Article

Assessing the Sustainability of the Consumption of Agricultural Products with Regard to a Possible Reduction in Its Imports: The Case of Countries That Import Corn and Wheat

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Abstract: The main goal of this study is to develop and apply a toolkit for assessing the sustainability level of countries that import certain types of agricultural products with regard to a possible reduction in the volume of such imports. An indicator was proposed for evaluating sustainability. A model of its decomposition was built, which made it possible to reveal the hierarchy of factors of the formation of the specified sustainability. The concept of sustainable growth in consuming a certain agricultural product by a group of importing countries was developed. In particular, such growth conditions were formalized. Approbation of the formed methodological principles was carried out on two groups of countries that import corn and wheat. In particular, it was established that an increase in the relative vulnerability level of countries to a reduction in imported food supplies is negatively correlated with an increase in the relative level of adaptation of countries to such a reduction. It was also found that as of 1 January 2023, the resistance level of the studied countries to a reduction in corn and wheat imports has significantly decreased. Proposals are developed to increase the resilience level of food-importing countries to possible disruptions in their import supplies.

Keywords: agricultural products; import; consumption; sustainability; sustainable growth; adaptation

1. Introduction

Nowadays, many countries' economies are characterized by a high level of dependence on imports of goods and resources. This dependence is mainly due to the lack of domestic capacity to produce certain products. At the same time, dependence on imports often has an economic background, i.e., it is determined by the economic feasibility of manufacturing certain goods abroad. However, in conditions of instability caused by political, economic, environmental, and other factors, dependence on imports may be associated with a high level of risk [1].

These risks are reflected in the threats of significant increases in prices for imported products, failure to meet the planned volumes of its supplies, and so on. These threats are particularly serious in food supplies [2]. This raises the importance of achieving adequate food security [3]. Moreover, the urgency of these issues is growing in the context of sustainable development, the essential component of which is agriculture development [4].

Reducing the risks associated with individual countries' dependence on imports, including agricultural supplies, requires various measures. In particular, this applies to import substitution, diversification, increasing stocks of imported goods, etc. [5]. However, the development of these measures should be preceded by a detailed assessment of the existing threats due to dependence on imported supplies [6]. One of the stages of such an assessment is to determine the sustainability of the consumption of certain products by country, as well as its importers sustainability to a possible reduction in imports of these products.

For countries that receive imported food supplies with a high risk of reducing their volumes, there are various ways to increase the sustainability of the consumption of relevant agricultural products. One such way is to reduce the volume of food imports from those countries that currently face a significant risk of ending or at least reducing the supply of their agricultural products. However, if we limit ourselves to these actions, the consumption of agricultural products in the remaining importing countries will decrease. In this regard, it is necessary to determine the possibilities of increasing the sustainability of the consumption of agricultural products by the importing countries without reducing the consumption of these products but, on the contrary, with their simultaneous growth.

Considering the above, the purpose of this study is to develop and apply a toolkit for assessing the sustainability level of countries that import certain types of agricultural products in the event of a possible reduction in the volume of such imports. Accordingly, the subject of the study is the theoretical and methodological foundations of the formation and assessment of agricultural products consumption sustainability in importing countries.

To achieve this purpose, the following main tasks were set and solved in this study:

(1) Develop an indicator for assessing the sustainability of agricultural product consumption in the event of a possible reduction in its import;
(2) Build a model of the decomposition of the level of sustainability of the agricultural products consumption in the event of a possible reduction in its import;
(3) Determine the conditions under which the sustainable growth of the consumption of agricultural products in the importing countries is ensured;
(4) Assess the sustainability consumption of corn and wheat by countries that import them in the event of a possible reduction in its import.

The further material of this study has the following structural construction. Section 2 reviews the literature on the research topic. Section 3 presents the methodological principles for assessing the sustainability of the consumption of certain types of agricultural products in the event of a possible reduction in their imports. Section 4 conducts an empirical analysis of several countries importing agricultural products and discusses the results obtained from this analysis. Finally, Section 5 summarizes the conclusions from the conducted research and indicates the limitations and prospects of further research.

2. Literature Review

The problem of assessing the resilience of economic systems is the focus of current research. In particular, the main factors influencing macroeconomic stability are identified, its modeling is carried out, and indicators and methods of assessing economic sustainability are proposed.

In general, it is possible to distinguish three groups of methods for assessing the stability of economic systems, as well as other systems and processes in which the economic component plays an important role. The first group of methods should include those that involve assessing sustainability using a set of partial indicators. At the same time, in most publications, and in particular in [7], three types of such indicators are considered which characterize economic, social, and environmental sustainability, respectively. In addition, some researchers, in particular the authors of [8], single out a fourth group of indicators that provide an institutional measure of sustainability.

The second group of publications, devoted to the assessment of sustainability, aims to provide an unambiguous assessment of it by reducing partial indicators to one generalizing one. At the same time, various methods of such a summary are proposed, and in particular,

the application of the weighting method [9], a multi-criteria decision-making model [10], a fuzzy logic model, a method of Saati hierarchies, the Mamdani algorithm [11], and other similar methods.

Finally, in the third group of publications, a generalized assessment of the stability of economic systems is proposed to be carried out with the help of one indicator, which has a relatively simple construction, but transparent economic content. So, in particular, in [12], it is proposed to carry out such an assessment on the basis of determining the reserve of stability of the economic system. At the same time, in work [13], the assessment of sustainability is carried out by comparing the increase in economic results caused by certain changes with the increase in the value of the indicator, which characterizes the magnitude of such changes.

With regard to publications devoted to the question of assessing the sustainability of food consumption, the approaches proposed in them can be attributed either to the first [14,15] or to the second [16,17] groups of publications.

Among other things, researchers have established the role played by adaptive capabilities of economic systems in ensuring the their stability [18,19]. At the same time, in the literature, there are different approaches to interpreting the essence of adaptation mechanisms. Thus, in [20], adaptation is considered a systemic reaction that counteracts the current or possible decrease in the efficiency of its functioning. In [21], a firm's adaptation is interpreted as its ability to interpret and translate signals from the external environment into new behavioral responses. Finally, the essence of adaptation is treated similarly in [22]. In this work, the authors study the regularities of the application of adaptation mechanisms in the context of the possibilities of a purposeful change in the system's functioning in anticipation of certain external stimuli or response to the action of these stimuli. Thus, adaptation to changes is associated with the homeostasis mechanisms of complex open systems. At the same time, special emphasis is placed on the need to adapt systems not only to those changes that have already occurred but also to those changes that may occur after a certain period.

Studying the process of adaptation of the economy with respect to the increase in energy prices, the authors of the work [23] establish the relationship between the economy's resistance to such growth, its vulnerability, and the ability to adapt to it. This relationship has a fairly universal character. Therefore, it is advisable to try to apply it also to the case of sustainability of the consumption of agricultural products.

The sustainability of the consumption of agricultural products is largely determined by the sustainability of the agricultural sector. It should be noted that the issue of sustainability in the agricultural sector was considered in several scientific works, particularly in [24,25]. This sustainability has been studied in various contexts, primarily concerning the following: changes in the climatic conditions of agriculture [26], rising demand for production resources necessary for the production of agricultural products [27], the task to more fully satisfy the need for agricultural products in certain regions of the world [28], etc. The connection between agricultural production's sustainability and food security provision in certain countries is also obvious [29,30].

Since many countries are importers of food, for them, in addition to the sustainability of agricultural production, the proper sustainability of the supply of agricultural products is also important. At the same time, as noted in [31,32], such supplies are often associated with significant risks. At the same time, different types of such risks were distinguished. In particular, product supply risks, including agricultural products, may have a logistical nature [33]. However, threats to reducing the volume of food production by countries that export relevant agricultural products can also significantly impact the stability of food supplies. Such threats include the deterioration of natural and climatic conditions for agriculture [34,35], political instability in the countries that produce it [36], and the emergence or escalation of military operations in these regions [37]. In general, military conflicts belong to the factors that have an extremely negative impact on the sustainability of the consumption of agricultural products [38]. At the same time, it is worth noting that

the lack of food can be not only a consequence, but also a cause of individual military conflicts [39]. In any case, food shortages and hostilities are closely related [40]. In particular, this connection was manifested in the armed conflicts that took place or are still taking place in Syria [41], Rwanda [42], Nigeria [43], Gaza [44], Sudan [45], and in other countries and regions. The military actions that have been taking place in Ukraine since 2014 pose a particularly significant threat to the stability of the global food system, as this country is a major exporter of many types of food [46]. In addition, the risk of rising world prices for agricultural products should be attributed to the risks associated with importing food [47,48]. This risk can be particularly acute concerning developing countries that are highly dependent on food imports [49].

It follows from the above that the stability of imported supplies of agricultural products depends on many factors. The effect of these factors is often quite difficult to predict. Therefore, assessing the sustainability of imported food supplies and, accordingly, the sustainability of its consumption by importing countries is difficult. At the same time, such an assessment is a necessary condition for determining ways of increasing the level of sustainability of food consumption.

It should be noted that in the modern scientific literature, there are quite a lot of studies devoted to finding ways to increase the sustainability of food consumption. Thus, in work [50], market, informational, regulatory, and stimulating tools for solving this task are considered. In [51], directions of state regulation of sustainability of food consumption are studied, in particular the levers of tax regulation. In [52], the management of this sustainability is investigated through the prism of changes in consumer behavior. Particular attention should be paid to the works that consider modern tools for increasing the sustainability of food supplies, in particular information and communication technologies [53,54]. In the scientific literature, considerable attention is also paid to such means of improving the sustainability of the consumption of agricultural products as diversification of their production [55], improving the yield of agricultural crops [56], creating adequate food stocks [57], performing detailed monitoring and regulation of food systems [58], etc.

