,37
44	Czechia	3278,0	1,31	Egypt	97,5	1,30	Slovenia	114,8	1,35
45	Belarus	3268,0	1,31	Slovenia	96,3	1,28	Cyprus	113,7	1,34
46	China, Hong Kong SAR	3267,0	1,31	French Polynesia	95,9	1,28	New Zealand	113,5	1,34
47	Estonia	3247,0	1,30	Brazil	95,7	1,28	Russian Federation	112,3	1,32
48	Latvia	3229,0	1,29	Switzerland	95,3	1,27	Kuwait	111,7	1,31
49	Uruguay	3198,0	1,28	Azerbaijan	94,4	1,26	New Caledonia	111,5	1,31
50	Slovenia	3194,0	1,28	Armenia	94,3	1,26	Republic of Korea	111,0	1,31
51	China	3193,0	1,28	New Zealand	93,8	1,25	Uruguay	109,3	1,29
52	New Zealand	3192,0	1,28	Uzbekistan	93,3	1,24	Bulgaria	107,9	1,27
53	China, mainland	3191,0	1,28	Belarus	92,0	1,23	North Macedonia	106,1	1,25
54	Sweden	3182,0	1,27	Algeria	91,8	1,22	Costa Rica	105,7	1,24
55	Mexico	3157,0	1,26	Chile	91,6	1,22	Lithuania	105,5	1,24
56	Azerbaijan	3145,0	1,26	Cyprus	91,6	1,22	Saudi Arabia	105,0	1,24
57	Colombia	3112,0	1,24	Kazakhstan	91,5	1,22	Bahamas	104,9	1,23
58	Ukraine	3102,0	1,24	Mexico	91,4	1,22	Dominican Republic	103,4	1,22
59	Iran (Islamic Republic of)	3084,0	1,23	Myanmar	90,7	1,21	Kiribati	102,3	1,20
60	Kiribati	3078,0	1,23	Croatia	90,5	1,21	Mexico	102,0	1,20
61	Croatia	3071,0	1,23	Saint Vincent and the Grenadines	89,9	1,20	Vanuatu	101,4	1,19
62	North Macedonia	3069,0	1,23	Hungary	89,5	1,19	China	100,3	1,18

63	Kazakhstan	3065,0	1,23	Barbados	89,1	1,19	China, mainland	99,6	1,17
64	Mauritius	3046,0	1,22	Mauritius	88,8	1,18	Mongolia	98,8	1,16
65	Ghana	3029,0	1,21	Turkmenistan	88,6	1,18	Saint Kitts and Nevis	96,9	1,14
66	Chile	3028,0	1,21	Samoa	87,8	1,17	Barbados	95,9	1,13
67	Samoa	3028,0	1,21	Japan	87,3	1,16	Armenia	95,6	1,13
68	Costa Rica	3027,0	1,21	Mongolia	87,3	1,16	Tunisia	94,6	1,11
69	Viet Nam	3023,0	1,21	Czechia	86,9	1,16	Mauritius	94,2	1,11
70	Cyprus	3015,0	1,21	Saudi Arabia	86,9	1,16	Jordan	94,0	1,11
71	Uzbekistan	3011,0	1,20	Ukraine	86,4	1,15	Ecuador	93,3	1,10
72	Armenia	2992,0	1,20	Uruguay	86,4	1,15	Chile	93,2	1,10
73	China, Taiwan Province of	2985,0	1,19	Guyana	86,1	1,15	Trinidad and Tobago	91,9	1,08
74	Trinidad and Tobago	2984,0	1,19	China, Taiwan Province of	86,1	1,15	Antigua and Barbuda	91,1	1,07
75	Saint Vincent and the Grenadines	2967,0	1,19	Saint Lucia	85,9	1,15	Malaysia	90,1	1,06
76	Barbados	2955,0	1,18	Iran (Islamic Republic of)	85,7	1,14	Serbia	89,1	1,05
77	Dominica	2953,0	1,18	Trinidad and Tobago	85,6	1,14	Japan	89,1	1,05
78	Oman	2938,0	1,18	Oman	85,3	1,14	Colombia	89,0	1,05
79	Guyana	2912,0	1,16	Cuba	84,9	1,13	United Arab Emirates	88,1	1,04
80	French Polynesia	2908,0	1,16	New Caledonia	84,4	1,13	Lebanon	88,1	1,04
81	South Africa	2895,0	1,16	Kyrgyzstan	84,4	1,13	Viet Nam	87,5	1,03
82	Dominican Republic	2892,0	1,16	South Africa	84,4	1,12	Ukraine	87,0	1,02

