



## FORMING THE SYSTEM OF FOOD SECURITY INDICATORS FOLLOWING THE CRITERIA OF THE SDGS-2030

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### ABSTRACT

Effective management of any system is impossible without a clear definition of its elements, hierarchical levels, and desired performance indicators. Considering this problem in the context of food security management, the authors set out to create a system of food security indicators at different hierarchical levels. The purpose of the article is to deepen theoretical and methodological provisions and develop a system of indicators as a component of food security management at different levels, which should meet the criteria and dimensions of the SDGs-2030. The methodological basis of the research is the dialectical method and general scientific and special methods of scientific knowledge. The results obtained are of great practical importance in shaping national and regional food security policies (programs) on a sustainable development basis. Proceeding from the results of the research and the scientific and theoretical positions of the epistemological content of the category of the concept “food security”, taking into account the criteria of food security of formation at different hierarchical levels and methodological aspects of its monitoring, it is proposed 54 indicators.

**Keywords:** food security; indicator; level; method; system

### INTRODUCTION

The process of food security should be accompanied by organized monitoring of the nature of the changes, their quantitative and qualitative assessment to prepare the appropriate recommendations, and management decisions. The monitoring system is based on a combination of economic and social indicators with indicators that reflect the results of activities of state authorities in food security. According to the monitoring results, the executive authorities should decide on changes to the food basket for the main social and demographic groups of the population, and the executive authorities should make decisions on changes and approve sets of food products for the main social and demographic groups (Verkhovna Rada of Ukraine, 2007a).

In the context of European integration, which involves openness of the internal and external markets of food, it is necessary to monitor the indicators of food security of the country at different hierarchical levels constantly, which will allow to react promptly to changes and to formulate corresponding state, regional and local policies.

Modern science does not provide a unified indicator system for food security monitoring. A large number of studies, devoted to this issue, indicates its relevance and the practical impossibility of the unification of indicators' system for all regions, subregions, and countries. It is obvious that the estimated indicators are not constant – they depend on the desirable criteria and specific features of a particular region, which ultimately forms the specific

tasks of the state policy of each country to achieve food security grounding on sustainable development.

Ukraine does not have a methodological approach to the food security monitoring, including the all level, which should meet the criteria and dimensions of the SDGs-2030.

Scientists have made a considerable effort over the decades to create the best set of indicators for assessing food security and nutrition safety.

The overwhelming majority of scientific works on monitoring of food security is devoted to detailed research of specific aspects of the issue, for example:

(1) prevalence of micronutrient malnutrition (Ramakrishnan, 2002);

(2) focus on three groups of risk factors: behavioral, environmental and occupational, and metabolic (Forouzanfar et al., 2015);

(3) a comprehensive dietary analysis of low-income adults and examined differences in dietary intake between SNAP participants and nonparticipants (Leung et al., 2012);

(4) examine the association between household food insecurity and the likelihood of perceived clinical malaria among 1- to 5-year-old children living in rural south Haiti (Pérez-Escamilla et al., 2009);

(5) underlying mechanisms of under- and over-nutrition among children in rural China (Zhang et al., 2016);

(6) summarizes the literature on the link between food insecurity and the following diet, weight gain, and chronic disease, especially among women (Laraia, 2013).

These studies are local in terms of geography (a specific place of residence or region is being investigated) or have component problems (only several aspects are being investigated). The combination of all mentioned in these works (and many other) problems into a single system of indicators for monitoring food security is not meaningful, since most of them are relevant only for specific areas or groups of the population.

Some works are devoted to global research on the achieved level of food security. In particular, Smith, Rabbitt and Coleman-Jensen (2017) identify and examines the common determinants of food insecurity in 134 countries using cross-country comparable experiential of food insecurity.

This approach is expedient when it comes to assessing the level reached by countries, continents, or mainlands in comparison to the level of food security at the global level. Pérez-Escamilla and Segall-Corrêa (2008) give an overview of the advantages and disadvantages of five commonly used methods that can be used to assess food security. This study is intended to help researchers in choosing methods, taking into account their advantages and disadvantages, in monitoring food security.

Summarizing, we can conclude that the methodology of food security monitoring is based on the following basic components: problems, features, location, and methods. The indicators' system of food security monitoring should provide coverage of these components. That is why indicators of food security monitoring at the global level are inadequate in determining food security at the level of region or individual – they have different levels of problems and opportunities. So, we support the viewpoints of the scholars, Frankenberger and McCaston (1998) and Gross et al. (2000) in particular, who examine food security through the prism of hierarchical levels: global, national, households and individuals. This approach allows taking into account all the peculiarities of the formation of the food chain both of the locality (resource supply, specialization, and natural conditions) and personality (incomes, tastes, individual needs).

### Global level

FAO provides information on 27 indicators of food security on the SDG-2030 (FAO, 2019a); according to other criteria of the Agenda for the period until 2030, the system of indicators is under development. Therefore, an assessment of the state of food security at the global level and FAO and scientists make due to the indicators proposed by FAO in the process of the new Sustainable Development Goals (SDGs-2).

FAO is the custodian UN agency for 21 SDG indicators and is a contributing agency for a further 4. In this capacity, FAO is supporting countries' efforts in monitoring the 2030 Agenda (FAO, 2019b).

Proposals of national scientists regarding the methodology for assessing food security at the global level are practically absent. Some of them are borrowed from individual indicators developed by FAO for use in the national system for monitoring food security.

### National level

At the state level, the assessment of food security is carried out following the Methodology for determining the main indicators of food security, approved by the Cabinet of Ministers of Ukraine Resolution "Some issues of food security" No. 1379 dated December 5, 2007 (Cabinet of Ministers of Ukraine, 2007) (Table 1).

Proposals of national scientists regarding the improvement of this Methodology for defining the main indicators of food security are different. However, some of them require a radical change of methodology for calculating the indicator, and change the value of the margin, and deeper analysis (calculation of additional indicators) in interpreting the results. So, Nud (2013) "believes that the 60% threshold for the indicator of economic availability of products is too high".

Another normative document, which defines food security indicators, cannot be overlooked – The Law of Ukraine "On Food Security of Ukraine" (Verkhovna Rada of Ukraine, 2007a). Currently, this document has the status of a project, and therefore official food security reports are based on the indicators contained in the Methodology for defining key indicators for food security.

We partially agree with several comments on food security indicators in the Conclusion on the draft Law of Ukraine "On Food Security of Ukraine" (Verkhovna Rada of Ukraine, 2007b).