The study of the stability of most economic phenomena will be characterized by sufficient completeness only if the dynamics of stability are considered [59,60]. This statement also applies to the sustainability of the consumption of agricultural products in importing countries. At the same time, it is essential to quantitatively assess changes in this stability and identify the factors that caused these changes. Among such factors, the dynamics of agricultural product consumption play an important role [61,62]. At the same time, the increase in the sustainability of the consumption of agricultural products by the importing countries may be accompanied by a negative trend towards a decrease in the volume of this consumption. This will happen if the increase in the sustainability of the consumption of agricultural products is caused by a decrease in food supplies from countries that have a high risk of disruptions in such supplies. Currently, against the backdrop of military operations in Ukraine, such countries should include several post-Soviet states that are powerful food exporters [63]. Therefore, there is a need to ensure the simultaneous growth of the sustainability of the consumption of agricultural products in the importing countries and the volume of such consumption. However, in the modern scientific literature, the problem of finding ways of such provision still needs to be solved.

Thus, despite the presence of a significant number of scientific works devoted to the sustainability of the consumption of agricultural products, there are certain gaps in the conducted research. Firstly, there is currently no generalizing and at the same time transparent indicator for assessing the sustainability of consumption of agricultural products in relation to a possible reduction in its imports. Secondly, there is a need to develop a method by which it would be possible to obtain a clear quantitative assessment of the level of the specified stability. Thirdly, the conditions under which there is a steady increase in the consumption of agricultural products in relation to a possible reduction in its import have not yet been formalized. At the same time, the solution of the last task should be based on closing the two previous gaps that exist in the literature. Ultimately,

such a closure will make it possible to form a methodological base for empirical studies devoted to assessing the sustainability of consumption of agricultural products in relation to a possible reduction in its imports. At the present time, when the threats in the field of global food security are significantly increasing, the need for such research is especially acute.

3. Methodology

3.1. Theoretical Bases of Formation and Assessment of the Sustainability of Consumption of Agricultural Products in the Importing Countries

A quantitative assessment of the level of sustainability of certain types of economic phenomena requires, first of all, a definition of the essence of the concept of sustainability and modeling the process of its formation [64,65]. In turn, such modeling should be based on identifying the main factors that influence the stability of the relevant economic phenomena, as well as on identifying the mechanisms of such influence [66,67]. These statements also apply to the case of assessing the level of sustainability of consumption of agricultural products in importing countries.

The study of different approaches to determining the essence of sustainability of economic phenomena makes it possible to define the essence of sustainability of the consumption of agricultural products in the importing countries as the ability of the respective countries to maintain a certain amount of such consumption in conditions of negative effects on it.

Considering the complexity and multifacetedness of the term "sustainability of consumption of agricultural products in the importing countries", it is possible to distinguish several types of such sustainability. In particular, three types of sustainability of such consumption can be distinguished based on the immediate reasons for a possible decrease in the consumption of agricultural products, namely: sustainability concerning a possible decrease in the volume of domestic production of agricultural products, stability concerning a possible decrease in the volume of imports of these products, and stability concerning both of the listed reasons.

In turn, the decrease in the volume of import of agricultural products, as already mentioned above, may be caused by various reasons. In particular, such reasons may include logistical difficulties, deterioration of natural and climatic conditions for farming, political instability in the cranes that produce food, etc. Accordingly, the sustainability of food consumption in taps that import it can be assessed separately for each reason or several at once.

It is also possible to distinguish types of sustainability of consumption of agricultural products according to the breadth of the conducted assessment. According to this feature, it is worth distinguishing sustainability by individual country, group sustainability (assessed simultaneously for food importing countries), and global sustainability (assessed by the entire set of countries that import a certain type (types) of food). In addition, the sustainability of consumption of agricultural products can be divided by the types of these products. At the same time, evaluating the specified sustainability by a separate type of agricultural product and by the totality of its types is possible.

Particular attention should be paid to distinguishing the types of sustainability of consumption of agricultural products in the time intervals during which such an evaluation takes place. In particular, it is possible to distinguish retrospective and predictive stability. If predictive stability is evaluated based on forecast data, that is, for future periods, then retrospective stability is determined based on data from past periods.

We will consider the case of assessing the sustainability of the consumption of agricultural products in the countries that import them concerning a possible reduction in the volume of imports of these products. However, regardless of the type of sustainability, its assessment should be based on information about the level of two main properties of food importing countries, namely:

(1) Vulnerability to a reduction in import supplies;
(2) Ability to adapt to such a reduction.

Generally, these two properties' level determines any economic phenomenon's stability. Let it be predictive of the possible results of the functioning of the economic system after the deterioration of the external conditions of its activity. Let it also be established that with a sufficiently high probability, the possible decrease in the value of a system functioning indicator will not exceed a certain value. Such a decrease will characterize the vulnerability of the system. Suppose that thanks to the adaptive capabilities of the system, it is able to partially or completely compensate for such a decrease. Then, the value of this compensation will characterize the adaptive capabilities of the economic system. Accordingly, the greater the ratio of the indicator's value, which characterizes the ability to adapt to the indicator's value, which characterizes the vulnerability to negative influences, the higher the stability of a specific economic phenomenon will be. Taking these considerations into account, the level of sustainability of consumption of agricultural products in the importing countries should be estimated using the following equation:

$$S_c = \frac{A}{V} \tag{1}$$

where S_c is the level of sustainability of the consumption of agricultural products in the importing countries, concerning a possible decrease in the volume of imports of these products, the share of the unit; A is the number of adaptation capabilities of countries to reduce food imports from some other countries, which is measured in natural or value units of the consumption of the corresponding type (types) of agricultural products; V is the amount of vulnerability of countries to a reduction in food imports from some other countries, which is measured in natural or value units of consumption of the corresponding type (types) of agricultural products.
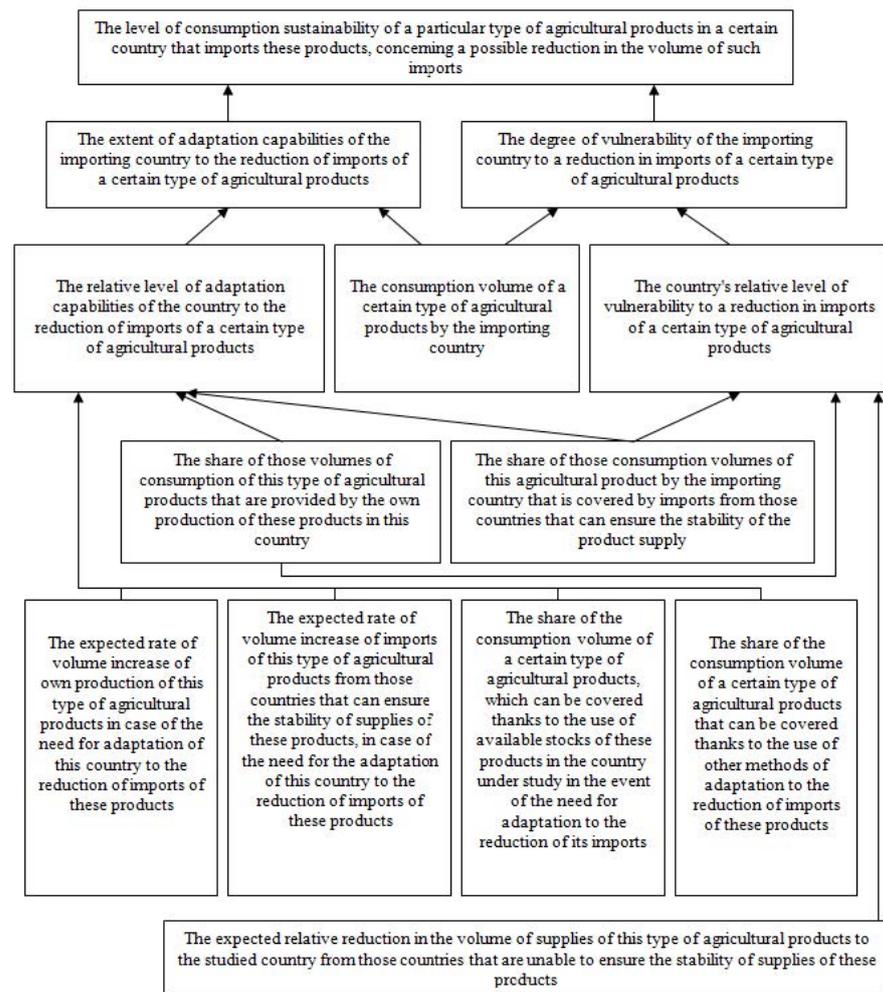
It should be noted that determining the values of adaptive capacity and vulnerability that appear in (1) is a difficult task. This is due, in particular, to the fact that both of these parameters are influenced by many factors. Therefore, first of all, it is necessary to carry out a decomposition of the values of adaptation possibilities and vulnerability. This will be conducted in the next subsection.

Thus, the amount of adaptation opportunities in Equation (1) is determined by those consumption volumes that the implementation of appropriate adaptation actions may give. For example, such actions can be an increase in the volume of domestic production of certain agricultural products and an increase in the volume of their deliveries from those countries that can provide such an increase. In addition, adaptation actions can include the substitution of some types of food by others that are less scarce in the structure of food consumption.

Regarding the vulnerability of countries to a reduction in food imports from some other countries, which appears in Equation (1), this value is determined by the expected volume of a possible reduction in food imports from countries behind which there is a risk of such a reduction. Of course, these volumes should be evaluated following a predetermined probability of occurrence of the specified risk events.