83	Indonesia	2882,0	1,15	North Macedonia	84,4	1,12	Paraguay	86,7	1,02
84	Mali	2873,0	1,15	Serbia	84,3	1,12	Bosnia and Herzegovina	85,5	1,01
85	Mauritania	2871,0	1,15	Mali	83,5	1,11	Saint Vincent and the Grenadines	85,4	1,00
86	Slovakia	2870,0	1,15	Bulgaria	83,1	1,11	Saint Lucia	84,4	0,99
87	Bulgaria	2857,0	1,14	Niger	82,6	1,10	Belize	84,3	0,99
88	Lebanon	2851,0	1,14	Costa Rica	82,4	1,10	Honduras	84,2	0,99
89	Panama	2849,0	1,14	Mauritania	82,0	1,09	South Africa	82,9	0,98
90	Malaysia	2843,0	1,14	Maldives	81,2	1,08	Panama	82,0	0,96
91	Georgia	2838,0	1,14	Bahamas	80,6	1,07	Dominica	79,6	0,94
92	Turkmenistan	2832,0	1,13	Panama	80,3	1,07	Uzbekistan	79,5	0,94
93	New Caledonia	2828,0	1,13	Burkina Faso	80,1	1,07	Grenada	79,0	0,93
94	Serbia	2824,0	1,13	Antigua and Barbuda	79,9	1,07	Oman	78,9	0,93
95	Thailand	2801,0	1,12	Dominica	79,0	1,05	Iran (Islamic Republic of)	78,9	0,93
96	Jamaica	2785,0	1,11	Gabon	79,0	1,05	Jamaica	78,6	0,93
97	Côte d'Ivoire	2777,0	1,11	Peru	77,7	1,04	Turkmenistan	78,4	0,92
98	Belize	2776,0	1,11	Malaysia	77,4	1,03	Fiji	78,2	0,92
99	Fiji	2775,0	1,11	Saint Kitts and Nevis	77,1	1,03	Pakistan	78,1	0,92
100	Peru	2774,0	1,11	Lao People's Democratic Republic	76,9	1,03	Myanmar	78,0	0,92
101	Nepal	2769,0	1,11	El Salvador	76,9	1,03	Algeria	77,3	0,91
102	Paraguay	2768,0	1,11	Georgia	76,8	1,02	Suriname	76,6	0,90
103	Benin	2757,0	1,10	Jamaica	76,0	1,01	Georgia	74,4	0,87

104	Lao People's Democratic Republic	2756,0	1,10	Nepal	74,1	0,99	Cuba	71,7	0,84
105	Guinea	2743,0	1,10	Kiribati	73,5	0,98	Republic of Moldova	71,6	0,84
106	Burkina Faso	2739,0	1,10	Bolivia (Plurinational State of)	73,2	0,98	Sao Tome and Principe	71,6	0,84
107	Sri Lanka	2737,0	1,09	Sudan	72,9	0,97	Morocco	71,0	0,84
108	Cameroon	2732,0	1,09	Colombia	72,9	0,97	Iraq	68,9	0,81
109	Jordan	2729,0	1,09	Cameroon	71,9	0,96	Kyrgyzstan	68,8	0,81
110	Kyrgyzstan	2728,0	1,09	Belize	71,8	0,96	Guinea	68,7	0,81
111	Japan	2707,0	1,08	Grenada	71,3	0,95	Mauritania	67,1	0,79
112	El Salvador	2696,0	1,08	Fiji	71,0	0,95	Azerbaijan	66,3	0,78
113	Djibouti	2695,0	1,08	Slovakia	71,0	0,95	Cabo Verde	66,1	0,78
114	Suriname	2694,0	1,08	Cabo Verde	70,9	0,94	Burkina Faso	66,0	0,78
115	Myanmar	2671,0	1,07	Paraguay	69,2	0,92	Sudan	65,9	0,78
116	Honduras	2670,0	1,07	Jordan	69,1	0,92	Botswana	65,0	0,76
117	Philippines	2657,0	1,06	Lebanon	69,1	0,92	Thailand	64,6	0,76
118	Bahamas	2654,0	1,06	Guatemala	68,9	0,92	Bolivia (Plurinational State of)	64,2	0,76
119	Gabon	2634,0	1,05	Indonesia	67,3	0,90	Guyana	63,8	0,75
120	Saint Lucia	2619,0	1,05	Malawi	67,1	0,89	Venezuela (Bolivarian Republic of)	63,4	0,75
121	Ecuador	2607,0	1,04	Pakistan	67,0	0,89	El Salvador	62,2	0,73
122	Iraq	2606,0	1,04	Lesotho	66,5	0,89	Djibouti	61,6	0,72
123	Vanuatu	2605,0	1,04	Ethiopia	66,3	0,88	Guatemala	61,3	0,72