Such an indicator of food security, determined in clause 3 of Part 1 in article 7, as "provision of grain stock food resources, defined as the ratio between the volumes of food grains in such resources and the volume of national consumption of bread and grain products in the calculation of grain". It is expedient, in our opinion, to supplement it with additional Corrective indicator – "grain production per person per year, tons". Such indicator is provided by the Methodical recommendations for calculating the level of economic security of Ukraine (Ministry of Economic Development and Trade of Ukraine, 2013). Secondly, it reduces the impact on the calculation of the marginal indicator of the adequacy of grain supplies in public food resources of such factors as the level of solvent demand (Verkhovna Rada of Ukraine, 2007a).

Grishova and Kryukova (2014) defined seven indicators and their corresponding normative values as the main indicators of food security. The authors also suggested a generalization of the system of indicators of the level of food security of the country using the integral coefficient.

The authors ranked the most significant integral indicators taking part in the formation of the integral index of food security level: the volume of grain production per capita, which forms the potential fund of population consumption; the level of economic availability of food; the share of food imports in the structure of consumption of the domestic market; the average wage as one of the main sources of household income.

In our opinion, this approach is appropriate in determining changes in the long-term dynamics or ranking of regions of Ukraine. The list of indicators is too large, and the method of their calculations is complicated.

Table 1 Methodology for determining the main indicators of food security.

Name of the indicator	Method of calculation	Limit (threshold) criterion
Daily energy value of a human diet	$EV = \sum m_i z_i$ , where EV – energy value of the daily ration of a person; $i_a$ – type of food; $m_i$ – a mass of the i-th product consumed by one and the person; $z_i$ – energy value of the mass of the i-th product;	2500 kcal per day, 55% of the ration should be provided at the expense of products of animal origin
Ensuring the human diet by main types of products	$C = \frac{C_f}{C_r}$ , where C – adequacy indicator consumption of certain products; $C_f$ – actual consumption of a single product per person per year; $C_r$ – rational norm of consumption of a separate product kg per person per year, agreed with the Ministry of Health	*
Availability of grain stocks in state resources	$G = \frac{H}{X}$ , where G – indicator of grain security by food resources; H – availability of food grain in the state food reserve; X – average annual internal consumption of bread and grain products in terms of grain	17%, corresponding to 60 days of consumption
Economic availability of products	$E = \frac{B_x}{B_c}$ , where E – an indicator of the economic availability of products; $B_x$ – population expenditures for food per year; $B_c$ – total expenditure of the population for the year	60%
Differentiation of the cost of food by social groups	$D = \frac{D_b}{D_m}$ , where D – an indicator of the differentiation of the cost of food; $D_b$ – the value of consumed products in the 20 percent of households with the highest incomes; $D_m$ – an indicator of the cost of consumed products in 20 percent of the lowest-income households	-
The capacity of the internal market of individual products	$V_i = F_i N$ , where $V_i$ – capacity of the domestic market of the i-th product; $i$ – a type of the i-th product; $F_i$ – annual average consumption of the i-th product; $N$ – average annual population	-
Food independence for a particular product	$P = \frac{I_i}{V_i}$ , where P – a share of food imports of the i-th product; $i$ – a type of i-th food product; $I_i$ – imports of the i-th product; $V_i$ – capacity of the domestic market of the i-th product	30%

Note: \* Bread products – 101; meat and meat products – 80; milk and dairy products – 380; fish and fish products – 20; eggs (pcs.) – 290; vegetables and food crops – 161; fruits, berries and grapes (without wine processing) – 90; potatoes – 124; sugar – 38; vegetable oil of all kinds – 13. Source: **Some issues of food security (2007)**.

It is possible to avoid these errors, in our opinion, if when developing a system of food security assessment indicators, take into account the criteria for the functioning of the system.

**Banakh (2016)** defines five basic food security criteria and their respective indicators for statistical analysis: physical accessibility; economic availability; social accessibility; food independence; ecological factor. **Stezhko (2014)** forms a system of indicators of the state of food security, based on three criteria (although the author calls them the direction of evaluation, and as criteria defines different indicators): physical availability of food; economic availability of food; food for consumption.

It should be noted that both **Banakh (2016)** and **Stezhko (2014)** proposed to add the indicators to the system. These are soil fertility indices (environmental factor, **Banakh (2016)**) and overweight population (food security for consumption, **Stezhko (2014)**). The first indicator is one that characterizes the degree of sustainability of agricultural development – a criterion that domestic scientists practically do not take into account. At the same time, sustainable development of agriculture is an integral part of SDG2, along with food security. The second indicator is also ignored by academics since it is believed that food security is the lack of calories, and not over their daily norm, which also leads to overweight. At the same time, in other equal terms, such an indicator simply

indicates the lack of economic access to food and the replacement of quality products with cheap ones, which in turn contain so-called “empty” calories, which do not allow to satisfy the need for the necessary minerals and vitamins but overload the body with carbohydrates, starch, and others.

Another important aspect for scientists is the question of the possibilities and limits of the use of food security assessment methodology in other countries. Of course, some indicators or methodologies, or methodological approaches can be borrowed, but their use in the national system for assessing food security should be justified and appropriate. Otherwise, in the end, we will have a large block of indicators, which will be difficult to interpret. There is another problem related to the methodology of collecting and processing statistical information, which has differences in each country. On January 10, 2003, Ukraine officially became the 52<sup>nd</sup> country (the first among the countries of the Commonwealth of Independent States), which joined the International Monetary Fund's Special Data Dissemination Standard. However, the list containing the IMF Special Data Dissemination Standard includes a limited list of indicators, most of which do not even indirectly reflect the state of food security. **Volchenko (2013)** introduced such indicator systems in the Russian Federation and Belarus as examples of foreign experience in the formation of the country's food security system. At

the same time, we should pay attention to the fact that the data of the systems of indicators of food security assessment of the countries are based on the criteria laid down in the approved Doctrine (RF) and the Concept (Belarus), which are aimed at achieving the goals that do not coincide with the goals that Ukraine sets itself.

We can accept may the experience of foreign researchers who propose establishing an optimal level of indicators for food security. So, **Bekenov (2003)** Error! Reference source not found., **Ilyna and Kondratenko (2007)** determine the levels of optimality of food security indicators, but in the first and second cases it is only one indicator.