Taking into account the above, it is possible to build a model of the formation of the sustainability of the consumption of agricultural products in the importing countries concerning a possible decrease in the volume of imports of these products. This model is shown in Figure 1. As seen from this figure, there is a certain hierarchy of factors for forming the specified stability. In other words, it is possible to distinguish factors of direct influence (their indicators appear in Equation (1)) and factors of indirect influence.

Using the model presented in Figure 1, it is possible to formalize the process of assessing the sustainability of consumption of agricultural products by the importing countries. At the same time, the relative level of adaptation capabilities (Figure 1) of the importing country to the reduction in imports of a certain type of agricultural products is defined as the ratio of the absolute value of the adaptation capabilities of the importing country to the volume of these products consumption. Similarly, the relative level of vulnerability of the importing country to a reduction in imports of certain agricultural products is determined.

Figure 1. A model of the formation of the sustainability of the consumption of agricultural products by the importing countries concerning a possible decrease in the volume of imports of these products.

The model presented in Figure 1 for the formation of the sustainability of the consumption of agricultural products by the importing countries concerning a possible reduction in the volume of imports of these products gives grounds to express certain considerations regarding the process of such a formation.

First, among the factors that influence the relative level of adaptation capabilities of the importing country and the relative level of its vulnerability are the same. These factors are the following: (1) the share of those consumption volumes of this type of agricultural product, which are provided by their own production of these products in this country; (2) the share of those consumption volumes of this agricultural product by the importing country, which is covered by imports from those countries that can ensure the stability of the supply of this product. At the same time, it is obvious that the larger these shares are, the higher the relative level of adaptability will be, and the lower the relative level of vulnerability of the importing country will be to a possible reduction in the import of agricultural products. Taking into account these considerations, the following hypothesis may be expressed:

Hypothesis 1. *There is a statistically significant relationship between the relative level of adaptability of importing countries to a reduction in agricultural imports and the relative level of vulnerability of these countries to such a reduction. At the same time, with a decrease in the level of vulnerability of importing countries, their adaptability to the reduction in imports of agricultural products increases.*

Secondly, the combined effect of the two factors mentioned above, which have an impact on the relative levels of adaptation capabilities and vulnerability of importing countries to a reduction in the import of agricultural products, is determined by the share of those consumption volumes that are covered by imports from those countries that are unable to ensure the stability of the supply of these products. Since the relative levels of adaptation capabilities and vulnerability of importing countries to a reduction in the import of agricultural products directly determine the level of resistance to such a reduction, are grounds for formulating such an assumption:

Hypothesis 2. *The indicator of the share of those volumes of agricultural product consumption that are covered by imports from those countries that are unable to ensure the stability of supplies of these products has a statistically significant effect on the resistance level to the reduction in its imports. At the same time, with an increase in the specified share, the resistance level of importing countries to a reduction in the import of agricultural products decreases.*

Thirdly, as follows from Figure 1, measures to adapt importing countries to reduce imports of agricultural products are mainly long-term or fairly limited. For example, implementing such adaptations due to the increase in the volume of their own production of agricultural products by the importing country may require a long time with limited opportunities for such an increase. Therefore, the resistance level of countries to a reduction in the import of agricultural products cannot be arbitrarily high. This is especially true of countries with a high proportion of the consumption of agricultural products covered by imports from countries that cannot ensure stable supplies of these products. Taking this into account, there are reasons to make the following assumption:

Hypothesis 3. *Let there be a sufficiently large group of importing countries, for which a high share of those consumption volumes of agricultural products covered by imports from those countries that cannot ensure the stability of the supply of these products is inherent. Then, for all or at least most of such countries, the level of their resistance to reducing imports of certain agricultural products will be lower than unity.*

3.2. Modeling of the Sustainability of Agricultural Products Consumption by a Certain Importing Country

We will consider the case when the indicators on the right-hand side of expression (1) are measured in natural units. Then, as follows from the scheme presented in Figure 1, the process of assessing the level of sustainability of the consumption of the agricultural product by a certain importing country with a possible reduction in the volume of imports of these products will involve the implementation of the following sequence of actions:

(1) The choice of a certain type of agricultural product and the country that is the importer of these products;

(2) Determination of the basic natural volume of consumption by this country of this type of agricultural product. Such volume can be taken at the reporting level (if retrospective sustainability is assessed) or at the forecast level (if predictive sustainability is assessed);

(3) Establish a list of exporting countries of this agricultural product, which carry out (or will carry out) its deliveries to the studied country. At the same time, these countries must be divided into two groups, namely, countries that are highly likely to be able to ensure the stability of the supply of this agricultural product and countries that are unable to do so;

(4) Calculating indicators of the structure of the basic natural volume of consumption by the studied country of this type of agricultural product. Such a calculation involves determining the shares in the volume of consumption that falls, respectively, on the domestic production of this type of agricultural product; imports from countries for which there is a guarantee of stable supply and imports from countries for which such a guarantee does not exist;

(5) Evaluation of the stocks of this type of agricultural product available in the studied country; which can be used in the event of a decrease in its imports;

(6) Assessment of the possibilities of increasing the volume of their own production of this product and increasing imports from countries that are characterized by stable supplies of this type of agricultural product in order to compensate for possible shortages of it from other countries;

(7) Assessment of the possibilities of applying other adaptation methods to reduce the volume of import deliveries of this type of agricultural product to the studied country. In particular, one of these methods, as already mentioned above, is the replacement of a given type of agricultural product with another type (types);

(8) Determining a possible reduction in the volume of deliveries of this type of agricultural product from those countries for which there is no complete guarantee of the fulfillment of contracts for such deliveries.

At certain stages of the implementation of the sequence of actions described above, it is advisable to involve experts who specialize in issues of export–import operations with the relevant types of agricultural products.

Taking into account the described sequence of actions regarding the assessment of the sustainability of the consumption of agricultural products by a certain country, Formula (1) takes on the following more detailed form:

$$S_c = \frac{C \cdot \alpha}{C \cdot \beta} = \frac{\alpha}{\beta} = \frac{\gamma_1 \cdot \alpha_1 + \gamma_2 \cdot \alpha_2 + \alpha_3 + \alpha_4}{(1 - \gamma_1 - \gamma_2) \cdot \lambda} \tag{2}$$

where C is the forecasted or reported natural volume of consumption of a certain type of agricultural product by a country that partially or fully imports these products; α is the relative level of adaptation capabilities of this country to the reduction in food imports (α = A/C), unit share; β is the country's relative level of vulnerability to a reduction in food imports (β = V/C), unit share; γ_1 is the share of the basic volumes of consumption of this type of agricultural product, which is provided by its own production of the country under study, in the total volume of its consumption of these products, unit share; α_1 is the rate of increase in the volume of their own production of this type of agricultural product in order to adapt the studied country to the reduction in food imports, unit share; γ_2 is the share of the basic volumes of consumption of this type of agricultural product by the studied country, which is covered by imports from those countries that are able to ensure the stability of supplies of these products, in the total volume of consumption of these products, unit share; α_2 is the rate of increase in the volume of imports of this type of agricultural product from those countries that are able to ensure the stability of supplies of these products, in order to adapt the studied country to the reduction in food imports, unit share; α_3 is share of the volume of consumption C of a certain type of agricultural products, which can be covered thanks to the use of available stocks of a certain type of agricultural products in the studied country in order to adapt to the reduction in its imports, unit share; α_4 is share of the volume of consumption C of a certain type of agricultural product, which can be covered thanks to the use of substitution goods and of other methods of adaptation to the reduction in imports of these products, unit share; $(1 - \gamma_1 - \gamma_2)$ is the share of the consumption of this type of agricultural product by the studied country, which is covered by imports from those countries that are unable to ensure the stability of the supply of this product, in the total volume of consumption of this product, unit share; λ is the expected possible relative reduction in the volume of supplies of this type of agricultural product to the studied country from those countries that are unable to ensure the stability of supplies of these products, unit share.

It should be noted that the assessment of the ability of countries to counteract the reduction in the consumption of agricultural products requires taking into account the possible increase in prices for it after the implementation of adaptation measures. At the same time, such growth, in turn, can reduce food consumption. In particular, additional deliveries of agricultural products from some countries in order to replace interrupted

deliveries from other countries may be made at higher prices. These considerations must be taken into account when determining the values of the coefficients that appear in (2). For example, determining the value of the coefficient α_2 should involve the following sequence of actions: (1) calculating the forecast volumes of supplies of a certain type of food from those countries for which there is a guaranteed stable supply; (2) assessing the possibilities of increasing food supplies from these countries in case of supply disruptions from other countries; (3) determining a part of these opportunities, which will ultimately be implemented by taking into account the internal solvent demand of the given food importing country; (4) dividing the results of the calculations obtained at the previous stage by the amount of forecasted deliveries calculated at the first stage.

The described approach to assessing the sustainability of the consumption of the agricultural product by the importing countries may also be used in the retrospective analysis of the adaptation of the countries that are food importers to the reduction in the volume of its import supplies from some countries. The main idea of such an analysis is to establish to what extent a certain country, which is an importer of agricultural products, managed to compensate for undersupply of these products from some other countries. Then, the actual level of sustainability of a certain country to the reduction in import supplies of a certain type of agricultural products from its certain exporting countries can be estimated using the following formula:

$$L_a = \frac{\Delta A}{\Delta I} = \frac{\Delta A_1 + \Delta A_2 + \Delta A_3 + \Delta A_4}{\Delta I} \qquad (3)$$

where L_a is the actual level of sustainability of a certain country to the reduction in import supplies of a certain type of agricultural products from its certain exporting countries, unit share; ΔA is the total coverage of the amount of reduction in import supplies of this type of agricultural product to the studied country, natural units; ΔI is the amount of reduction in import supplies of a certain type of agricultural products to the studied country from individual countries is exporters of these products, natural units; ΔA_1, ΔA_2, ΔA_3, ΔA_4 are covering the amount of reduction in import supplies of this type of agricultural product to the studied country due to the corresponding increase in own production of this product, increase in its import from certain countries, use of available stocks of this product, and use of other adaptation mechanisms, natural units.

