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INFORMATION PROVISION, ACCOUNTING AND ANALYSIS OF FOOD LOSSES AND WASTE: EU EXPERIENCE FOR UKRAINE

Purpose. *The purpose of the study is to substantiate the theoretical, methodological and methodical foundations for the formation of the system of accounting, analysis and information base of food losses and waste in Ukraine.*

Methodology / approach. *The collection of information for conducting a scientific study was carried out using qualitative (literature review, research of ideas and experience on research issues) and quantitative (study of quantitative indicators of food losses in production and sales chains in Ukraine) methods based on the description of secondary research (synthesis of existing knowledge and analysis of established trends). Data analysis was carried out using thematic analysis (systematization of scientific results from research issues), statistical method (construction of a trend line and determination of forecast data), the method of comparisons (selection of a specific system based on qualitative analysis) and generalizations (substantiation of proposals and formation of conclusions).*

Results. *The need to introduce in Ukraine the accounting methodology for food losses and waste, recommended by FAO is determined; the expediency of using the mass flow analysis method is substantiated; systematized data sources of information provision for food losses and waste monitoring. As a result of a critical analysis of theoretical, methodological and methodical principles regarding the formation of a system of accounting, analysis and information base of food losses and waste in Ukraine, the authors proposed a system of accounting, analysis and information provision of food losses and waste in Ukraine. The proposed system includes 1) a methodological basis for accounting for food losses and waste, 2) a method of analysis in the accounting system food losses and waste, and 3) information support for accounting and analysis of the process of food losses and waste.*

Originality / scientific novelty. *For the first time, a study of the methodology of accounting for food losses and waste, methods of analysis and information provision of this process in the EU was conducted, based on the results of which approaches to the formation of a corresponding system in Ukraine were proposed.*

Practical value / implications. *The application of a unified methodology of the food losses and waste accounting system will allow accurate quantitative assessment of food losses and waste in Ukraine, which will be suitable for international comparison, tracking progress in achieving the target indicators of the SDG12, developing relevant policies and applying effective frameworks for reduction of food losses and waste in Ukraine. This work emphasizes the need for further empirical research aimed at the quantitative analysis of food losses and waste in Ukraine, as well as the assessment of the losses caused by the russian federation in the agricultural sector and the reduction of the food potential of our country, which is a significant component of reparations and contributions from the aggressor state.*

Key words: *methodology, accounting, system, analysis, information provision, food loss, food waste.*

Introduction and review of literature. More than thirty years have passed since the introduction of market economy mechanisms in Ukraine, and scientific discussions about approaches to the formation of a sustainable food security system in the country are only intensifying. In the domestic scientific opinion, there is still a conviction that achieving food security is impossible without increasing the volume of agricultural production. At the same time, the results of our previous studies [1–4] indicate that the main problem in solving this issue in Ukraine is significant food losses. A thorough scientific study of this problem requires the formation of an appropriate accounting methodology and information base for a systematic analysis of the process in space (national, regional and local levels) and time (dynamics of indicators and the achievement level of target indicators). The experience of EU countries, where comprehensive systematic studies of food losses have been conducted for more than twenty years, can be a useful source for the formation of appropriate approaches in Ukraine. Moreover, taking into account the need for maximum harmonization of all monitoring systems in Ukraine and the EU, where, according to the amendments to the Waste Framework Directive 2008/98/EC (WFD) [5], monitoring and reporting on food waste by member states is mandatory. This position of the EU is explained by the need to monitor the achievement of food waste reduction goals and help in determining the relevant flows of food waste, which must be evaluated in the perspective of implementing a circular economy.

One of the Sustainable Development Goals defined by the UN in 2015 is SDG12.3. Responsible consumption and production, which requires "by 2030 to halve global food waste per capita at the retail and consumer levels and reduce food losses at all stages of the food chain, including post-harvest losses" [6]. New challenges faced by scientists stimulated researchers to find solutions to the problem of food losses and waste, including at the interdisciplinary and interdisciplinary levels.

A significant contribution to the formation of the food losses and waste accounting system was made by the authors of the work "Food waste accounting along food supply chains: state of the art and outlook" [7]. The researchers focused the main attention on the methodology of accounting for food waste and the choice of analysis methodology. The authors conducted an in-depth review of the scientific literature on the subject using the Scopus bibliometric database. According to the results of the work, the authors systematized scientific works according to: research goals; definitions of food losses and waste; data sources for accounting; approaches to quantitative assessment of food losses and waste; breakdown by product groups and the reliability of estimates. At the same time, in the mentioned work, scientists do not give their own vision of the accounting system – only propose regarding important elements of its formation. The authors present more detailed proposals for systematic accounting of food waste for the EU (at the macro level) based on the mass flow method in their next work [8]. Based on the proposed system, the authors conduct an analytical study of the amount of food waste in terms of product groups at different stages of the food chain and draw conclusions regarding food groups with a greater share of food waste and stages at which the amount of food waste is the largest. In our

opinion, the use of the mass flow method for the accounting system of food losses and waste at the macro level (for Ukraine it can be regional and national accounting levels) is quite appropriate, however, the methodology of accounting for food waste proposed by the authors needs adjustment, which will be discussed in detail below.

In the scientific work [9], researchers proposed a system of accounting for food waste by various types of products and socio-demographic characteristics of household members based on the direct survey method. The study was conducted on the basis of 115 Croatian households, which self-reported the amount of food waste during a seven-day period. This approach can be applied at the local level (small communities, etc.) for planning by local self-government bodies to prevent food loss and promoting healthy eating and food handling in educational institutions to minimize food waste. However, the proposed approach is not relevant for accounting for food losses and waste at the macro level.