Russian explorer **Ogluzdin (2010)** proposes applying a five-point system of assessments of the state of food security. At the same time, it should be noted that it is not clear how to determine some of the proposed scientific indicators, because they sound, rather, as criteria-tasks than specific indicators. Secondly, not all indicators have limit levels defined, and therefore assign them to one of the five groups is not so easy. Thirdly, the list of indicators is too large and involves, in practice, the calculation of most of the indicators of economic, and not just food security. Instead, there are no specific indicators that determine the level of food security in the system.

We support the opinion of scientists who believe that the methodology for assessing food security indicators involves identifying their optimal, threshold and marginal levels, where the optimal level of food security indicators represents the range of values within which the most favorable conditions for reproductive processes in the national agro-industrial production are created; the threshold level is determined by the value of quantitative values, the violation of which causes unfavorable tendencies; marginal level – the limit violation of which causes threatening processes and trends in the system.

Research shows that the overwhelming majority of scientists define only the threshold levels of indicators. Some researchers' suggestions relate only to individual indicators. Thus, according to the classification proposed by **Kochetkov and Markov (2002)**, there are seven levels of food security of the population in Ukraine, which is determined by the indicator of the daily energy value of a human diet.

**Kundeeva (2013)** recommends to determine “the indicator of the overall physical availability of food”, according to the criterion for assessing the level of food security, to assess the state of food security (levels of food security), and also, it is based on the actual state of the country's economy (unbalanced agricultural development and significant property stratification of the population) and the availability of statistical data.

The idea of evaluating food security on one indicator is attractive, but it is suitable for determining changes in the long-term dynamics or ranking of regions of Ukraine, that is, as part of a more complete monitoring of the state of food security.

**Artimonova (2016)** Error! Reference source not found. argues that “the goal and direction of food security are different for each level, but there are several characteristics of food security that are acceptable for assessing food security at all levels: ensuring food security; food security is ensured; unsafe food security; food disaster”.

In our opinion, some of these characteristics are controversial regarding the levels of food security of the household and the individual. In particular, for the consumer, the country of production is not important if the price and quality of the product meet the requirements of the individual. The same applies to the characteristic features identified by the author as “secure food security” for a particular person, the level of consumption above the minimum necessary for physiological activity cannot be a determining indicator, since an important indicator is not the number of calories, but their quality. If consumer demand for food is met mainly through own production, this means certain restrictions for a particular person concerning her personal preferences. Every country has certain restrictions in the range of production of food products, as well as the formed food stocks, which take into account a specific list of basic products, but they do not provide the personal needs of each individual.

At the same time, we agree with the author's statement that “only the integral functioning of all levels of food security – the food security at the individual, national and international levels – will allow achieving positive qualitative changes in the provision of food products to people from all over the world, region, city and the individual person.” (**Artimonova, 2016**).

### Regional level

Most scientists propose to assess food security at the regional level in the same manner as at the state level (**Error! Reference source not found.** According to the results that we substantiated, the necessity of taking into account the stability criterion of the food system of the region is determined, which requires a deeper investigation of this issue.

**Piskunova and Osipova (2015)** believe that “the indicator of the level and structure of per capita consumption of food can be the most informative and general indicator of the state of food security of the region.”

Another group of authors (Error! Reference source not found.) propose to define an “integral indicator of food security in the regions of Ukraine”: this indicator is based on the original approach, because there are less differentiation and closer interactions between the studied objects. For example, the grain stock is not taken into account, because at the regional level, the urgent transportation of grain in extreme situations is much less costly, both material and time. Consequently, only the stock of national reserves is of key importance.

### Household and individual levels

The issue of food security at the household level became relevant when it was found that adequacy at the aggregated level could not ensure adequate nutrition at households or individual level. That is why the United Nations Special Committee proposed the definition of food security through the availability of food for households. Food security is provided when households have access to safe food in the amount necessary to ensure a healthy lifestyle for all its members (adequate in terms of quality, quantity, and cultural traditions) and when there is no excess risk of

loss of such access (Error! Reference source not found.).  
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To establish the degree of satisfaction of personal needs through surveys, but the results will be reliable only for a certain period. On the other hand, it is fair to assert that, in other equal conditions, in the modern world, the level of income determines the level of access of a person to any material goods, including food.

**Golikova (2014)** believes that “food security at the household level is linked to the income of individuals.”

**Error! Reference source not found.**The low-income level of the population leads to the fact that price fluctuations directly affect the food situation of the poorest layers not only in the city but also in the countryside. In several countries, owners of small plots of land are frequent buyers of food, they do not provide themselves with products at the expense of their plots.

However, judging from the list of goods and services that are included in the calculations in determining the subsistence minimum, in many countries, under this term, they understood no longer the minimum need. As **Sokol (2012)** noticed, “this is no longer the subsistence minimum in its original treatment as the poverty line, but the income reflecting the minimum rates of consumption of the employee in a given period, taking into account the state of the economy.” **Error! Reference source not found.**

Indicators of economic accessibility and differentiation of the cost of food by social groups become more important at the levels of the household and the individual. However, the analysis and interpretation of these indicators should be made more thoroughly according to the proposed Methodology for defining key indicators for food security. In Japan, a poor household is considered to be a family whose share of food expenditure exceeds 35% (**Nud, 2013**). **Error! Reference source not found.**By comparing the data with such threshold values, the researcher will always have false data about the actual state of affairs. Analysis of the indicator of the differentiation of the cost of food by social groups following the Methodology for defining the main indicators of food security in the “general mass” will not allow to establish dependencies and identify the problematic aspects of household nutrition. Such an approach does not take into account the culture of food and the needs of the family, depending on their place of residence.

### Scientific hypothesis

In our opinion, from a methodological point of view, the construction of a system of food security indicators should take place through the definition of the criteria for the functioning of the system. Such an approach ensures the interconnection and interdependence between the nature, objectives, and monitoring of food security at any level.

### MATERIAL AND METHODOLOGY

The theoretical basis of the research is the fundamental provisions of the formation of the food security system, the modern economic theory, which defines the goals and patterns of sustainable development of the world and Ukraine, scientific works of domestic and foreign scientists on issues of food security, state administration and legislative regulation of this problem.

The methodological basis of the research is the dialectical method and general scientific and special methods of scientific knowledge. In the process of research, the following methods of economic research were used: abstract-logical (the formation of theoretical generalizations and conclusions); historical (in the study of the evolution of the formation of terminology); monographic (the study of best practices on food security issues); system analysis and synthesis (formation of a system of food security criteria based on existing problems); terminological analysis and operationalization of concepts (research of conceptual approaches to the interpretation of the concepts of “food security”, “components”, “criteria” and “indicators”).