124	Nicaragua	2582,0	1,03	Dominican Republic	66,3	0,88	Guinea-Bissau	61,3	0,72
125	Saint Kitts and Nevis	2579,0	1,03	Cambodia	65,9	0,88	Indonesia	61,1	0,72
126	Sudan	2576,0	1,03	Ecuador	65,9	0,88	Nicaragua	60,8	0,71
127	Mongolia	2575,0	1,03	Namibia	65,6	0,88	Senegal	60,7	0,71
128	Niger	2569,0	1,03	Botswana	65,6	0,87	Central African Republic	60,6	0,71
129	Nigeria	2569,0	1,03	Iraq	65,5	0,87	Gambia	60,1	0,71
130	Bangladesh	2564,0	1,03	Djibouti	65,5	0,87	Papua New Guinea	59,9	0,71
131	Guatemala	2550,0	1,02	Gambia	65,5	0,87	Egypt	59,7	0,70
132	Senegal	2548,0	1,02	Sri Lanka	65,2	0,87	Côte d'Ivoire	59,4	0,70
133	Cabo Verde	2540,0	1,02	Papua New Guinea	64,4	0,86	India	58,9	0,69
134	Gambia	2531,0	1,01	Benin	64,0	0,85	Mali	58,8	0,69
135	India	2530,0	1,01	Vanuatu	64,0	0,85	Angola	57,7	0,68
136	Cambodia	2492,0	1,00	Nicaragua	63,4	0,85	Sri Lanka	57,5	0,68
137	Pakistan	2484,0	0,99	India	63,4	0,84	Philippines	57,0	0,67
138	Namibia	2464,0	0,99	Thailand	63,3	0,84	Tajikistan	56,8	0,67
139	Sao Tome and Principe	2447,0	0,98	Honduras	62,9	0,84	Namibia	54,9	0,65
140	Antigua and Barbuda	2442,0	0,98	Philippines	62,5	0,83	Nigeria	54,7	0,64
141	Togo	2441,0	0,98	Senegal	62,2	0,83	Nepal	54,6	0,64
142	Eswatini	2423,0	0,97	Eswatini	61,8	0,82	Cameroon	54,4	0,64
143	Solomon Islands	2412,0	0,96	Kenya	61,7	0,82	Timor-Leste	53,8	0,63
144	Bolivia (Plurinational State of)	2410,0	0,96	Republic of Moldova	61,6	0,82	Peru	53,8	0,63
145	Grenada	2401,0	0,96	Ghana	61,6	0,82	United Republi	53,5	0,63