A group of scientists gives important practical results based on the results of quantitative accounting of food losses and waste. In particular, in the work [10] the following was established: the highest indicators of losses are associated with livestock products; the largest absolute losses of biomass occur before harvesting – 44.0 % of the dry matter of the crop (36.9 % of energy and 50.1 % of protein); overeating is at least as significant a contributor to losses in the food system as consumer food waste – excessive human consumption of food (above nutritional needs) results in the loss of 48.4 % of harvested crops (53.2 % energy and 42.3 % protein). The latter factor, in our opinion, needs a deeper discussion in order to ensure ethical approach regarding the applied methods of measurement and formulation of conclusions on such sensitive issues. The authors also conclude that influencing consumer behavior, such as reducing consumption of animal products or reducing consumption of produce in line with rational standards, has significant potential to improve food security for a growing world population in a sustainable manner.

The documents “Food Waste Accounting – Methodologies, Challenges and Opportunities” [11] and “Food waste accounting methodologies: Challenges, opportunities, and further advancements” [12] are, in fact, resolutions based on the results of seminars on food waste accounting organized jointly by the Joint Research Center of the European Commission and the Directorate General for Health and Food Safety in order to stimulate the harmonization of accounting methodology, identify problems and opportunities for further improvement of food waste accounting. The documents present methodological aspects of accounting for food losses and waste and in particular: system limits, data reliability, accounting for flows, etc.

The value of these works lies in the suggestions for providing better support for the development of policies to reduce food losses and waste, which can be used in the formulation of relevant recommendations for Ukraine after carrying out quantitative calculations.

Part of the works is devoted to the search for methods of analysis of accounting for food losses and waste. Thus, the work [13] has the results of a study of 202 publications containing the results of quantitative accounting of food losses and

waste in 84 countries for the period from 1933 to 2014. The authors found that most studies are made for a few industrialized countries (such as the United Kingdom and the United States) and that food waste per capita in households increases with GDP per capita. The researchers also found that more than half of the studies were based on secondary data, indicating high uncertainty in the existing global database of food losses and waste. To address this problem, the researchers suggest more consistent, in-depth, and based on primary data research, especially for developing economies. We agree with the opinion of the authors about the need to conduct research using primary accounting data (for example, direct survey of producers and consumers), but such an approach is only appropriate to apply at the micro level. To apply this method at the macro level, it is necessary to use large aggregates of homogeneous objects from different regions (due to different specialization of producers and traditions of consumer nutrition), which currently does not seem possible in Ukraine.

In the work [14] the authors review the available data on the generation of food waste in the EU-27 and discuss their reliability compared to the results of the calculations of their own model, which is based on the methodology of the Food and Agriculture Organization of the United Nations. The researchers' study shows that the results vary significantly depending on the data sources chosen and the assumptions made, and the available database for Europe is very heterogeneous. The scientists recommend that further research should be focused on finding the sources necessary for the formation of a quality database that creates a basis for monitoring and managing food waste. The involvement of Ukraine in this process at this stage is the most advisable and reasonable.

Consequently, accounting for food losses and waste is still at an early stage of development, and a consolidated system for quantifying food waste in the European Union (EU) is still an open challenge [15–20].

In Ukraine, the SDG was also ratified, and the task of SDG 12.2. Responsible consumption and production is intended to "reduce food losses in production and sales chains" [21]. However, in domestic science, research on the accounting system of food losses and waste that is based on the concept of system analysis along the entire food chain and takes into consideration the existing typology of products, is critically limited. It should be noted that the vast majority of domestic researchers in accounting issues focus on certain areas of the agricultural sector. So, over the past five years, according to the search system of the National Library of Ukraine named after V. I. Vernadskyi, eight scientific works is devoted to accounting in animal husbandry, in particular the works of such scientists as: L. Hnatyshyn et al. [22], D. Liudvenko [23–28] and T. Mulyk [29]. Various aspects of the accounting system in crop production were studied by N. Bondarenko, N. Rizchenko [30], Yu. Hrybovska et al. [31], M. Kravchenko, T. Vilkhova [32], L. Nyzova, N. Zolotarova [33], O. Panchenko [34], O. Podolianchuk, L. Markevych [35], V. Savchuk [36], O. Symonenko, N. Desiatnykova [37], L. Suk, P. Suk [38], N. Tsitska, H. Matskiv [39] and others. At the same time, the study of the the food system accounting in Ukraine is the subject of scientific research for a limited circle of scientists, among them: D. Liudvenko [40],

K. Pylypenko, O. Didyk [41].

At the same time, in the absence of a unified accounting system for food losses and waste, it is impossible to monitor the process over time and make international comparisons, as well as to assess progress in achieving target indicators. The development of such approach is also very important as a possibility of forming adequate policies for effective management aimed at reducing food losses and waste.

In Ukraine, there is no unified accounting system for food losses and waste. The existing practices of the EU regarding the system of accounting, analysis and information base of food losses and waste can be used as a basis for the system of accounting, analysis and information base of food losses and waste in Ukraine.

The purpose of the article. The purpose of the study is to substantiate the theoretical, methodological and methodical foundations for the formation of the system of accounting, analysis and information base of food losses and waste in Ukraine.

Results and discussion. Accounting for food losses and waste is at the stage of significant development, but several open problems need to be solved in order to create a reliable and comprehensive system of accounting for food losses and waste, which will be a reliable basis for making effective decisions [11]. Problematic questions determine the main components of the system.

The main elements of accounting for food losses and waste are definitions related to food losses and waste, data sources, methods used for data collection, and approaches for quantifying food losses and waste [11].

According to the Food Loss and Waste Accounting and Reporting Standard [42], the main principles of accounting for food losses and waste are: appropriateness, completeness, consistency, transparency and accuracy.

To carry out accounting, it is necessary to establish its main objects and stages. In general, we can distinguish two approaches to the definition of accounting objects.