### RESULTS AND DISCUSSION

Critical analysis of scientists' approaches to the definition of the system of food security criteria allowed to establish features of their formation in the national science (**Figure 1** – “Problem” and “Consequences”). The author's suggestions for solving these problems, including improving food security, can be summarized (**Figure 1** – “Proposals”).

Therefore, when developing a system of food security indicators, we should point out the levels at which the monitoring and regulation process is conducted: global, national, and regional levels, household, and individual levels.

#### National level

In general, the system of indicators, approved by the Methodology for determining the main indicators of food security, meets the dimensions and criteria for food security.

At the same time, the defined system does not fully assess the criterion of implementation of effective agricultural trade policy of the state, which is the determining determinant of the national level. To ensure the objectivity of monitoring and interpretation of the obtained results, it is expedient:

(1) Include a list approved by the Methodology for defining the main indicators of food security, adding them to the system of indicators of food security assessment at the national level:

- the level of cereal stocks at the end of the period, the percentage of consumption;
- share of sales of imported food products through the trading network of enterprises, percentages;
- grain production per person per year, tons;

(2) The calculation of these new indicators should be carried out following the provisions of the Guidelines for the calculation of the level of economic security in Ukraine;

(3) Set the value of the marginal level of the indicators:

- the level of cereal stocks at the end of the period, the percentage of consumption – 100 percent;
- the share of sales of imported food products through the business network of enterprises – 25 percent;

(4) grain production per person per year – 0.8 tons (**Figure 2**).

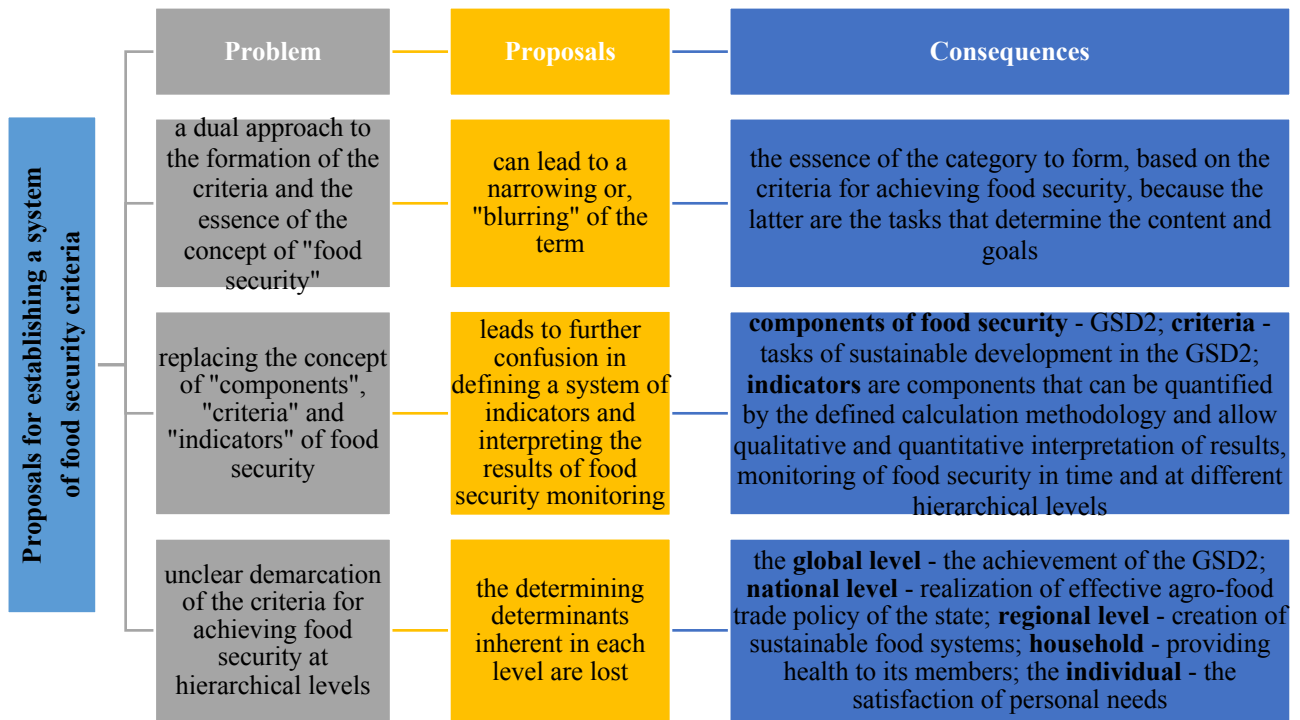


Figure 1 Proposals for establishing a system of criteria for ensuring effective food security management based on existing problems. Note: Source – Authors’ work.