If the value of the indicator (1) is equal to one or exceeds it, this may mean that in the corresponding country, there are sufficiently effective mechanisms of adaptation to reduce import supplies of the corresponding type of agricultural products from its individual exporting countries. At the same time, it is necessary to consider the possibility of reducing the total amount of imports of certain agricultural products to some countries not due to the disruption of import supplies, but due to a decrease in demand for such types of products in these countries.

It should be noted that calculations of indicators (2) and (3) can be performed not only for each country but also for a group of countries that import a specific type of agricultural product.

When calculating the group value of the indicator (2), it is worth averaging the individual values of this indicator by importing countries, taking into account the share of consumption of certain agricultural products by each country in the total amount of consumption by all countries:

$$S_{cg} = \frac{\sum\limits_{i=1}^{n} c_i \cdot \alpha_i}{\sum\limits_{i=1}^{n} c_i \cdot \beta_i} \qquad (4)$$

where S_{cg} is the average sustainability level of the consumption of agricultural products by the group of importing countries, concerning a possible decrease in the volume of imports of these products, unit share; n is the number of countries in the group; c_i is the share of consumption of certain agricultural products by the i-th country in the total volume of consumption by the entire group of countries, unit share; α_i is the relative level of

adaptation capabilities of the i-th country to the reduction in imports of a certain type of agricultural products, unit share; β_i is the relative level of vulnerability of the i-th country to a reduction in the import of a certain type of agricultural products, unit share.

Similarly, it is possible to determine the average value of the indicator (3) for a group of countries. For this purpose, the following formula should be used:

$$L_{ag} = \frac{\sum\limits_{i=1}^{n} \Delta A_i}{\sum\limits_{i=1}^{n} \Delta I_i} = \frac{\sum\limits_{i=1}^{n} \Delta A_{1i} + \sum\limits_{i=1}^{n} \Delta A_{2i} + \sum\limits_{i=1}^{n} \Delta A_{3i} + \sum\limits_{i=1}^{n} \Delta A_{4i}}{\sum\limits_{i=1}^{n} \Delta I_i} = L_{ag1} + L_{ag2} + L_{ag3} + L_{ag4} \tag{5}$$

where L_{ag} is the actual sustainability level of a group of countries to the reduction in import supplies of a certain type of agricultural product from individual exporting countries, unit share; ΔA_{1i} is total coverage of the amount of reduction in import deliveries of this type of agricultural product to the i-th country, natural units; ΔI_i is the amount of reduction in import deliveries of a certain type of agricultural products to the i-th country from individual exporting countries, natural units; ΔA_{1i}, ΔA_{2i}, ΔA_{3i}, ΔA_{4i} are covering the amount of reduction in import supplies of this type of agricultural product to the i-th country due to the corresponding increase in own production of this product, increase in its import from certain countries, use of available stocks of this product and use of substitution goods and of other adaptation mechanisms, natural units; L_{ag1}, L_{ag2}, L_{ag3}, L_{ag4} are the actual sustainability of a group of countries to the reduction in import supplies of a certain type of agricultural products from certain exporting countries due to the corresponding increase in their own production of these products, an increase in their imports from certain countries, the use of available stocks of these products, and the use of substitution goods and of other adaptation mechanisms, unit share:

$$L_{ag1} = \frac{\sum\limits_{i=1}^{n} \Delta A_{i1}}{\sum\limits_{i=1}^{n} \Delta I_i} \tag{6}$$

$$L_{ag2} = \frac{\sum\limits_{i=1}^{n} \Delta A_{i2}}{\sum\limits_{i=1}^{n} \Delta I_i} \tag{7}$$

$$L_{ag3} = \frac{\sum\limits_{i=1}^{n} \Delta A_{i3}}{\sum\limits_{i=1}^{n} \Delta I_i} \tag{8}$$
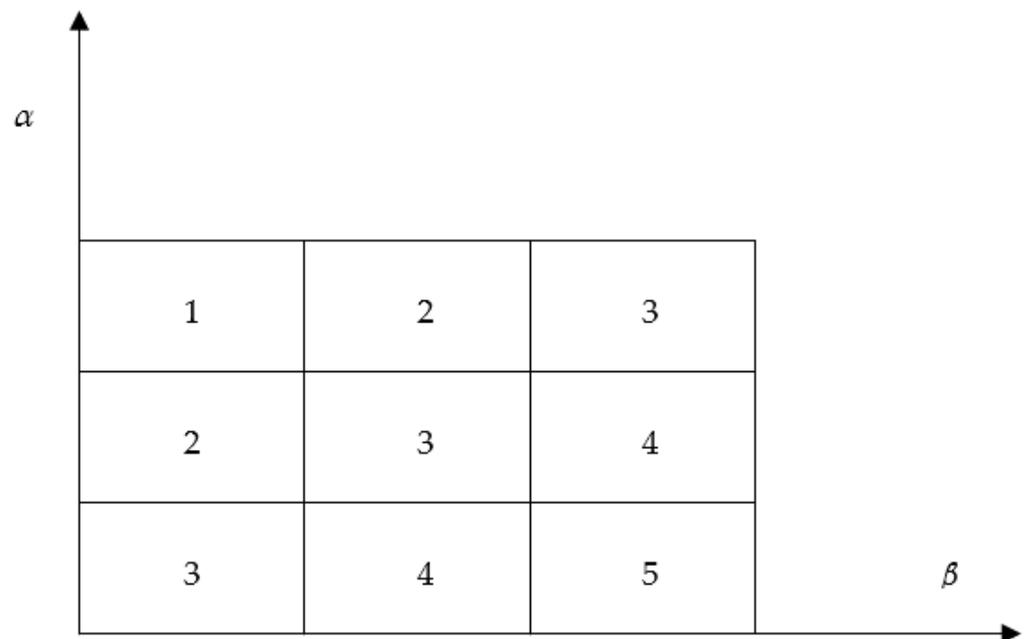
$$L_{ag4} = \frac{\sum\limits_{i=1}^{n} \Delta A_{i4}}{\sum\limits_{i=1}^{n} \Delta I_i} \tag{9}$$

Thus, the models (2) and (5) presented above make it possible to decompose the forecasted and actual levels of sustainability of the consumption of agricultural products to a possible reduction in its import.

3.3. Methodological Principles of Analyzing the Dynamics of the Level of Sustainability of the Consumption of Agricultural Products by the Totality of Its Importing Countriesr

As noted above, the sustainability of the consumption of agricultural products by countries that import them depends on two indicators, namely, relative adaptability and vulnerability to a reduction in import supplies. In turn, it is possible to graduate these levels by dividing the range of their values into equal intervals and assigning each country

that imports the corresponding type of food to certain intervals for each of the two named indicators. It is advisable to consider a two-dimensional matrix for a more visual presentation of the results of the described actions. In this matrix, the level of vulnerability will be plotted along the abscissa axis, and the level of adaptability of each of the studied countries to the reduction in imports of a specific type of food will be plotted along the ordinate axis. At the same time, the length of all intervals into which the abscissa and ordinate axes are divided should be the same. Then, for each country that imports certain agricultural products, it is possible to conduct a qualitative assessment of the level of resistance to reducing imports of these products. For example, the general view of the matrix with three gaps on each coordinate axis is presented in Figure 2. Accordingly, depending on which cell the levels of adaptation and vulnerability of a particular country fall into, there are five possible levels of its resistance to a reduction in the import of a given type of agricultural products.

Figure 2. An example of a matrix for qualitative assessment of the level of resistance of countries to the reduction in imports of a certain type of agricultural product, where the numbers of the cells characterize the level of the stated resistance: 1—very high; 2—high; 3—sufficient; 4—low; 5—very low.

In general, the matrix (Figure 2) can be used as a tool for visualization and analysis of the sustainability level of consumption of certain agricultural products by importing countries. In particular, the cells of this matrix may contain data on the number of countries that belong to their respective subgroup and on the share of their consumption of certain agricultural products in the total amount of such consumption by all the studied countries. In addition, having formed a series of matrices for several consecutive periods, it is possible to see the changes that have occurred with those indicators, the data of which are entered in these matrices. Therefore, the matrix of qualitative assessment of the resistance level of countries to the reduction in imports of a certain type of agricultural product can be applied to analyze the dynamics of the sustainability level of consumption of agricultural products by importing countries. For a generalized evaluation of such dynamics, it is worth using, first of all, the following two indicators:

$$I_s = \frac{S_{cg1}}{S_{cg0}} \tag{10}$$

$$I_c = \frac{C_{g1}}{C_{g0}} \tag{11}$$

where I_s is the index of the average sustainability level of the consumption of agricultural products by the group of importing countries, concerning a possible decrease in the volume of imports of these products; S_{cg1}, S_{cg0} are the average sustainability level of the consumption of agricultural products by the group of importing countries, concerning the possible decrease in the volume of imports of these products, respectively, in the reporting and base years, unit share; I_c is index of consumption of a certain type of agricultural products by a group of importing countries; $Cg1$, $Cg2$ are natural volume of consumption of a certain type of agricultural products by a group of importing countries, respectively, in the reporting and base years.