							c of Tanzania		
146	Malawi	2392,0	0,96	Chad	61,5	0,82	Chad	52,9	0,62
147	Republic of Moldova	2385,0	0,95	Bangladesh	60,7	0,81	Gabon	52,7	0,62
148	Angola	2383,0	0,95	Suriname	60,7	0,81	Lesotho	52,6	0,62
149	United Republic of Tanzania	2370,0	0,95	Zambia	60,5	0,81	Niger	52,3	0,62
150	Sierra Leone	2368,0	0,95	Rwanda	59,1	0,79	Zimbabwe	52,0	0,61
151	Botswana	2339,0	0,94	United Republic of Tanzania	58,9	0,79	Benin	51,9	0,61
152	Ethiopia	2337,0	0,93	Nigeria	58,6	0,78	Solomon Islands	51,4	0,60
153	Lesotho	2321,0	0,93	Togo	58,4	0,78	Maldives	50,6	0,60
154	Timor-Leste	2286,0	0,91	Timor-Leste	58,0	0,77	Uganda	50,1	0,59
155	Congo	2285,0	0,91	Congo	57,9	0,77	Sierra Leone	50,0	0,59
156	Papua New Guinea	2283,0	0,91	Côte d'Ivoire	57,6	0,77	Togo	49,3	0,58
157	Maldives	2235,0	0,89	Guinea	57,4	0,76	Liberia	49,1	0,58
158	Guinea-Bissau	2229,0	0,89	Afghanistan	55,5	0,74	Mozambique	48,8	0,57
159	Kenya	2191,0	0,88	Yemen	54,5	0,73	Zambia	48,4	0,57
160	Rwanda	2186,0	0,87	Sao Tome and Principe	54,5	0,73	Kenya	47,9	0,56
161	Liberia	2164,0	0,87	Tajikistan	54,2	0,72	Lao People's Democratic Republic	47,3	0,56
162	Yemen	2152,0	0,86	Venezuela (Bolivarian Republic of)	54,2	0,72	Eswatini	47,2	0,56
163	Haiti	2120,0	0,85	Democratic People's	53,3	0,71	Congo	45,1	0,53

				Republic of Korea					
164	Venezuela (Bolivarian Republic of)	2120,0	0,85	Solomon Islands	53,1	0,71	Haiti	44,9	0,53
165	Chad	2113,0	0,85	Angola	53,1	0,71	Yemen	43,3	0,51
166	Tajikistan	2107,0	0,84	Sierra Leone	51,0	0,68	Ghana	41,1	0,48
167	Mozambique	2097,0	0,84	Haiti	49,6	0,66	Malawi	40,3	0,47
168	Afghanistan	2038,0	0,82	Uganda	46,9	0,63	Cambodia	35,3	0,42
169	Democratic People's Republic of Korea	2012,0	0,80	Central African Republic	44,6	0,59	Democratic People's Republic of Korea	34,5	0,41
170	Zambia	2000,0	0,80	Zimbabwe	44,1	0,59	Bangladesh	34,4	0,40
171	Uganda	1981,0	0,79	Madagascar	44,1	0,59	Afghanistan	31,9	0,37
172	Madagascar	1934,0	0,77	Guinea-Bissau	43,2	0,58	Rwanda	30,9	0,36
173	Zimbabwe	1904,0	0,76	Liberia	42,8	0,57	Ethiopia	27,1	0,32
174	Central African Republic	1784,0	0,71	Mozambique	42,4	0,57	Madagascar	24,1	0,28
175	Belgium-Luxembourg	0,0	0,00	Belgium-Luxembourg	0,0	0,00	Belgium-Luxembourg	0,0	0,00
176	Comoros	0,0	0,00	Comoros	0,0	0,00	Comoros	0,0	0,00
177	Czechoslovakia	0,0	0,00	Czechoslovakia	0,0	0,00	Czechoslovakia	0,0	0,00
178	Ethiopia PDR	0,0	0,00	Ethiopia PDR	0,0	0,00	Ethiopia PDR	0,0	0,00
179	Netherlands Antilles (former)	0,0	0,00	Netherlands Antilles (former)	0,0	0,00	Netherlands Antilles (former)	0,0	0,00
180	Serbia and Montenegro	0,0	0,00	Serbia and Montenegro	0,0	0,00	Serbia and Montenegro	0,0	0,00
181	Seychelles	0,0	0,00	Seychelles	0,0	0,00	Seychelles	0,0	0,00
182	Sudan (former)	0,0	0,00	Sudan (former)	0,0	0,00	Sudan (former)	0,0	0,00