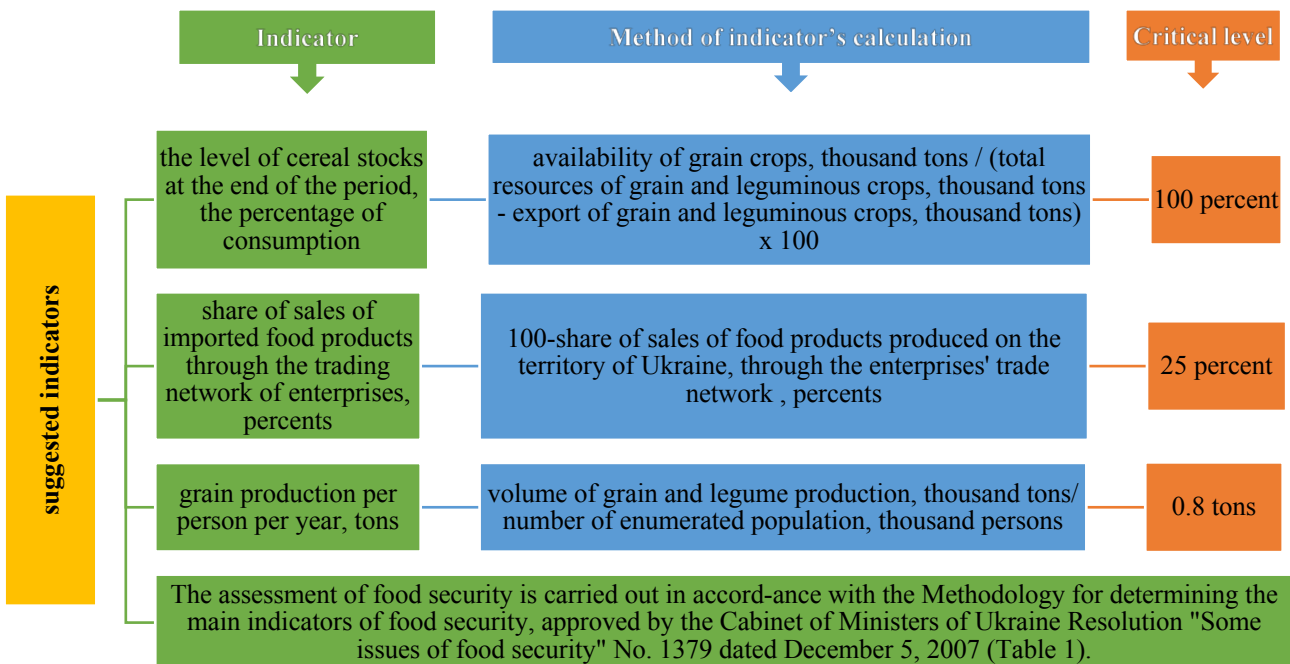


Figure 2 Proposals to improve the system of indicators to ensure effective food security management at the national level. Note: Source – Authors’ work.

**Regional level**

Taking into account the above mentioned, there is a need for monitoring and assessment of food security at the regional level by carrying out calculations of the regional rating (ranking) of each indicator and calculating the overall rating in general for all indicators following with the Methodology for monitoring and evaluating the effectiveness of the implementation of the state regional policy (Error! Reference source not found.).

The ranking is conducted by comparing the deviation of the values of the indicators for each specific region from their best values by region for the corresponding (reporting) period and the corresponding ranking of regions from 1st to 24<sup>th</sup> place. The rating assessment is based on the calculation of relative deviations of the indicators of each region from the maximum and minimum values of such indicators of other regions by the formula:

$$R_j = \sum_{i=1}^n \frac{x_{maxi} - x_{ij}}{x_{maxi} - x_{mini}} + \sum_{i=1}^n \frac{x_{ij} - x_{mini}}{x_{maxi} - x_{mini}}, \quad (1)$$

Where:  $R_j$  – amount of the rating estimates for a particular region for each of the indicators that characterize a particular year;  $x_{ij}$  – a value of the  $i$ -th indicator in the  $j$ -th region;  $x_{maxi}$  – maximum value of the  $i$ -th indicator;  $x_{mini}$  – minimum value of the  $i$ -th indicator.

The second part of the formula is used to evaluate the indicators, which increase positively (for example, the volume of realized industrial output per capita), the first part – to assess the indicators, which increase the negative value (for example, the amount of unpaid wages).

Determination of the average arithmetic value of the sum of rating assessments of a specific region for all indicators of the annual evaluation, which characterize a separate line of activity, is carried out by the formula:

$$R_{cpj} = \frac{R_j}{n}, \quad (2)$$

Where:  $R_{cpj}$  – an average arithmetic sum of ratings of a specific region for all indicators of a particular year;  $n$  – the number of indicators used for the calculation for a particular direction.

Due to the results of calculations, the integral rating is determined as the average arithmetic mean of the sum of rating estimates of a particular region for all years by the formula:

$$I_j = \frac{\sum_1^m R_{cpj}}{m}, \quad (3)$$

Where:  $I_j$  – an average arithmetic sum of ratings of a specific region for all years;  $m$  – number of years for which the calculation was made.

The criterion of stability of the food system of the region is characterized by indices of production and consumption of the main types of foodstuffs, branching out of the retail chain, as well as a system for reducing, processing and subsequent use of food waste.

Official statistics do not provide information according to the latest criterion, to perform calculations of the ranking of regions with levels of food security, we propose the use of the 9 indicators (Figure 3).

In general, the scheme for researching at the regional level will include six stages (Figure 4).

### Household and individual levels

In our opinion, it is advisable to apply the approaches proposed by Golikova K.P. (Error! Reference source not found.) Error! Reference source not found. to assess the food security at the household level, and Mostenska T.G. (Error! Reference source not found.) Error! Reference source not found.

The first approach ensures the objectivity of the analysis of the economic availability of products by comparing: the actual consumption of food with a consumer basket and rational standards; ratio and share of food costs in total costs and subsistence minimum. The second approach allows us to establish dependencies and identify the nutritional aspects of households depending on their place of residence.

In respect that neither the first nor the second approaches make it possible to characterize the health of household members as the main criterion for food security at the household level, therefore, in our opinion, to carry out

a comprehensive assessment of food security at the household level, it is expedient to analyze the indicators of the expected life expectancy at birth (years) and the rate of infant mortality (deaths of children under one year per 1,000 live births). Even more problems, regarding the assessment of food security at the level of the individual, occur as follows: on the one hand, the main criterion for achieving it is the degree of satisfaction of personal needs; and on the other hand, it is necessary to comply with the principle of state administration of personal interests' subordination to the national ones, after all, eventually, only such an approach can ensure the rights and freedoms of everyone.

The hypothesis of the study is the assumption that there is a significant overproportion in the level of consumption of food products by different categories of households as well as an impact of the economic availability of products upon this misbalance. Based on this thesis, it is proposed to evaluate the level of food security of households in terms of by households' categories, based on the main indicators of food economic availability and consumption (Figure 5).

There are discussions around the issue of food security indicators. In general, the proposals of domestic scientists regarding the improvement of the food security assessment system are based on the official Methodology for defining the main indicators of food security (Error! Reference source not found.) and are mainly concentrated in five areas:

(1) the formation of a system of indicators – the establishment of a list of indicators, their subordination to the criteria, the reduction or increase of their number compared with the approved Methodology for determining the main indicators of food security – were studied by Banakh (2016) Error! Reference source not found., Stezhko (2014), Ogluzdin (2010);

(2) improvement of the methodology for calculating the individual indicators that were proposed by the Methodology for determining the main indicators of food security, or – absolutely new indicators – were investigated by Grishova and Kryukova (2014), Stavitsky and Prokopenko (2014);

(3) systematization of indicators at different hierarchical levels – was studied by Artimonova (2016), Piskunova and Osipova (2015), Golikova (2014), Sokol (2012), Mostenska (2015);

(4) finding out of the optimal value of the normative (optimal, threshold and boundary) indicator level – was investigated by Grishova and Kryukova (2014), Kochetkov and Markov (2002), Nud (2013), Kundeeva (2013);

(5) borrowing methodologies for assessing the food security of others (mainly post-Soviet) countries – were investigated by Bekenov (2003), Volchenko (2013).