The first approach is based on the establishing one object of accounting – the so-called solid [42] or food [43–44] waste. This approach is not appropriate, in our opinion, because it introduces a certain imbalance in the accounting system. Thus, the concepts of "food waste" and "solid waste" are much narrower than the actual object of accounting, because there are also food losses and liquid waste.

The second approach involves a division into several accounting objects. This group includes:

a) biological and food waste [45];

b) losses of agricultural production (we mean losses in the field of crop production); losses and inefficiency of livestock production; losses during processing, storage and transportation; consumer waste; excessive consumption [46];

b) food losses and waste [47–49].

Taking into account the essence of the accounting objects proposed by scientists, we can state that the second approach is based on subordinating the accounting objects to the stages of the food chain with minor deviations from the generally accepted division, which, among other things, causes a different number of objects.

Based on the position of the expediency of detailing the objects distribution, their

meaningful content and compliance with the stages of the food chain, we consider it expedient to define food losses and waste as accounting objects, the content of which determines the specific stages at which the accounting of food losses and waste takes place (Figure 1).

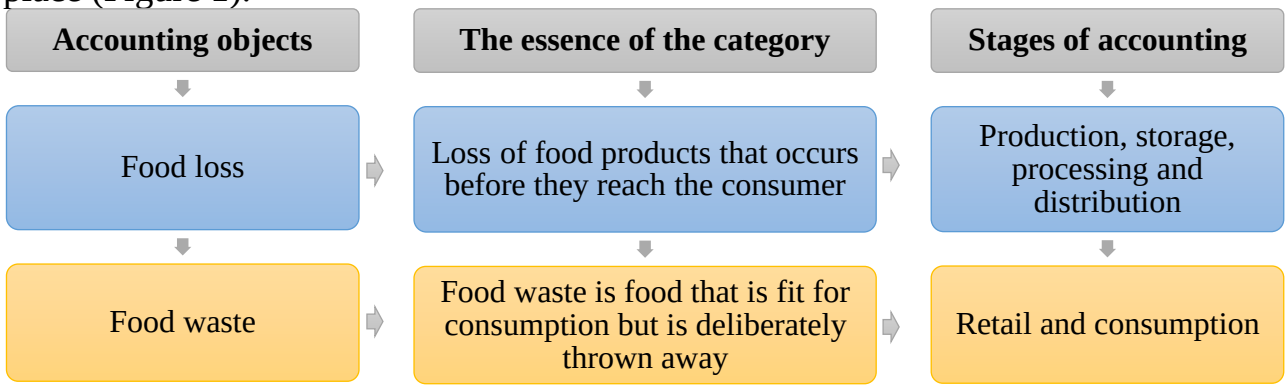


Figure 1. Objects and stages of food losses and waste accounting

Source: developed by the authors.

Different opinions can be found in the scientific literature regarding the methodological approaches of accounting for food losses and waste. In the scientific literature, you can find different opinions regarding methodological approaches to accounting for food losses and waste. However, there are only two fundamental differences: 1) accounting for food losses and waste is conducted either simultaneously based on one measurement system, or separately based on two measurement systems – separately for food losses and separately for food waste; 2) different quantitative values of food losses and waste coefficients.

In our opinion, an approach based on the simultaneous accounting of food losses and waste (in one measurement system) should be generally accepted for use in Ukraine, because such an approach will allow rational use of time and human resources. This thesis is also confirmed by our earlier studies [1–4]. In the mentioned scientific works, the expediency of simultaneous accounting of food losses and waste was verified and proved by the empirical method. In addition, from the point of view of information provision of the process of monitoring and analysis of food losses and waste, it does not make sense to first do accounting separately for two different systems, and as a result again look for approaches to combine them. It should also be noted that when using separate accounting systems, misunderstandings often arise regarding the stages at which the accounting of objects should take place. Thus, the methodological approach of accounting for food waste proposed by a group of scientists [8] (Figure 2) also includes the stages at which the accounting for food losses is carried out (in Figure 2 it is marked with a red dotted line). A dissonance arises because even products that are ready and fit for consumption at the stages of production, storage, processing or distribution (for example, fresh vegetables and fruits) cannot be deliberately thrown away at these stages, because they have not yet reached a consumer who can throw them away. In the case if the producer and the consumer are the same person, as may be the case in households where produce is grown for own consumption, not all the produced products can be consumed or thrown

away (if it is fit for consumption) instantly – there is always a period of storage or processing and storage until the time of full use (consumption) of the harvest (products). Such confusion, among other things, may be caused by differences in the interpretation of the meaning of the concepts of accounting objects. That is why, at the beginning of the study, we determined the categorical essence of the concepts of accounting objects and their corresponding stages of the life cycle of products (food chain).