Using indicators (10) and (11), it is possible to simulate the conditions for ensuring sustainable growth in the consumption of a certain agricultural product by a group of importing countries. At the same time, as already noted above, this sustainability is evaluated in this study concerning a possible decrease in the volume of imports of products. Then, for there to be a steady increase in the consumption of a certain type of agricultural products by a group of importing countries, it is necessary to fulfill the following two inequalities:

$$\frac{S_{cg1}}{S_{cg0}} > 1 \tag{12}$$

$$\frac{C_{g1}}{C_{g0}} > 1 \tag{13}$$

It should be noted that taking into account Formula (2), inequality (12) can be presented in this form:

$$\frac{\gamma_{11} \cdot \alpha_{11} + \gamma_{21} \cdot \alpha_{21} + \alpha_{31} + \alpha_{41}}{(1 - \gamma_{11} - \gamma_{21}) \cdot \lambda_1} > \frac{\gamma_{10} \cdot \alpha_{10} + \gamma_{20} \cdot \alpha_{20} + \alpha_{30} + \alpha_{40}}{(1 - \gamma_{10} - \gamma_{20}) \cdot \lambda_0} \tag{14}$$

where the indicators on the left side of the inequality correspond to the indicators in Formula (2), but at the same time refer to the entire population of the studied countries and characterize the data for the reporting year and are, therefore, marked with the additional index "1", and the indicators on the right side of inequality (14) correspond to the indicators in the Formula (2), but at the same time refer to the entire population of the studied countries and characterize the data for the base year and are, therefore, marked with the additional index "0".

To specify the conditions under which there is a steady increase in the consumption of a certain type of agricultural products by a group of importing countries, it is worth considering two more indices, namely:

$$I_{c1} = \frac{C_{g11}}{C_{g10}} \tag{15}$$

$$I_{c2} = \frac{C_{g21}}{C_{g20}} \tag{16}$$

where I_{c1} is the index of consumption volumes of a given type of agricultural product provided by its production by the group of studied countries; C_{g11}, C_{g10} are the natural volume of consumption of this type of agricultural product, which is provided by its own production, by the group of studied countries, respectively, in the reporting and base years; I_{c2} is the index of the consumption of this type of agricultural product by the group of studied countries, which is covered by imports from those countries that can ensure the stability of the supply of these products; C_{g21}, C_{g20} are the natural volume of consumption of this type of agricultural product by the group of studied countries, which is covered by imports from those countries that can ensure the stability of supplies of these products, respectively, in the reporting and base years.

Then inequality (14) can be expressed as follows:

$$\frac{C_{g10} \cdot I_{c1} \cdot \alpha_{11} + C_{g20} \cdot I_{c2} \cdot \alpha_{21} + C_{g31}}{\left(C_{g0} \cdot I_c - C_{g10} \cdot I_{c1} - C_{g20} \cdot I_{c2}\right) \cdot \lambda_1} > \frac{C_{g10} \cdot \alpha_{10} + C_{g20} \cdot \alpha_{20} + C_{g30}}{\left(C_{g0} - C_{g10} - C_{g20}\right) \cdot \lambda_0} \tag{17}$$

The use of inequality (17) makes it possible to establish the following relationships between the values of the indices I_{c1} and I_{c2}, which will ensure a steady growth in the consumption of a certain type of agricultural products by a group of importing countries. At the same time, as follows from (17), in case of transformation of this inequality into equality, the dependence between these two indices will have a linear character. In addition, using inequality (17), it is possible to formalize and specify the conditions for ensuring sustainable growth in the consumption of certain agricultural products by a group of importing countries. These conditions will be reflected in the implementation of such a chain of inequalities:

$$\frac{\left(C_{g10} \cdot I_{c1} \cdot \alpha_{11} + C_{g20} \cdot I_{c2} \cdot \alpha_{21} + C_{g31}\right) \cdot \left(C_{n0} - C_{n10} - C_{n20}\right) \cdot \lambda_0}{\left(C_{g10} + C_{g20} \cdot \alpha_{20} + C_{g30}\right) \cdot C_{g0} \cdot \lambda_1} + \frac{C_{g10} \cdot I_{c1} + C_{g20} \cdot I_{c2}}{C_{g0}} > I_c > 1 \tag{18}$$

In addition, in order to analyze the dynamics of the level of resistance of the importing countries to a possible reduction in the import supplies of a certain type of agricultural products, it is possible to introduce three more such indices into consideration:

$$I_a = \frac{C_{g10} \cdot I_{c1} \cdot \alpha_{11} + C_{g20} \cdot I_{c2} \cdot \alpha_{21} + C_{g31}}{C_{g10} \cdot \alpha_{10} + C_{g20} \cdot \alpha_{20} + C_{g30}} \tag{19}$$

$$I_{sc} = \frac{C_{g10} \cdot I_{c1} + C_{g20} \cdot I_{c2}}{C_{g10} + C_{g20}} \tag{20}$$

$$I_\lambda = \frac{\lambda_1}{\lambda_0} \tag{21}$$

where I_a is index of changes in the adaptation capabilities of importing countries to a possible reduction in import supplies of a certain type of agricultural products in the reporting year compared to the base year; I_{sc} is index of changes in the stable part of the consumption of a certain type of agricultural products by the importing countries in the reporting year compared to the base; I_λ is the index of changes in the possible relative reduction in the volume of supplies of this type of agricultural product to the importing countries from those countries that are unable to ensure the stability of supplies of these products, in the reporting year compared to the base.

By substituting Formulas (19)–(21) into the chain of inequalities (18), it is possible to transform it into the following:

$$\frac{I_a \cdot \left(C_{n0} - C_{n10} - C_{n20}\right)}{I_\lambda \cdot C_{g0}} + \frac{I_{sc} \cdot \left(C_{g10} + C_{g20}\right)}{C_{g0}} > I_c > 1 \tag{22}$$

The chain of inequalities (22) may also be presented in this form:

$$\frac{I_a \cdot (1 - \varepsilon)}{I_\lambda} + I_{sc} \cdot \varepsilon > I_c > 1 \tag{23}$$

where ε is the share of the stable part of the consumption of a certain agricultural product by the importing countries, in the total consumption volume in the base year, unit shares.

It was already suggested above that the share of the agricultural products consumption, which is covered by imports from those countries that are unable to ensure the stability of the supply of these products, may have an impact on the level of resistance to a reduction in its imports. In turn, this level increases in the case of steady growth in the consumption

of certain agricultural products by the group of importing countries. Therefore, there are certain reasons for formulating such a hypothesis:

Hypothesis 4. *The indicator of the share of those volumes of agricultural product consumption that are covered by imports from those countries that are unable to ensure the stability of supplies of these products has a statistically significant effect on the calculated by Formula (10) level of sustainable growth in the consumption of a certain type of agricultural product. At the same time, with an increase in the specified share, the level of steady growth in the consumption of a certain type of agricultural product by the group of importing countries decreases.*

Verification of the validity of this assumption, like all other assumptions formulated in this section, requires forming a group of countries that import certain agricultural products.
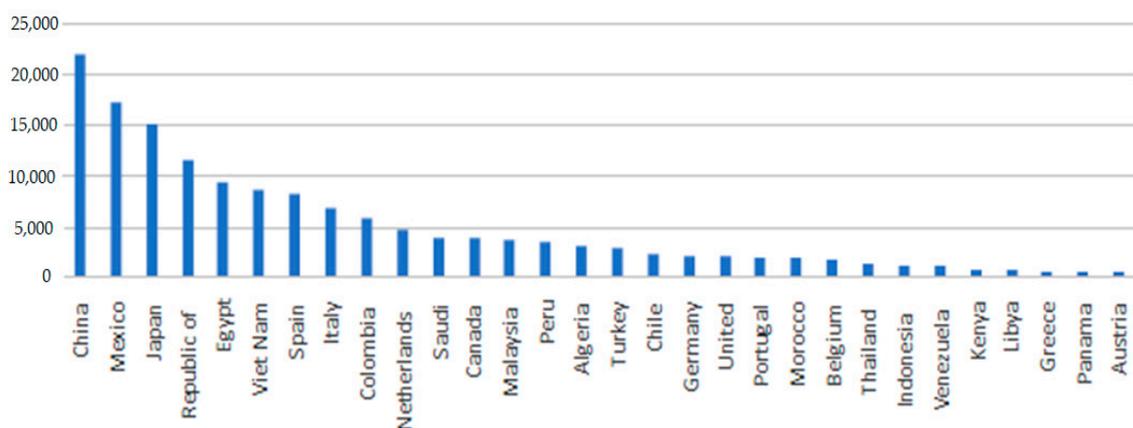
4. Results of Empirical Analysis and Their Discussion

4.1. General Characteristics of the Studied Countries

Assessing the consumption sustainability of agricultural products by the importing countries requires, first of all, the selection of the types of products to be considered and the creation of a group of the studied countries. In this study, the empirical analysis will be based on two agricultural products: corn and wheat. Significant global volumes of their imports characterize these two types of products.
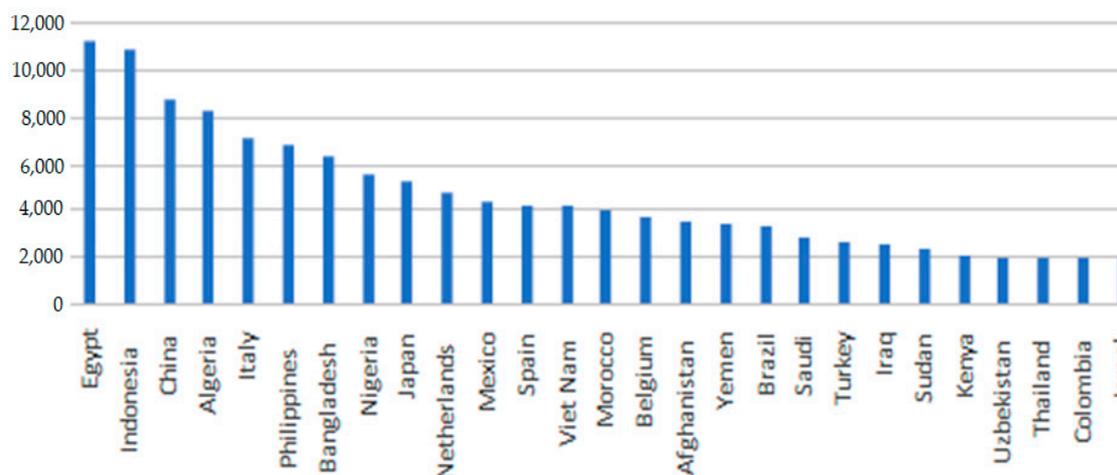
The group size of the studied countries is 30 countries for each of the two types of agricultural products. These groups were formed from the countries with the largest volumes of net imports of the two relevant types of agricultural products in 2021 (Figure 3). At the same time, the sources of the necessary information were [68,69]. As it follows from the data presented in Table 1, the selected countries represent most of the continents, that is, the diversity of the geographical location of the studied countries characterizes the created groups.