183	USSR	0,0	0,00	USSR	0,0	0,00	USSR	0,0	0,00
184	Yugoslav SFR	0,0	0,00	Yugoslav SFR	0,0	0,00	Yugoslav SFR	0,0	0,00

Source: FAO (2018) and own processing

Apendix Table 3 - Norms of physiological needs for energy and nutrients for men

	Indicators, (per day)	Physical activity group, (coefficient of physical activity (CPA))														Men, older 60 years
		I (1,4)			II (1,6)			III (1,9)			IV (2,2)			V (2,5)			
		Age groups														
		18-29	30-39	40-59	18-29	30-39	40-59	18-29	30-39	40-59	18-29	30-39	40-59	18-29	30-39	40-59	
		Energy and macronutrients															
	Energy, kcal	2450	2300	2100	2800	2650	2500	3300	3150	2950	3850	3600	3400	<4200	3950	3750	2300
2	**Protein, g**	72	68	65	80	77	72	94	89	84	108	102	96	117	111	104	68
	incl. animal, g	36	34	32,5	40	38,5	36	47	44,5	42	54	51	48	58,5	55,5	52	34
	% of kcal	12	12	12	12	12	12	11	11	11	11	11	11	11	11	11	12
3	**Fat, g**	81	77	70	93	88	83	110	105	98	128	120	113	154	144	137	77
	Fat,% of kcal	30	30	30	30	30	30	30	30	30	30	30	30	33	33	33	30
	MUFA,% of kcal	10															
	PUFA,% of kcal	6-10															
	Omega-6,% of kcal	5-8															
	Omega-3,% of kcal	1-2															
	Phospholipids, g	5-7															
4	**Carbohydrates, g**	358	335	303	411	387	366	484	462	432	566	528	499	586	550	524	335
	Sugar,% of kcal	<10															
	Dietary fiber, g	20															
		Vitamins															
	Vitamin C, mg	90															
	Vitamin B1, mg	1,5															
	Vitamin B2, mg	1,8															
	Vitamin B6, mg	2,0															

	Niacin, mg	20	
	Vitamin B12, µg	3,0	
	Folate, mcg	400	
	Pantothenic Acid, mg	5,0	
	Biotin, mcg	50	
	Vitamin A, µg ret.eq.	900	
	Beta-carotene, mg	5,0	
	Vitamin E, mg	15	
	Vitamin D, µg	10	15
	Vitamin K, µg	120	
		Minerals	
	Calcium, mg	1000	1200
	Phosphorus, mg	800	
	Magnesium, mg	400	
	Potassium, mg	2500	
	Sodium, mg	1300	
	Chlorides, mg	2300	
	Iron, mg	10	
	Zinc, mg	12	
	Iodine, mcg	150	
	Copper, mg	1,0	
	Manganese, mg	2,0	
	Selenium, mcg	70	
	Chromium, mcg	50	
	Molybdenum, mcg	70	
	Fluorine, mg	4,0	

Source: Federal Research Center for Nutrition, Biotechnology and Food Safety of the Russian Federation (2021) and own analysis

Apendix Table 4 - Norms of physiological needs for energy and nutrients for women

	Indicators, (per day)	Physical activity group, (coefficient of physical activity (CPA))				Women older 60 years
		I (1,4)	II (1,6)	III (1,9)	IV (2,2)	
		Age groups				

		18-29	30-39	40-59	18-29	30-39	40-59	18-29	30-39	40-59	18-29	30-39	40-59	
		Energy and macronutrients												
	Energy, kcal	2000	1900	1800	2200	2150	2100	2600	2550	2500	3050	2950	2850	1975
2	**Protein, g**	61	59	58	66	65	63	76	74	72	87	84	82	61
	incl. animal, g	30,5	29,5	29	33	32,5	31,5	38	37	36	43,5	42	41	30,5
	% of kcal	12	12	12	12	12	12	12	12	12	12	12	12	12
3	**Fat, g**	67	63	60	73	72	70	87	85	83	102	98	95	66
	Fat,% of kcal	30	30	30	30	30	30	30	30	30	30	30	30	30
	MUFA,% of kcal	10												
	PUFA,% of kcal	6-10												
	Omega-6,% of kcal	5-8												
	Omega-3,% of kcal	1-2												
	Phospholipids, g	5-7												
4	**Carbohydrates, g**	289	274	257	318	311	305	378	372	366	462	432	417	284
	Sugar,% of kcal	<10												
	Dietary fiber, g	20												
		Vitamins												
	Vitamin C, mg	90												
	Vitamin B1, mg	1,5												
	Vitamin B2, mg	1,8												
	Vitamin B6, mg	2,0												
	Niacin, mg	20												
	Vitamin B12, µg	3,0												
	Folate, mcg	400												
	Pantothenic Acid, mg	5,0												
	Biotin, mcg	50												
	Vitamin A, µg ret.eq.	900												
	Beta-carotene, mg	5,0												
	Vitamin E, mg	15												
	Vitamin D, µg	10											15	
	Vitamin K, µg	120												
		Minerals												
	Calcium, mg	1000											1200	