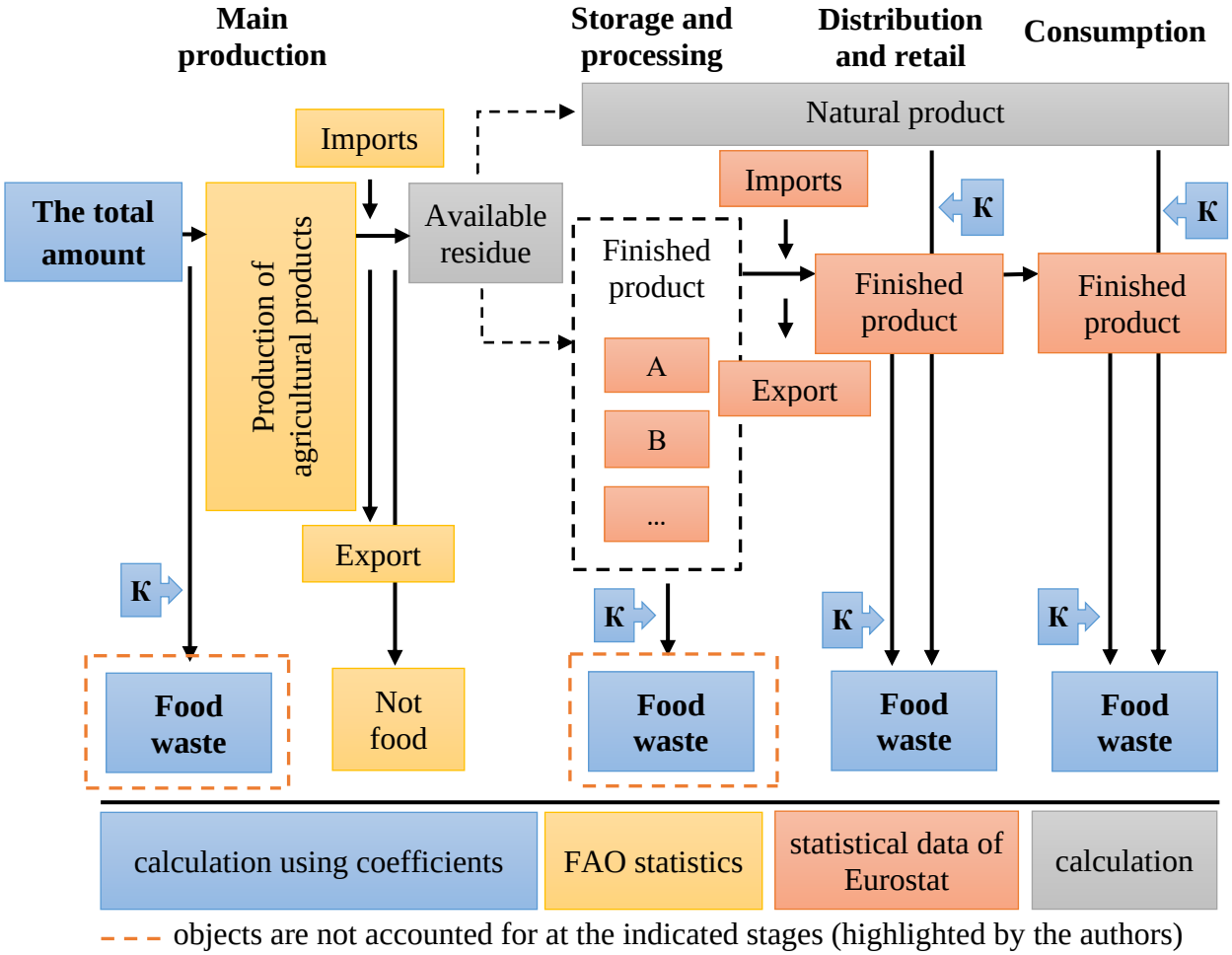


Figure 2. Accounting approach and main sources of data used to calculate food waste

Source: according to data from [31].

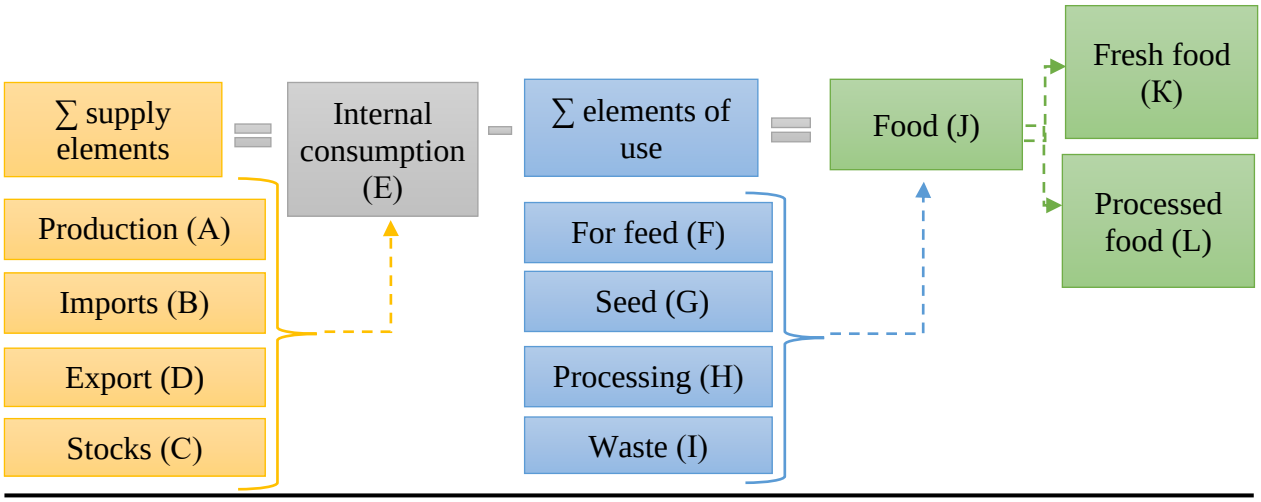
In order to avoid confusion regarding accounting objects and coefficients of food losses and waste, it is advisable to use the methodological approach developed and proposed by FAO (Figure 3).

Firstly, this approach to monitoring and accounting for food losses and waste makes it possible to compare the data obtained in Ukraine with international data.

Secondly, the system of division by types of products and stages of the product life cycle corresponds to the Ukrainian classification used by the State Statistics Service of Ukraine.

Thirdly, the information required for accounting and analysis of food losses and waste at different levels does not require additional detailing or correction from already

presented by the State Statistics Service of Ukraine in public access.



A+B+C–D=E–(F+G+H+I)=J=K+L

Figure 3. Methodology for accounting for food losses and waste, developed by FAO

Source: according to data from [27].

Food losses and waste analysis methods can be based on direct or indirect measurements derived from primary or secondary data. Direct measurements tend to require more resources and are therefore applied to individual stages of the supply chain, involving a limited number of participants in data collection [7]. Indirect measurements, on the contrary, are well adapted to large amounts of information [50], but may have higher uncertainty, and their accuracy depends on the quality and representativeness of the data sources [13].