In addition, as evidenced by the data in Tables 2 and 3, the studied countries are characterized by significant differences in the indicators values of the imports share in the structure of consumption of the corresponding types of agricultural products and the dynamics of the volumes of such consumption.

(**a**)

Figure 3. *Cont.*

(b)

Figure 3. Volumes of net imports by country in 2021 in descending order of these volumes, in thousand tons: (**a**) corn; (**b**) wheat.

Table 1. Distribution of the studied importing countries of agricultural products by region.

Regions	Corn-Importing Countries		Wheat-Importing Countries	
	Number	List	Number	List
North America	3	Canada, Mexico, Panama	1	Mexico
South America	4	Chile, Colombia, Peru, Venezuela	3	Brazil, Colombia, Peru
Europe	10	Austria, Belgium, Germany, Greece, Italy, Netherlands, Portugal, Spain, Turkey, United Kingdom	6	Belgium, Italy, Netherlands, Spain, Turkey, United Kingdom
Africa	5	Algeria, Egypt, Kenya, Libya, Morocco	6	Algeria, Egypt, Kenya, Morocco, Nigeria, Sudan
Asia	8	China, Indonesia, Japan, Republic of Korea, Malaysia, Saudi Arabia, Thailand, Vietnam	14	Afghanistan, Bangladesh, China, Indonesia, Iraq, Israel, Japan, Malaysia, Philippines, Saudi Arabia, Thailand, Uzbekistan, Vietnam, Yemen
Total	3	Canada, Mexico, Panama	1	Mexico

Table 2. Distribution of the studied importing countries of agricultural products by the imports share in the consumption structure of the corresponding types of these products for 2021.

Types of Agricultural Products	The Number of Studied Importing Countries in Which in 2021 the Imports Share of Relevant Types of Agricultural Products in the Total Volume of Their Consumption Was			
	Less than 20%	From 20% to 40%	From 40% to 60%	More than 60%
Corn	11	12	5	2
Wheat	10	14	4	2

Table 3. Distribution of the studied importing countries of agricultural products according to the dynamics of consumption volumes of the corresponding types of these products in 2021 compared to 2020.

Types of Agricultural Products	The Number of Studied Importing Countries in Which in 2021 the Index of Natural Volumes of Consumption of the Relevant Types of Agricultural Products Compared to 2020 Was			
	Less than 1	From 1 to 1.1	From 1.1 to 1.2	More than 1.2
Corn	8	17	3	2
Wheat	6	20	3	1

From the data in Table 2, it follows that for both corn and wheat in the vast majority of the studied countries, the share of imports of these agricultural crops in the structure of their consumption varied from 20% to 60% in 2021. At the same time, the dynamics of the consumption of both types of products in the vast majority of the studied countries in 2021 compared to 2020 were either negative or characterized by a slight increase in such consumption (Table 3).

4.2. Analysis of the Sustainability of Corn and Wheat Consumption by Importing Countries in Relation to a Possible Decrease in Import Supplies

As mentioned in Section 3, the importing countries' sustainability of agricultural product consumption depends on two main factors. These factors are the relative level of adaptation capabilities of countries to the import reduction in the corresponding type of product and the relative level of vulnerability of countries to such a reduction. In turn, both of these relative levels depend on, among other things, the share of the consumption of agricultural products, which are provided by imports from countries with unstable (non-guaranteed) supplies of these products. Taking this into account, we surveyed twelve experts knowledgeable on the import of relevant types of agricultural products. Such a survey was conducted thrice during 2020–2022 (at the end of the corresponding calendar year). Each of the experts for each of the thirty studied countries had to provide the following information for both types of agricultural products:

1. The value of the consumption share of agricultural products provided by imports from countries with unstable (non-guaranteed) supplies of these products.
2. The class to which the importing country belongs according to the relative level of adaptation capabilities to reduce imports of the corresponding product type. At the same time, four such classes were distinguished in advance: countries with a low level of these capabilities (the value of the relative level of adaptation capabilities does not exceed 0.2); countries with an average level of these capabilities (the value of the relative level of adaptation capabilities ranges from 0.2 to 0.4); countries with a high level of these capabilities (the value of the relative level of adaptation capabilities ranges from 0.4 to 0.6); countries with a very high level of adaptive capacity (the value of the relative level of adaptive capacity exceeds 0.6).
3. The class to which the importing country belongs according to the relative level of vulnerability to the reduction in imports of the corresponding type of product. At the same time, four such classes were distinguished in advance: countries with a low level of vulnerability (the value of the relative level of vulnerability does not exceed 0.2); countries with an average level of vulnerability (the value of the relative level of vulnerability is in the range from 0.2 to 0.4); countries with a high level of vulnerability (the value of the relative level of vulnerability is in the range from 0.4 to 0.6); countries with a very high level of vulnerability (the value of the relative level of vulnerability exceeds 0.6).

The information from the experts made it possible to build matrices to identify the level of resistance of the studied countries to the reduction in imports of certain agricultural products. In particular, the numerical values of the elements of these matrices as of

1 January 2022, and 1 January 2023, are presented in Tables 4 and 5, respectively. At the same time, each country was assigned to the appropriate class according to the opinion of the majority of the interviewed experts. The majority of countries for both types of agricultural products belong to the classes with low and medium levels of adaptation capabilities and to the classes with medium and high levels vulnerability to a reduction in import supplies (Tables 4 and 5). Regarding the classes with very high values of the levels of adaptation capabilities and vulnerability, according to the expert survey, none of the countries belongs to these classes. At the same time, comparing the data presented in Table 5 with the data in Table 4 allows us to conclude that there is a negative trend in the evaluated characteristics.

Table 4. Distribution of the investigated importing countries of agricultural products according to the relative level of adaptation possibilities to the reduction in the import of the corresponding type of this product and according to the relative level of vulnerability to such a reduction as of 1 January 2022.

Gradation of the Relative Level of Adaptation Capabilities of Countries to the Reduction in Product Imports	The Number of Importing Enterprises of Corn, in Which, as of 1 January 2022, the Relative Level of Vulnerability to a Reduction in the Import of This Product, According to the Interviewed Experts, Was			The Number of Importing Enterprises of Wheat, in Which, as of 1 January 2022, the Relative Level of Vulnerability to a Reduction in the Import of This Product, According to the Interviewed Experts, Was		
	Low	Average	High	Low	Average	High
High	4	1	2	5	2	1
Average	2	2	6	3	1	7
Low	1	5	7	1	4	6

Table 5. Distribution of the investigated importing countries of agricultural products according to the relative level of adaptation possibilities to the reduction in the import of the corresponding type of this product and according to the relative level of vulnerability to such a reduction as of 1 January 2023.

Gradation of the Relative Level of Adaptation Capabilities of Countries to the Reduction in Product Imports	The Number of Importing Enterprises of Corn, in Which, as of 1 January 2023, the Relative Level of Vulnerability to a Reduction in the Import of This Product, According to the Interviewed Experts, Was			The Number of Importing Enterprises, in Which, as of 1 January 2023, the Relative Level of Vulnerability to a Reduction in the Import of This Product, According to the Interviewed Experts, Was		
	Low	Average	High	Low	Average	High
High	2	0	1	3	2	1
Average	1	2	6	2	1	8
Low	1	8	9	0	6	7

Special attention was paid to achieving the proper consistency when processing the expert survey results. For this purpose, we used two indicators (Table 6), namely:

(1) The maximum percentage of those experts who disagreed with the opinion of the largest number of experts by the studied countries;

(2) The maximum coefficient of variation according to the average linear deviation of expert assessments by the studied countries. The use of this indicator seems justified since its value cannot exceed 2 with non-negative values of the survey results. Therefore, it makes it possible to establish more clearly how high the inconsistency of experts' opinions is. At the same time, to calculate the coefficient of variation based on the average linear deviation, as well as in subsequent calculations, the numerical values of the levels of adaptation capabilities and vulnerability were determined as the average arithmetic values of the lower and upper limits of the intervals of the corresponding classes.

Table 6. The results of the assessment of the consistency of the opinions of the interviewed experts.