At the same time, national scientists did not agree on the construction of a unified system of indicators as part of the management of food security at different levels.

The world's scientific community also does not offer the unified indicators' system for food security monitoring at various levels, only for global one, whose indicators' system was developed by FAO (2019a).



Figure 3 Suggestions for improvement of the system of indicators to ensure effective food security management at the regional level. Note: Source – Authors’ work.

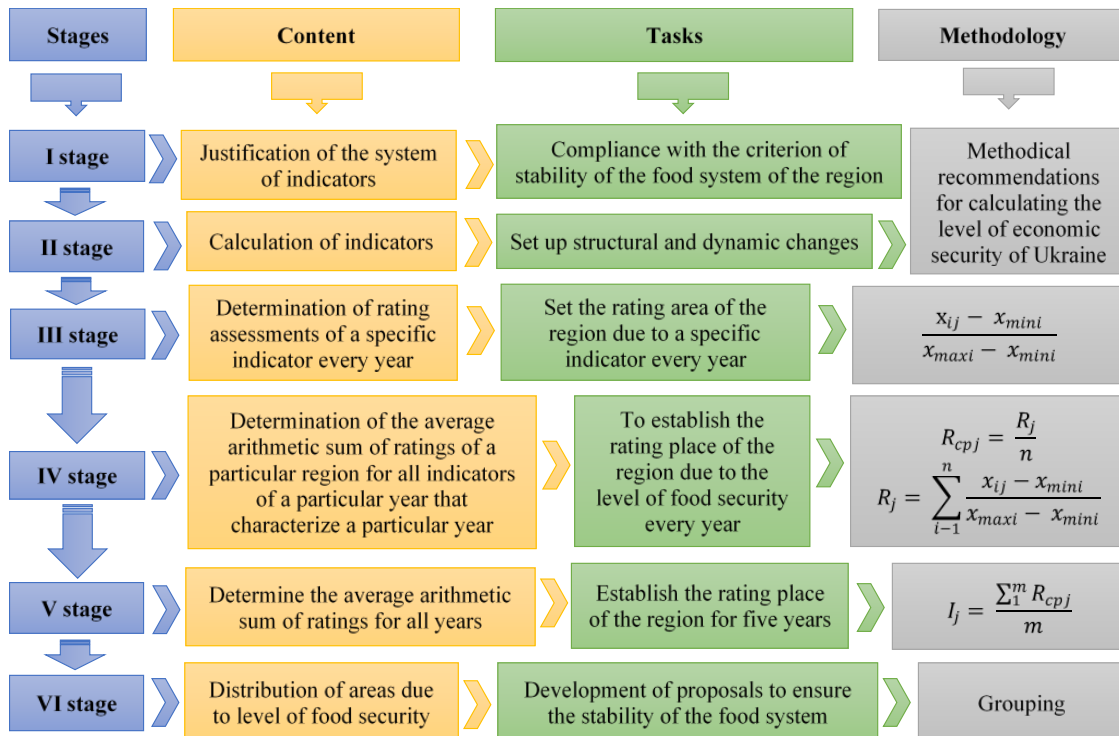
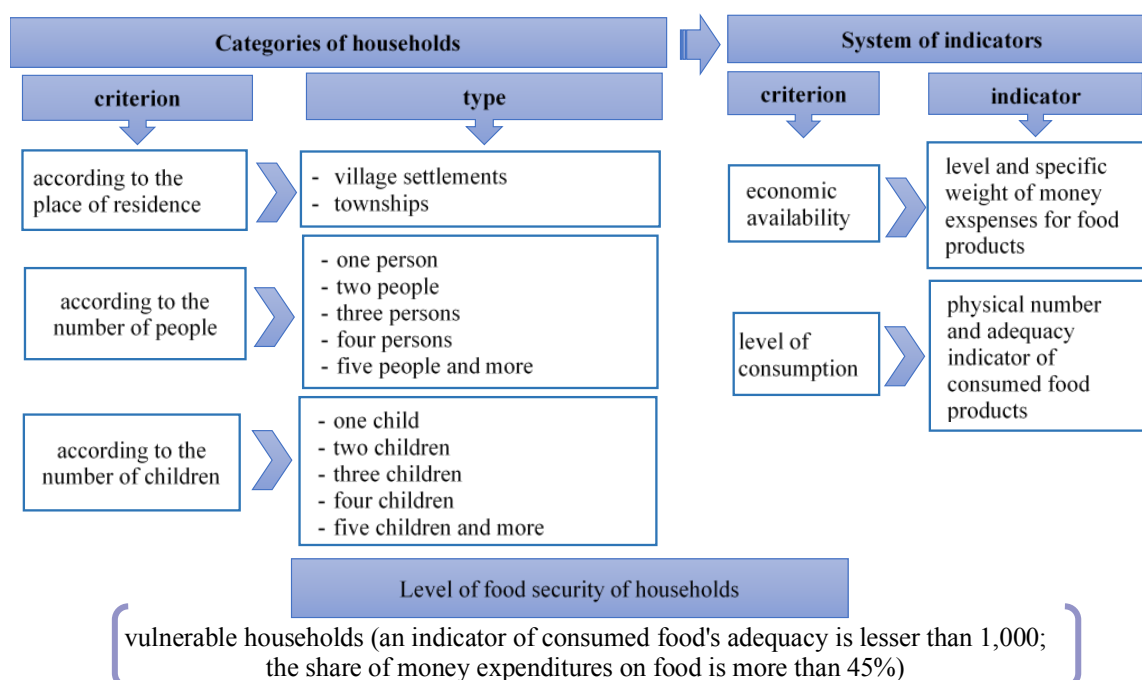


Figure 4 Methodological framework for monitoring and assessing to ensure the effective management of food security at the regional level. Note: Source – Authors’ work.