Considering the fact that the methodology of accounting for food losses and waste is based on the principles of the life cycle of products (food chain), the analysis methods should be adapted as best as possible to the requirements for relevance at different stages of the food chain, especially in terms of the possibility of qualitative quantitative measurement of indicators, taking into account division of food into different groups. The scale of research should also be taken into account. In particular, the use of direct measurements obtained from primary data is possible and expedient for determining the amount of food losses and waste at the micro level (household, farm, etc.), at the same time, the use of such an approach is practically impossible for determining the amount of food losses and waste at the macro level (region, country, international studies).

We agree with the opinion of scientists [7; 8], who believe that for this purpose it is appropriate to use the method of mass flow analysis, which involves a systematic assessment of the movement and stocks of materials in the system. Analysis of the mass flow in the accounting system of food losses and waste allows maintaining the balance at each stage of the product life cycle. Thus, mass flow analysis provides a systematic approach to accounting for food waste at different levels with distribution by stages, as well as by product groups (Figure 4).

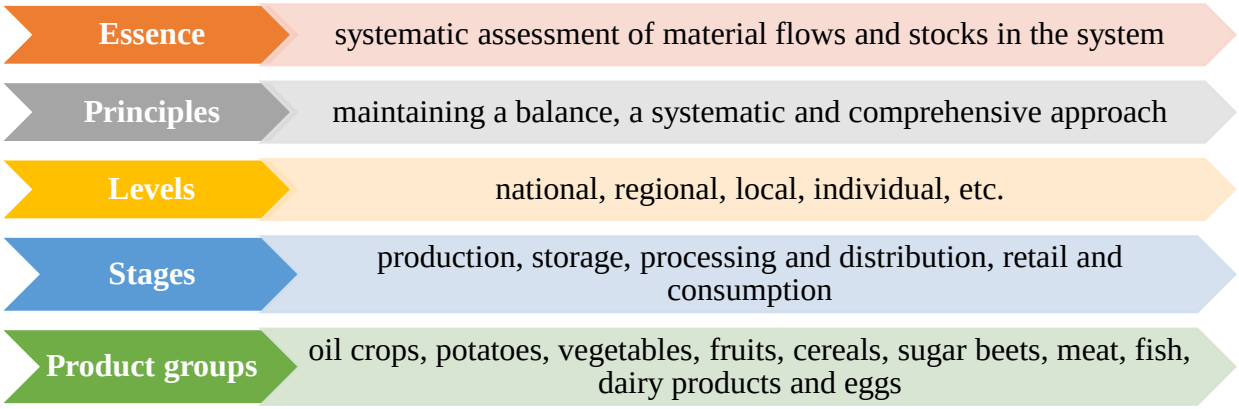


Figure 4. Components of mass flow analysis in the food losses and waste accounting system

Source: developed by the authors.

Information provision for accounting and analysis of the process of food losses and waste in the EU is based on data from official statistics and direct surveys. The results of scientific research are more often used not as a primary source of information, but as a justification for improving accounting methodology. In our opinion, the information source determines the task and level of research (Figure 5).

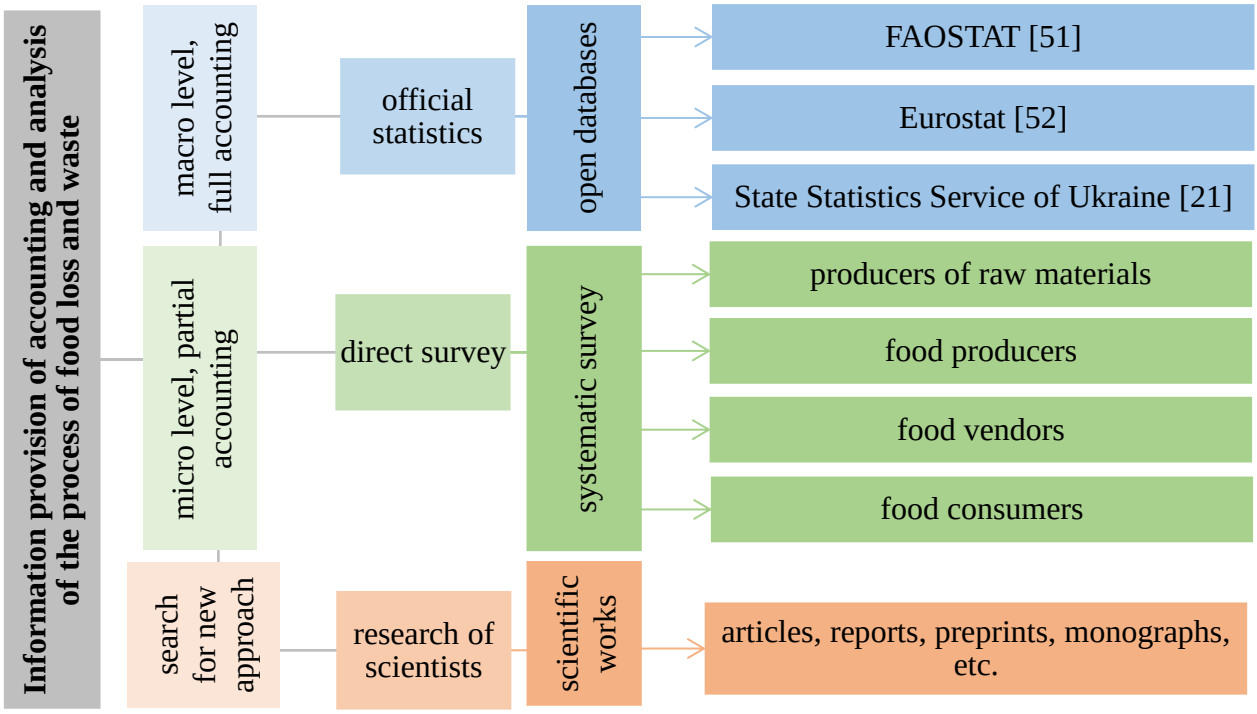


Figure 5. Information provision of accounting and analysis of the process of food losses and waste

Source: developed by the authors.