Survey Questions	The Maximum Percentage of Those Experts Who Did Not Agree with the Opinion of the Largest Number of Experts by the Studied Countries, % by Types of Products		The Maximum Value of the Coefficient of Variation According to the Average Linear Deviation of Expert Evaluations by the Studied Countries, the Unit Share by Types of Products	
	Corn	**Wheat**	**Corn**	**Wheat**
1. Assigning each country to a certain class based on the relative level of adaptation capabilities of countries to reduce imports of the corresponding type of product:				
1.1. As of 1 January 2021	16.67	8.33	0.27	0.14
1.2. As of 1 January 2022	25.00	8.33	0.38	0.11
1.3. As of 1 January 2023	8.33	16.67	0.17	0.28
2. Assigning each country to a certain class according to the relative level of vulnerability of countries to a reduction in imports of the corresponding type of product:				
2.1. As of 1 January 2021	25.00	16.67	0.39	0.26
2.2. As of 1 January 2022	16.67	25.00	0.24	0.36
2.3. As of 1 January 2023	8.33	8.33	0.15	0.13

As can be seen from the data presented in Table 6, the level of consistency of experts' opinions is high for both types of agricultural products and for all moments. This conclusion follows from the fact that the maximum values of the percentages of those experts who disagreed with the opinion of the largest number of experts do not exceed 25%, and the maximum values of the coefficient of variation according to the average linear deviation of expert assessments are not greater than 0.4.

Using matrices to identify the resistance level of countries to the reduction in imports of certain agricultural products (Figure 2), it is possible to divide countries into five classes of the specified level. Each class corresponds to a certain matrix diagonal. The results of the distribution of the studied countries by classes of their resistance to the reduction in corn and wheat imports and other indicators of such resistance are presented in Table 7.

Table 7. Indicators of the sustainability of the consumption of agricultural products in the studied importing countries, before a possible reduction in such imports.

Indicator Names	Values of Indicators by Countries That Import Corn, as of the Beginning of the Corresponding Year			Values of Indicators by Countries That Import Wheat, as of the Beginning of the Corresponding Year		
	2021	**2022**	**2023**	**2021**	**2022**	**2023**
1. The number of countries in which the level of sustainability of consumption of a certain type of agricultural products to a possible reduction in its imports is as follows:						
1.1. Very high	3	4	2	6	5	3
1.2. High	5	3	1	5	5	4

Table 7. *Cont.*

Indicator Names	Values of Indicators by Countries That Import Corn, as of the Beginning of the Corresponding Year			Values of Indicators by Countries That Import Wheat, as of the Beginning of the Corresponding Year		
	2021	2022	2023	2021	2022	2023
1.3. Sufficient	3	5	4	4	3	2
1.4. Low	11	11	14	10	11	14
1.5. Very	8	7	9	5	6	7
2. The share in the total number of studied countries of those in which the level of sustainability of the consumption of a certain type of agricultural product to a possible reduction in its import is as follows:						
2.1. Very high	0.100	0.133	0.067	0.200	0.167	0.100
2.2. High	0.167	0.100	0.033	0.167	0.167	0.133
2.3. Sufficient	0.100	0.167	0.133	0.133	0.100	0.067
2.4. Low	0.367	0.367	0.467	0.333	0.367	0.467
2.5. Very low	0.267	0.233	0.300	0.167	0.200	0.233
3. The average level of consumption sustainability of agricultural products by the group of importing countries, in relation to a possible decrease in the volume of imports of these products, unit share	0.584	0.591	0.457	0.632	0.638	0.491

As follows from the data given in the Table 7, as of 1 January 2023, the level of resistance of the studied countries to a reduction in corn and wheat imports has significantly decreased compared to the previous two years. In particular, the average level of consumption sustainability of agricultural products by the group of countries calculated according to Formula (4) decreased for corn by 0.127 and 0.134, and for wheat it decreased by 0.141 and 0.147. In response to an additional question about the causes of this phenomenon, all experts named the large-scale military operations that began on the territory of Ukraine in February 2022 as the main reason. At the same time, as of 1 January 2023, for both corn and wheat, the level of sustainability of consumption according to the data in Table 7 was less than 0.5; that is, it was not high enough.

It should be noted that, in addition to determining the forecast level of adaptation capabilities of countries to a possible reduction in imported food supplies, it is also possible to estimate the actual value of this level using Formulas (5)–(9). Individual results of such an assessment by the studied countries are presented in Table 8.

As follows from the data presented in Table 8, the countries' average actual adaptation level to the reduction in import supplies of corn and wheat in both 2020 and 2021 was moderate (about 0.65). At the same time, the main way for countries to adapt to the reduction in import supplies was to increase imports from other countries. Therefore, a positive trend towards a certain increase in the average adaptation level capabilities of the studied countries to the reduction in imported supplies of corn and wheat in 2021 compared to the previous year is worth noting.

As already assumed above, an increase in the relative vulnerability level of countries to a reduction in imported food supplies can be negatively correlated with an increase in the relative adaptation level of countries to such a reduction. It was also hypothesized that with an increase in the share of those consumption volumes of agricultural products that are covered by imports from countries that are unable to ensure the stability (guarantee) of

supplies of these products, the level of resistance of importing countries to a reduction in imports of these products decreases. To test these two hypotheses, an array of data was generated (Tables 9 and 10).

Table 8. Indicators of sustainability of countries to the reduction in import supplies of agricultural products from certain exporting countries.

Indicator Names	The Value of Indicators by Countries That Import Corn, by Years			The Value of Indicators by Countries That Import Wheat, by Years		
	2020	**2021**	Change, %	**2020**	**2021**	Change, %
1. The actual average sustainability level of countries to the reduction in import supplies, unit share	0.645	0.672	0.027	0.663	0.681	0.018
2. The actual average sustainability level of countries to the reduction in import supplies due to the increase in their own production of these products, unit share	0.194	0.213	0.019	0.245	0.272	0.027
3. The actual average sustainability level of countries to the reduction in import supplies due to the increase in its imports from some other countries, unit share	0.415	0.423	0.008	0.38	0.367	−0.013

Table 9. Indicators for assessing the relationship between the relative adaptability level of importing countries to a reduction in agricultural product imports and the relative vulnerability level of these countries to such a reduction.

Indicator Names	Values of Indicators by Countries That Import Corn, as of the Beginning of the Corresponding Year			The Value of Indicators by Countries That Import Wheat, as of the Beginning of the Corresponding Year		
	2021	**2022**	**2023**	**2021**	**2022**	**2023**
1. The number of countries in which the level of vulnerability of the consumption of certain types of agricultural products to the reduction in their imports is as follows:						
1.1. Low	6	7	4	9	9	5
1.2. Average	10	8	10	9	7	9
1.3. High	14	15	16	12	14	16
2. The average value of the adaptability level to a reduction in the agricultural products import in those countries in which the vulnerability level to such a reduction is:						
2.1. Low	0.468	0.543	0.490	0.556	0.439	0.507
2.2. Average	0.257	0.321	0.344	0.269	0.292	0.354
2.3. High	0.109	0.135	0.097	0.147	0.169	0.106
3. The actual value of the F-criterion	5.24	6.03	5.56	5.32	5.73	6.22

Table 10. Indicators for assessing the relationship between the share of agricultural product consumption that is provided by imports from countries with unstable (non-guaranteed) supplies of these products, and the resistance level of importing countries to reducing their imports.

Indicator Names	Values of Indicators by Countries That Import Corn, as of the Beginning of the Corresponding Year			The Value of Indicators by Countries That Import Wheat, as of the Beginning of the Corresponding Year		
	2021	2022	2023	2021	2022	2023
1. The number of countries in which the share of those volumes of consumption of agricultural products that are provided by imports from countries with unstable (non-guaranteed) supplies of these products is as follows:						
1.1. Low (up to 20%)	7	6	4	8	8	5
1.2. Average (from 20% to 40%)	11	10	11	11	9	10
1.3. High (more than 40%)	12	14	15	11	13	15
2. The average value of the resistance level to a possible reduction in the agricultural products import in those countries in which the share of the consumption of agricultural products is provided by imports from countries with unstable (non-guaranteed) supplies of these products is:						
2.1. Low (up to 20%)	0.972	0.994	0.963	0.964	0.997	0.978
2.2. Average (from 20% to 40%)	0.646	0.703	0.687	0.726	0.699	0.671
2.3. High (more than 40%)	0.198	0.176	0.161	0.234	0.241	0.237
3. The actual value of the F-criterion	6.13	6.56	5.94	5.76	6.09	5.54

As follows from the data presented in Tables 9 and 10, hypotheses 1 and 2 are valid for both types of agricultural products and for all time points under consideration for the totality of the studied countries. This follows from the results of the variance analysis. These results indicate that the studied dependencies are statistically significant since the actual values of the F-criterion exceed its critical values with a significance level of $\alpha = 0.05$. In addition, the hypothesis about the low resistance level to the reduction in imported food supplies of those countries with a high consumption share of agricultural products supplied by imports from countries with unstable (non-guaranteed) supplies of these products was tested. The data presented in Table 11 should be used to perform such a check.

Table 11. Indicators of the sustainability level of importing countries depending on the share of those consumption volumes of agricultural products that are provided by imports from countries with unstable (non-guaranteed) supplies of these products.

The Level of the Share of Those Consumption Volumes of Agricultural Products That Are Provided by Imports from Countries with Unstable (Non-Guaranteed) Supplies of These Products	The Number of Countries in Which the Value of the Sustainability of the Consumption of Agricultural Products to a Possible Reduction in Its Import Is at Least One					
	By Countries That Import Corn, as of the Beginning of the Corresponding Year			By Countries that Import Wheat, as of the Beginning of the Corresponding Year		
	2021	2022	2023	2021	2022	2023
Low (up to 20%)	6	5	3	7	6	4
Average (from 20% to 40%)	5	7	5	8	7	5
High (more than 40%)	0	0	0	0	0	0

As can be seen from the data presented in Table 11, hypothesis 3 is valid for both types of agricultural products and for all time points considered. This follows from the fact that for all countries with a high share of the agricultural products consumption, which are provided by imports from countries with unstable (unguaranteed) supplies, the resistance level to a reduction in imported food supplies is less than one.