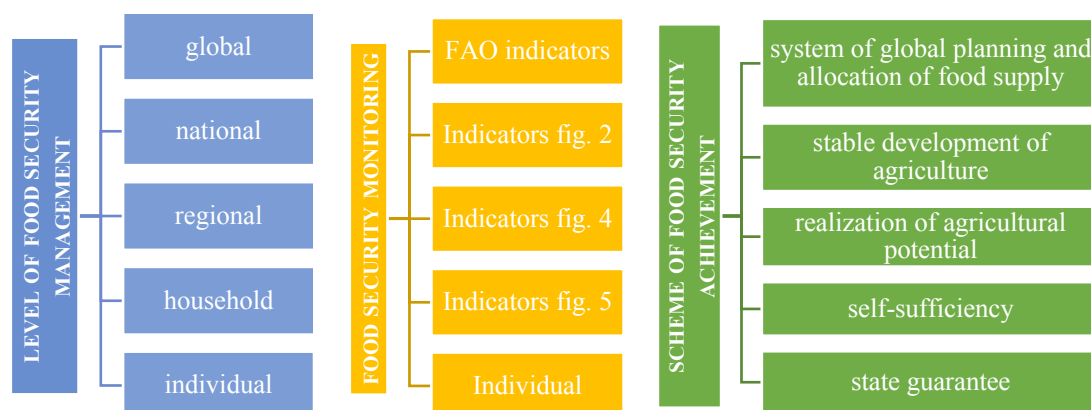


**Figure 5** Methodology for the economic evaluation of the assessment system for the effective management of food security at the household level. Note: Source – Authors’ work.

**Table 2** The system of indicators and food security margins.

The system of indicators	Monitoring and evaluation methodology	Margin level
<b>Global level</b>		
FAO’s system of indicators	FAO’s monitoring and evaluation methodology	Threshold levels set by FAO
<b>National level</b>		
<i>The system of indicators following the Methodology for determining the main indicators of food security</i>	Methodology for determining the main indicators of food security	Threshold levels indicated in the Methodology for determining the main indicators of food security
<i>Grain stock levels at the end of the period, percentages of consumption, %</i>	Methodical recommendations for calculating the level of economic security of Ukraine	100 percent
<i>Share of sales of imported food products through the company's trade network, %</i>		25 percent
<i>Grain production per capita per year, t</i>		0.8 tons
<b>Regional level</b>		
<i>List of 7.2-7.8 indicator due to the Guidelines for the calculation of economic security of Ukraine</i>	Methodology for monitoring and evaluating the effectiveness of the implementation of the state regional policy	Minimum and maximum values of indicators (regional ranking for each indicator and overall rating in general for all indicators)
<i>The ratio of trading places on the food market to the general population, ed. per 10000 people</i>		
<i>The ratio of the size of space for the retail stores to the total population, m2 per 1000 people</i>		
<b>Household-level</b>		
<i>Indicators proposed by Golikova K.P. and Mostenska T.G.</i>	Approaches proposed by Golikova K.P. and Mostenska T.G.	Establishing positive or negative changes in dynamics
<i>Expected life expectancy at birth, years</i>	Methodological statements on the statistical analysis of the natural population movement	
<i>Infant mortality rate (death of children under one-year-old) per 1,000 live births</i>		
<b>Individual-level</b>		
<i>System of indicators, characterizing the degree of satisfaction of personal needs</i>	questionnaire survey	Satisfaction or dissatisfaction of the needs

Note: Italics font – suggestions by the authors for improving the system. Source – Authors’ work.



**Figure 6** The place of indicators in the food security management system at different levels. Note: Source – Authors’ work.

The proposed system solves a range of problems that currently exist: firstly, in the domestic monitoring system, there are developed indicators only at the national level; however, we proposed system that covers all levels; and secondly, the criteria underlying the national food security monitoring system do not meet the SDGs; instead, our proposed system of indicators is based on the need to achieve the SDGs2.

The developed system of indicators and margins of food security ensures monitoring and evaluation of the achievement of the criteria of the respective levels (global, national, regional, households, and individuals) based on the actual official information provision of the processes of food security according to the SDGs2.

The proposed system of indicators allows monitoring of food security in a systematical and integrated way, at various hierarchical levels, which enables the quality management of food security taking into account specific features and needs at each level (**Figure 6**).

Further research will be aimed at making the strategic framework and mechanism for ensuring food security at various hierarchical levels, taking into account the monitoring results of the proposed methodology.

## CONCLUSION

The formation of theoretical and methodological guidelines and methodological recommendations for the development of a system of food security indicators requires further systematic research on its content-based basis as a component of food security management at different levels in the context of the implementation of the concept of sustainable development goals 2016 – 2030.

Based on the results of the conducted research and the scientific and theoretical positions of the epistemological content of the category of the concept of “food security”, taking into account the criteria of food security, formation at different hierarchical levels and methodological aspects of its monitoring, we propose:

(1) to use the FAO’s system of indicators to assess global food security. It makes no sense to develop a new system that requires complex calculations in all countries of the world (because the global level has the same information – comparisons across different countries, continents, continents, etc.) when FAO outlines all indicators and reports on the state of food security in the world in open access;

(2) to assess food security at the national level, we should use the system based on the indicators of the Methodology for defining the main indicators of food security, taking into account the indicators characterizing the level of the country’s agricultural and food trade policy;

(3) to use a system based on the indicators of the Methodological recommendations for assessing food security at the regional level, for calculating the level of economic security of Ukraine, taking into account indicators that characterize the stability of the food system;

(4) to assess food security at the household level, use the technique proposed by **Mostenska (2015)**, taking into account indicators that characterize the health of household members;

(5) the assessment of food security at the individual level is currently only possible through the application of a questionnaire, where attention should be focused on the analysis of indicators characterizing the degree of satisfaction of personal needs.

## REFERENCES

- Artimonova, I. V. 2016. Theoretical Approaches to the Formation of the Food security System. *Formation of market relations in Ukraine*, vol. 178.
- Banakh, O. I. 2016. Theoretical fundamentals of food security assessment as an object of statistical observation. *Bulletin of the ONU named after I.I. Mechnikov*, vol. 49.
- Bekenov, S. S. 2003. Criteria and assessments of food security. *Vestnyk KRSU*.
- Cabinet of Ministers of Ukraine. 2007. *Some issues of food security*. Available at: <http://zakon2.rada.gov.ua/laws/show/1379-2007-%D0%BF>. (in Ukrainian)
- Cabinet of Ministers of Ukraine. 2015. *Methodology for monitoring and evaluating the effectiveness of the implementation of the state regional policy*. Available at: <http://zakon2.rada.gov.ua/laws/show/856-2015-%D0%BF/page3>. (in Ukrainian)
- FAO. 1996. World Food Summit. Rome. Available at: [http://www.fao.org/wfs/index\\_en.htm](http://www.fao.org/wfs/index_en.htm).
- FAO. 2019a. Food security indicators. Available at: <http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/>.
- FAO. 2019b. Indicators under FAO custodianship. Available at: <http://www.fao.org/sustainable-development-goals/indicators/en/>.
- Forouzanfar, M. H, Alexander, L., Anderson, H. R., Bachman, V. F., Biryukov, S., Brauer, M., Burnett, R., Casey,