For full accounting (at all stages of the food chain) and analysis of the process of food losses and waste at the macro level, the main sources of statistical data are open access information databases provided by FAOSTAT, Eurostat and the State Statistics Service of Ukraine. FAOSTAT and Eurostat provide both primary data needed to calculate food losses and waste, and secondary indicators that show absolute (in tons

and kcal) and relative values of food losses and waste. The State Statistics Service of Ukraine does accounting of only primary data that can be used to calculate food losses and waste. Currently, the State Statistics Service of Ukraine provides full information on the dynamics of indicators of the Sustainable Development Goals in Ukraine, but these indicators are adapted and do not agree with international ones at all purposes and objectives. In particular, according to SDG12.2, the actual value is provided only for 2 indicators (Table 1). At the same time, the data give us an idea about the dynamics of development and allow us to make predictions about the possibility of achieving the target indicators.

Table 1

The rate of achievement of the goals of the SDG12.2 "Reduce food losses in production and sales chains" in Ukraine

Indicator	2015	2016	2017	2018	2019	2020	2021	2025	2030
The share of post-harvest losses in the total production of grain crops, %									
Actual value	2.3	2.0	1.8	1.8	1.8	1.7	1.7	x	x
Growth rate, %	100.0	87.0	78.3	78.3	78.3	73.9	73.9	x	x
Predicted value*	2.2	2.0	1.9	1.8	1.8	1.7	1.7	1.6	1.5
Target value	2.2	x	x	x	x	1.8	x	1.0	0.5
The share of post-harvest losses in the total production of vegetables and melon crops, %									
Actual value	12.3	12.0	10.8	10.6	12.2	12.2	12.5	x	x
Growth rate, %	100.0	97.6	87.8	86.2	99.2	99.2	101.6	x	x
Predicted value**	12.3	11.6	11.3	11.2	11.4	12.0	12.8	19.1	33.8
Target value	12.3	x	x	x	x	10.0	x	7.0	5.0

Notes. *The predicted value is determined using the exponent function $y = 2.2409x^{-0.152}$, the approximation coefficient (R^2) is 0.941.

**The predictive value is determined using the polynomial function $y = 0.512x^2 - 1.1143x + 13.257$, approximation coefficient (R^2) is 0.592.

Source: predicted values were calculated by the authors based on primary data of the State Statistics Service of Ukraine.

Thus, the calculations show that if the established dynamics of the share of post-harvest losses in the total production of grain crops are maintained, other things being equal, the set target values in 2025 and 2030 will not be reached: the target indicators are exceeded by 0.6 and 1.0 %, respectively. Considering the high level of the value of the approximation coefficient, the calculated predictive data are quite relevant.

A similar conclusion is also confirmed by calculations regarding the share of post-harvest losses in the total production of vegetables and melon crops. Given the insufficiently high level of the value of the approximation coefficient, the calculated forecast data are relevant and, other things being equal, in the long run will have a slight deviation from the actual data.

The obtained data are important from the point of view of making managerial decisions and adjusting programs for the introduction of relevant economic, legal and organizational norms and frameworks for reducing food losses and waste in Ukraine.

The consistent harmonization of the accounting methodology of economic, social, political and other processes in Ukraine with the international space provides much wider opportunities for the analysis of national indicators in an international

comparison.

To carry out partial accounting at the micro level, it is advisable to use a survey. It should be noted that in Ukraine, despite the long-standing practice of using questionnaires, this method of obtaining information has significant obstacles: starting with insufficient trust and openness of respondents and ending with problems related to financial, time and human resources necessary for organization, implementation and analytical processing of survey results. The choice of a specific form, method and ways of surveying depends on the objectives of the survey and can vary significantly for different focus groups, which also greatly complicates the process. Taking into account the above and the fact that the survey should be systematic (periodically repeated) and comprehensive (surveys should be conducted by all participants of the food chain), in our opinion, such surveys, at least at the first stage of the implementation of the monitoring system, should be conducted by the State Statistics Service of Ukraine. To do this, it is necessary to develop appropriate questionnaires for each of the focus groups (producers of raw materials, producers of products, sellers of food and consumers of food) and place it on the official website of the State Statistics Service of Ukraine, similarly to the others in the tab "General Questionnaire". By the way, this practice is also used in the EU. This approach will significantly reduce the amount of resources used for the questionnaire, ensure compliance with the principles of systematicity and comprehensiveness, relevance, accessibility and openness of the obtained results.

Therefore, the approaches used in the EU for accounting, analysis and information provision of food losses and waste are quite suitable for their application in Ukraine (Figure 6).