	Phosphorus, mg	800
	Magnesium, mg	400
	Potassium, mg	2500
	Sodium, mg	1300
	Chlorides, mg	2300
	Iron, mg	18
	Zinc, mg	12
	Iodine, mcg	150
	Copper, mg	1,0
	Manganese, mg	2,0
	Selenium, mcg	55
	Chromium, mcg	50
	Molybdenum, mcg	70
	Fluorine, mg	4,0

Source: Federal Research Center for Nutrition, Biotechnology and Food Safety of the Russian Federation (2021) and own analysis

Apendix Table 5 – Countries quartile deviation according to GLFSS calculation for 2018

Best environment	Good environment	Moderate environment	Needs environment
Argentina	Belarus	Azerbaijan	Afghanistan
Australia	Bolivia (Plurinational State of)	Bangladesh	China, Taiwan Province of
Poland	Ethiopia	Benin	Cuba
Brazil	Kazakhstan	Burkina Faso	Cyprus
Bulgaria	Kyrgyzstan	Central African Republic	Eswatini
Canada	Lithuania	Côte d'Ivoire	Finland
China	Pakistan	Denmark	Gambia
China, mainland	United States of America	Egypt	Greece
France	Chad	Guinea	Guyana
India	Czechia	Kenya	Haiti
Russian Federation	Democratic People's Republic of Korea	Lao People's Democratic Republic	Iceland
Serbia	Ecuador	Madagascar	Mongolia
Ukraine	Latvia	Morocco	North Macedonia
	Malawi	Mozambique	Slovenia
	Mali	Niger	Timor-Leste
	Myanmar	Nigeria	Venezuela (Bolivarian Republic of)
	Nepal	Peru	El Salvador
	Slovakia	Rwanda	Fiji
	South Africa	Sweden	Grenada
	Thailand	Tajikistan	Israel
	Turkey	Togo	Jamaica
	United Republic of Tanzania	Tunisia	Japan
	Zimbabwe	United Kingdom of Great Britain and Northern	Jordan

		Ireland	
	Albania	Algeria	Lebanon
	Chile	Armenia	Lesotho
	Croatia	Austria	Malaysia
	Estonia	Bosnia and Herzegovina	Mauritania
	Germany	Cambodia	Mauritius
	Hungary	Cameroon	Namibia
	Paraguay	Colombia	Norway
	Republic of Moldova	Costa Rica	Panama
	Romania	Honduras	Papua New Guinea
	Spain	Indonesia	Portugal
	Uganda	Iran (Islamic Republic of)	Republic of Korea
		Ireland	Saint Lucia
		Luxembourg	Saint Vincent and the Grenadines
		Mexico	Saudi Arabia
		Netherlands	Solomon Islands
		New Zealand	Suriname
		Nicaragua	Switzerland
		Sierra Leone	Vanuatu
		Sri Lanka	Botswana
		Uruguay	China, Macao SAR
		Viet Nam	Djibouti
		Zambia	Dominica
		Angola	Iraq
		Belgium	Kiribati
		Belize	Kuwait
		Congo	Liberia
		Dominican Republic	Montenegro
		Georgia	New Caledonia
		Ghana	Oman
		Guatemala	Samoa
		Guinea-Bissau	Trinidad and Tobago
		Italy	Antigua and Barbuda
		Philippines	Bahamas
		Senegal	Barbados
		Sudan	Cabo Verde
		Turkmenistan	China, Hong Kong SAR
		Uzbekistan	French Polynesia
		Yemen	Gabon
			Maldives
			Malta
			Saint Kitts and Nevis
			Sao Tome and Principe
			United Arab Emirates

Source: FAO (2018) and own processing