4.3. Assessment of the Sustainable Growth Level in the Agricultural Products Consumption by the Group of Importing Countries

To estimate the average level of sustainable growth in the consumption of corn and wheat by the group of studied countries, the index of consumption sustainability of certain agricultural products before a possible reduction in their import supplies was used. The results of calculations of the specified index, performed according to Formula (10), are presented in Table 12. At the same time, the previous years were chosen as the base years.

Table 12. Indicators of the sustainable growth level in the consumption of a certain type of agricultural products in the studied importing countries.

Indicator Names	The Indicators Value by Countries That Import Corn, as of the End of the Year			The Indicators Value by Countries That Import Wheat, as of the End of the Year		
	2021	2022	Change	2021	2022	Change
1. The average sustainable growth level in the consumption of a certain type of agricultural products for all studied importing countries	1.012	0.773	−0.239	1.009	0.770	−0.239
2. The average sustainable growth level in the consumption of a certain type of agricultural products by groups of studied importing countries:						
2.1. For countries in which the share of those consumption volumes of agricultural products, which are provided by imports from countries with unstable (unguaranteed) supplies of these products, is low	1.023	0.969	−0.054	1.019	0.983	−0.036
2.2. For countries in which the share of those consumption volumes of agricultural products, which are provided by imports from countries with unstable (unguaranteed) supplies of these products, is average	1.088	0.977	−0.111	1.054	0.897	−0.157
2.3. For countries in which the share of those consumption volumes of agricultural products, which are provided by imports from countries with unstable (unguaranteed) supplies of these products, is high	0.889	0.915	0.026	0.877	0.921	0.044

As can be seen from the data presented in Table 12, the value of the average level of sustainable consumption growth for both corn and wheat in 2021 exceeded one, which is positive. However, let us consider the second condition for sustainable food consumption growth: an increase in the physical volumes of such consumption. An additional study showed that for countries that consumed approximately 23% of corn and 27% of wheat in 2021, this condition is not fulfilled. However, for all other countries, when considered separately, the value of the average sustainable growth level in consumption for both corn and wheat in 2021 also exceeded one.

Regarding the year 2022, data on the corn and wheat consumption volumes for all the studied countries were still missing at the time of the empirical analysis. However, we can state that the sustainability index of the consumption of both types of agricultural products concerning a possible reduction in import supplies decreased in 2022. At the same time, its value is less than one, which indicates the negative dynamics of the level of consumption sustainability of both types of food in the studied countries. Moreover, the data presented in Table 12 indicate that with an increase in the consumption share covered by food imports from countries with an unstable supply, the level of sustainable growth in consumption of both agricultural products by the group of studied countries does not always decrease. Therefore, hypothesis 4, which was formulated in Section 3.3, was not confirmed by empirical data.

5. Conclusions

5.1. Theoretical Results

The conducted research showed the possibility of a quantitative assessment of the sustainability of agricultural product consumption in the importing countries concerning a possible reduction in the import volume of these products. For this purpose, it is proposed to calculate the ratio value between the two indicators. The first such indicator is the number of adaptation capabilities of countries to reduce food imports from some other countries, which is measured in natural or value units of consumption of the corresponding type (types) of agricultural products. The second indicator is the vulnerability level of countries to a reduction in food imports from some other countries, which is measured in the same units as the level of adaptation capabilities.

At the same time, there is a possibility of decomposing the level of consumption sustainability of agricultural products in the importing countries, concerning a possible reduction in the volume of imports of these products. The construction of the corresponding model showed the existence of a certain hierarchy of factors of the formation of the specified stability.

The proposed approach to assessing the sustainability of agricultural product consumption by the importing countries may be used in the retrospective analysis of the actual adaptation level of the food importers to the reduction in the volume of import supplies from some countries. The main idea of such an analysis is to establish to what extent and at the expense of which actions a certain country, which is an importer of agricultural products, managed to compensate for the short supply of these products from other countries. An important tool for visualizing and analyzing the level of consumption sustainability of certain agricultural products by importing countries may also be the method of building a matrix of identification of the sustainability level proposed in this paper. Regarding the assessment of its dynamics, it is worth using the proposed concept of sustainable consumption growth of certain agricultural products by the group of importing countries. In particular, this approach formalized the conditions for such growth.

Thus, three main theoretical results were obtained in this study. First, an indicator for assessing the sustainability of agricultural product consumption in the event of a possible reduction in its import is proposed. The calculation of this indicator involves comparing the levels of adaptability and vulnerability of the economies of the respective countries to such a reduction. Secondly, a model of the decomposition of the level of sustainability of the agricultural products consumption to a possible reduction in its import was built. This model makes it possible to establish the degree of influence of individual factors on the level of the specified stability. At the same time, among the factors of influence, special attention is paid to the ability of food importing countries to adapt to the cessation or reduction in the volumes of individual import deliveries of agricultural products. Thirdly, the conditions were established, and the main factors for ensuring the sustainable growth of the consumption of agricultural products in the importing countries were determined.

5.2. Empirical Results

In this study, two groups were formed. Each contained thirty countries that imported corn and wheat, respectively. Using the results of an expert survey, several empirical regularities were established. In particular, it was established that an increase in the relative vulnerability level of countries to a reduction in imported food supplies is negatively correlated with an increase in the relative adaptation level of countries to such a reduction. Furthermore, it also confirmed the validity of the hypothesis that with an increase in the share of those volumes of the consumption of agricultural products that are covered by imports from countries that are unable to ensure the stability (guarantee) of supplies of these products, the resistance level of importing countries to a reduction in imports of these products decreases.

Moreover, the hypothesis of a low resistance level to a reduction in imported food supplies of those countries with a high share of the agricultural products' consumption provided by imports from countries with unstable (non-guaranteed) supplies of these products was confirmed.

It was established that the sustainability index of the consumption of both agricultural products before a possible reduction in import supplies decreased in 2022. At the same time, its value turned out to be less than one, which indicates the negative dynamics of the average level of consumption sustainability of both types of food in the studied countries.

It was also found that as of 1 January 2023, the resistance level of the studied countries to a reduction in corn and wheat imports has significantly decreased compared to the previous two years. In particular, the average sustainability level of agricultural product consumption by the group of countries decreased by 0.127 and 0.134 for corn, and by 0.141 and 0.147 for wheat, respectively. In response to an additional question about the causes of this phenomenon, all experts named the large-scale military operations that began on the territory of Ukraine in February 2022 as the main reason. At the same time, as of 1 January 2023, for both corn and wheat, the level of sustainability of consumption was less than 0.5, that is, it was not high enough.

Thus, the empirical results obtained in this study show the need to increase the level of the sustainability consumption of corn and wheat by countries that import them, to a possible reduction in its import. At the same time, the obtained empirical results make it possible to establish the possibilities of ensuring sustainable growth in the consumption of agricultural products in the importing countries. In particular, it was established that the insufficient level of sustainability of the consumption of agricultural products is, to a greater extent, due to the irrational structure of food imports in terms of countries and its exporters. At the same time, the adaptive capacity of countries that import agricultural products has less of an impact on the resilience of these countries in the event of a possible reduction in food imports.

5.3. Recommendations for Management Practice

As our research has shown, there are many ways to increase the sustainability level of food-importing countries in the event of a possible reduction in such imports. These directions can be divided into internal ones, which are directly determined by the internal conditions of the activity of each importing country, and external ones, which are determined by factors external to the importing countries. The sustainability level of countries that are importers of agricultural products largely depends on the share of those consumption volumes of agricultural products covered by imports from countries that cannot ensure the stability (guarantee) of supplies of these products. Reducing such a share may be achieved, in particular, by improving the internal conditions of each importing country and increasing the volume of own production of the relevant types of agricultural products. In addition, an important way to reduce the consumption share of agricultural products provided by imports from countries with unstable (unguaranteed) supplies of these products is to improve the overall structure of imports in terms of exporting countries. At the same time, it is necessary to keep in mind that increasing the sustainability level of

food-importing countries in the event of a possible reduction in such imports may also be achieved due to the improvement of the operating conditions of food-exporting countries. Therefore, the end of military operations in Ukraine, which is one of the most powerful food-exporting countries, and the provision of conditions for the rapid post-war recovery of this country should be considered as one of the most important directions for increasing the resilience of several food-importing countries in the event of a possible reduction in such imports.

In addition, public administration bodies responsible for the development of state economic development programs can take into account the formalized conditions for sustainable growth in the consumption of agricultural products established in this study. For this purpose, first of all, it is necessary to monitor and regulate the following four main indicators: (1) the index of changes in the adaptation capabilities of importing countries to a possible reduction in import supplies of a certain type of agricultural products; (2) the index of changes in the stable part of the consumption of a certain type of agricultural product by the importing countries; (3) the index of changes in the possible relative reduction in the volume of supplies of this type of agricultural product to the importing countries from those countries that are unable to ensure the stability of supplies of these products; (4) the share of the stable part of the consumption of a certain agricultural product by the importing countries, in the total consumption volume.

5.4. Limitations and Prospects for Further Research

During the performance of this research, some issues were not considered. In particular, the factors affecting individual ways of adapting countries to a possible reduction in food imports were not considered. Such factors include natural and climatic conditions, financial and logistical possibilities, etc. In addition, when assessing the sustainability level of food-importing countries, a detailed grouping of exporting countries should have been carried out, depending on the risks of the disruption of supplies of certain types of agricultural products, before a possible reduction in such imports. Therefore, various scenarios of partial or complete cessation of food supplies from certain countries were not considered, and the probability of such scenarios was not assessed. After all, the dynamics of the sustainability of the consumption of agricultural products were evaluated only in the short-term. Eliminating these limitations is the main direction of further research on this topic.

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