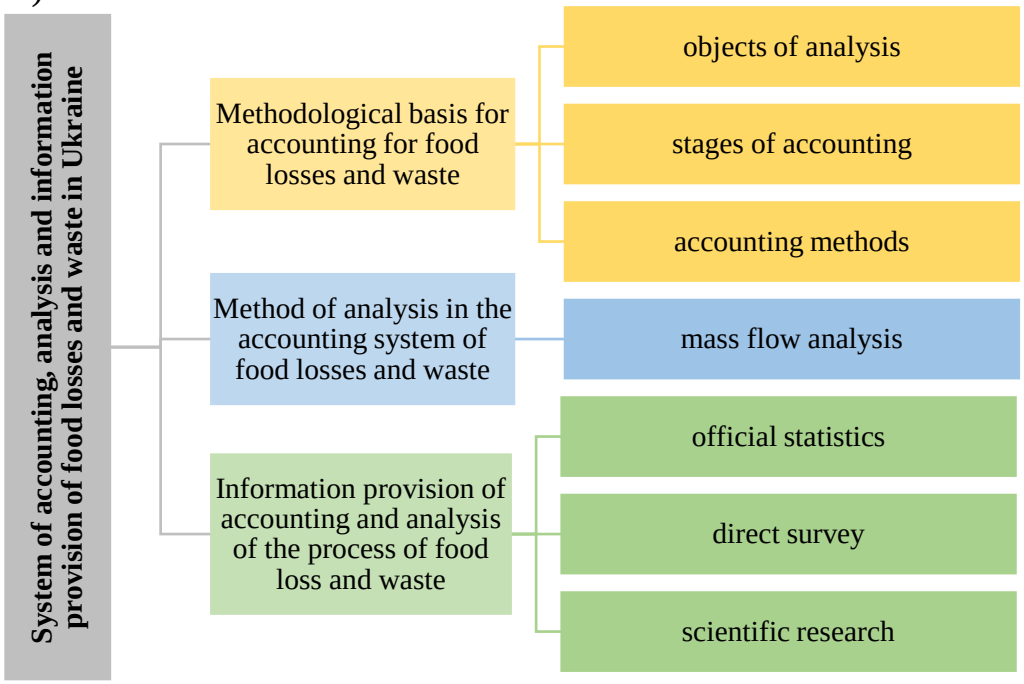


Figure 6. The proposed system of accounting, analysis and information provision of food losses and waste in Ukraine

Source: developed by the authors.

Firstly, Ukraine has the necessary tools, including at the international level, needed for the introduction of a system of accounting for food losses and waste. Secondly, the system of accounting for food losses and waste requires only certain additional efforts related to the digitalization of monitoring processes, which fully corresponds to the general strategy of introducing electronic governance in Ukraine. Thirdly, the information sources necessary for accounting and analysis, both at the national and international levels, are open, accessible and consistent with each other.

The United Nations Environment Programme [54] provides a road map for the implementation of a system of accounting for food losses and waste at the national level (Figure 7). At the regional and local levels of management, the same approaches apply, the only difference is accountability: accountable entities report to the Main Statistical Offices of the region or the city of Kyiv. Therefore, the methodological approaches proposed by us fully describe the necessary tools for the implementation of the food losses and waste accounting system in accordance with the UN recommendations.

The United Nations Environment Programme on the implementation of the food losses and waste accounting system is aligned with the Food Loss and Waste Accounting and Reporting Standard.

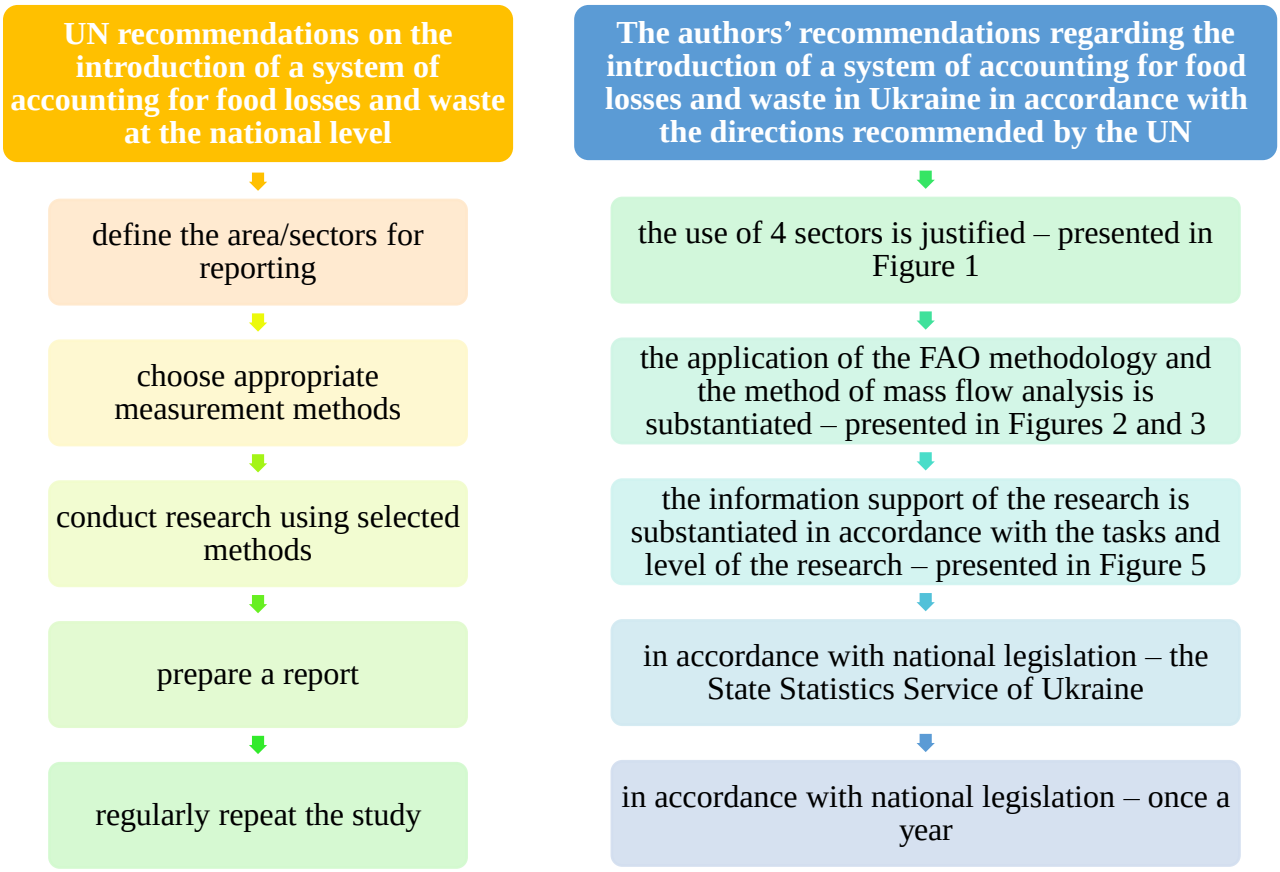


Figure 7. Ensuring the results of the study of the recommendations of the United Nations Environment Programme on the implementation of the system of accounting for food losses and waste at the national level

Source: developed by the authors.