- D., Coates, M. M., GBD 2013 Risk Factors Collaborators. 2015. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*, vol. 386, no. 10010, p. 2287-2323 [https://doi.org/10.1016/S0140-6736\(15\)00128-2](https://doi.org/10.1016/S0140-6736(15)00128-2)
- Frankenberger, T. R., McCaston, M. K. 1998. Household livelihood security: a unifying conceptual framework for CARE programs. *Proceedings of the USAID workshop on performance measurement for food security*. Arlington, VA. Washington (DC), United States : Agency for International Development, p. 30-35. Available at: <http://www.fao.org/3/X0051t/X0051t05.pdf>.
- Golikova, K. P. 2014. The state of food security of Ukraine: socio-economic aspect. *Scientific Herald of Kherson State University*, vol. 7., p. 183-186.
- Grishova, I. Y., Kryukova, I. O. 2014. Current state and problems of food security of Ukraine. *Bulletin of the Sumy National Agrarian University. Series «Economics and Management»*, vol. 61, p. 20-25.
- Gross, R., Schoeneberger, H., Pfeifer, H., Hans-Joachim, A. 2000. The Four Dimensions of Food and Nutrition Security: Definitions and Concepts. *Nutrition and Food Security*, p. 1-17. Available at: [http://www.fao.org/elearning/course/fa/en/pdf/p-01\\_rg\\_concept.pdf](http://www.fao.org/elearning/course/fa/en/pdf/p-01_rg_concept.pdf).
- Ilyna, Z. M., Kondratenko, S. A. 2007. Theoretical and methodological criteria and approaches to assessing national food security. *News of the National Academy of Sciences of Belarus*, vol. 2, p. 12-20.
- Kochetkov, O. V., Markov, R. V. 2002. Formation of a system of indicators of food security of Ukraine. *Economy of agroindustrial complex*, vol. 9, p. 142-158.
- Kundeeva, O. I. 2013. Food security: differentiation of food supply levels of the country. *Scientific works of NUKHT*, vol. 49, p. 139-145.
- Laraia, B. A. 2013. Food insecurity and chronic disease. *Adv. Nutr.*, vol. 4, no. 2, p. 203-212. <https://doi.org/10.3945/an.112.003277>
- Leung, C. W., Ding, E. L., Catalano, P. J., Villamor, E., Rimm, E. B., Willett, W. C. 2012. Dietary intake and dietary quality of low-income adults in the Supplemental Nutrition Assistance Program. *Am. J. Clin. Nutr.*, vol. 96, no. 5, p. 977-988. <https://doi.org/10.3945/ajcn.112.040014>
- Ministry of Economic Development and Trade of Ukraine. 2013. *Methodical recommendations for calculating the level of economic security of Ukraine*. (In Ukrainian)
- Mostenska, T. H. 2015. Food security at the household level. *Economics and social development: scientific works of NUKHT*, vol. 21, no. 1, p. 121-133.
- Nud, O. P. 2013. Food security of Ukraine: theoretical and practical aspect. *Bulletin of the Donetsk University of Economics and Law*, vol. 2, p. 168-174.
- Ogluzdin, N. S. 2010. Food security of Russia. Available at: <http://geopolitika.narod.ru/New/prod.htm>
- Pérez-Escamilla, R., Dessalines, M., Finnigan, M., Pachón, H., Hromi-Fiedler, A., Gupta, N. 2009. Household food insecurity is associated with childhood malaria in rural Haiti. *J. Nutr.*, vol. 139, no. 11, p. 2132-2138. <https://doi.org/10.3945/jn.109.108852>
- Pérez-Escamilla, R., Segall-Corrêa, A. M. 2008. Food insecurity measurement and indicators. *Rev. Nutr.*, vol. 21, p. 15s-26s. <https://doi.org/10.1590/S1415-52732008000700003>
- Piskunova, O. V., Osipova, O. I. 2015. Rationalization of the regions of Ukraine on the level of food security. *Formation of market relations in Ukraine*, vol. 167, p. 191-198.
- Ramakrishnan, U. 2002. Prevalence of micronutrient malnutrition worldwide. *Nutr. Rev.*, vol. 60, no. 5, p. 46-52. <https://doi.org/10.1301/00296640260130731>
- Smith, M. D., Rabbitt, M. P., Coleman-Jensen, A. 2017. Who are the World's Food Insecure? New Evidence from the Food and Agriculture Organization's Food Insecurity Experience Scale. *World Dev.*, vol. 93, p. 402-412. <https://doi.org/10.1016/j.worlddev.2017.01.006>
- Sokol, M. V. 2012. The subsistence minimum and its importance in the formation of a quality system of social standards. *The forum is right*, vol. 4, p. 841-846.
- Stavytsky, A. V., Prokopenko, O. O. 2014. Assessing the state of food security in Ukraine at the regional level. *Bulletin of the Sumy State and regions*, vol. 2, no. 77, p. 41-47.
- Stezhko, N. V. 2014. Theoretical and methodical approaches to the definition of indicators of world food security. *Regional Business Economics and Management*, vol. 2, p. 103-113.
- Verkhovna Rada of Ukraine. 2007a. *On food security of Ukraine*. Available at: [http://w1.c1.rada.gov.ua/pls/zweb2/webproc4\\_2?pf3516=8370-1&skl=7](http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_2?pf3516=8370-1&skl=7). (In Ukrainian)
- Verkhovna Rada of Ukraine. 2007b. *The Conclusion to the draft Law of Ukraine "On food security of Ukraine"*. Available at: [http://w1.c1.rada.gov.ua/pls/zweb2/webproc4\\_1?pf3511=44744](http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511=44744). (In Ukrainian)
- Volchenko, N. V. 2013. Formation of the system of food security indicators of the country: foreign experience. *Visn. Kharkiv. Nats. Tech. un-th. agriculture. Series: Econ. science*, vol. 138, p. 98-105.
- Zhang, N., Bécares, L., Chandola, T. 2016. Patterns and determinants of double-burden of malnutrition among rural children: evidence from China. *PLoS One*, vol. 11, no. 7, p. e0158119. <https://doi.org/10.1371/journal.pone.0158119>

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