From the point of view of finding ways to reduce food losses and waste, it is advisable to do accounting of food losses and waste at the enterprise level, indicating the causes of losses (Table 2).

Table 2

An example of accounting for food losses and waste at an enterprise

Product type	Volume, kg	Cause	Driver
Tomatoes	500	Cosmetic damage	Incorrect conditions of transportation of products
Berries	700	Deterioration	Malfunction of refrigeration equipment
Wheat	7000	The product was collected late	Weather conditions

Source: developed by the authors.

It is quite understandable that there are certain restraining factors for the introduction of the system immediately, but the elimination of existing restrictions does not require significant additional costs and is fully in line with the modern doctrine of Ukraine's development strategy, which is focused on the fastest possible integration into the EU.

Indeed, the issue of weighting coefficients for calculating food losses and waste at different stages of the food life cycle remains a debatable issue in the system of accounting for food losses and waste for Ukraine. Since Ukraine is a member of the group of European countries, the weighting coefficients of food losses and waste for Ukraine are the same as for EU countries (Table 3). It can be assumed that the actual values of the coefficients for individual types of products may differ from those determined by the FAO methodology. In particular, according to official statistics, the share of post-harvest losses in the total production of vegetables and melon crops in Ukraine in the period from 2015 to 2021 was from 10.6 to 12.5 %, which is below the level of the weighting factor according to the FAO methodology.

Table 3

Weight percentages of food and waste losses (as a percentage of what is included at each stage) for Europe

Type of production	Production	Storage	Processing	Distribution	Consumption
Cereals	2	4	0.5–10	2	25
Roots and tubers	20	9	15	7	17
Oilseeds and legumes	10	1	5	1	4
Fruits and vegetables	20	5	2	10	19
Meat	3.1	0.7	5	4	11
Fish and seafood	9.4	0.5	6	9	11
Milk	3.5	0.5	1.2	0.5	7

Source: according to data from [32].

In contrast, the share of post-harvest losses in the total production of grain crops in Ukraine according to official data for the specified period was from 1.7 to 2.3 %, which corresponds to the level of the weighting factor proposed by FAO. Since the

official statistics do not provide data for other types of products and, even more so, for accounting stages, the task of further scientific research is to clarify the weighting factors for specific types of products at different accounting stages. At the same time, at the national and regional levels, the calculation of food losses and waste using defined weighting factors is quite acceptable, since those deviations that may exist at different stages of accounting are balanced in the total amount of losses. It should also be noted that there is currently no other system of weighting factors for accounting for food losses and waste. For individual enterprises and households, the practice of ongoing, comprehensive and systematic tracking of food losses and waste should be applied.

Certain issues, which are subject to scientific debate, are removed in terms of their practical application by the Food Loss and Waste Accounting and Reporting Standard – "this is a global standard that contains requirements and guidelines for quantifying and reporting the weight of food products and/or food products" of non-edible parts removed from the food supply chain, commonly referred to as "food losses and waste" [41].

For example, the Food Loss and Waste Accounting and Reporting Standard removes the problem of choosing a methodological approach to accounting for food losses and waste in relation to the simultaneous accounting of food losses and waste (in one measurement system). Obviously, enterprises can apply a double accounting approach: separate accounting of food losses and separate accounting of food waste losses, but, in any case, it will be necessary to bring the final results to the form of accounting defined by the standard. Otherwise, such data will not be representative for the formation of a regional and national report on accounting for food losses and waste.

The Standard also provides an answer to another question regarding the essential content of accounting entities. Discussions regarding the categorical content of the concepts "food loss" and "food waste" are the subject of research in a significant number of scientific works [55–62]. In this matter, we adhere to the principle of the unity of approaches in determining the essence of the concepts of accounting entities for the possibility of comparing the data obtained over time, by territories (at different levels) and industries (different areas of activity), as well as providing the possibility of aggregating indicators, their synthesis and analysis.

There is no unanimity among scientists on the issue of the expediency of detailing the accounting of food losses and waste. In this matter, we support the position of scientists [63], who explain the need for detailing by individual types of products and accounting stages. Such an approach can contribute to the determination of priorities in the formation of relevant programs and the introduction of certain practices to reduce food losses and waste. A summary of the relationship between policy interventions and possible accounting needs is provided in Table 4.

Consequently, the debatable issues regarding the accounting of food losses and waste are quite extensive and have a different vector of direction. However, scientific publications, standards, programs and, ultimately, logic always help to find the right solution in each specific case. Consequently, the debatable issues regarding the

accounting of food losses and waste are quite extensive and have a different vector of direction. However, scientific publications, standards, programs and, ultimately, logic always help to find the right solution in each specific case.

Table 4

An example of the relationship between areas of policy intervention and possible needs for food losses and waste accounting

Spheres of political intervention	Accounting of needs
Waste prevention/food security (e.g. improving the efficiency of the food system)	✓ distinguishing parts of food into edible and non-edible parts ✓ detailed division of product groups and processes ✓ establishing the relationship between the amount of food losses and waste, causes and drivers
Waste management (optimization of waste processing using treatment facilities)	✓ assessment of the total amount of waste to be treated/recycled and the methods of treatment/recycling (e.g. by anaerobic digestion, composting, incineration) ✓ moisture assessment ✓ a detailed description of the components and origin of the waste stream
Valuation of waste as energy/material (e.g. using waste to produce biomaterials or biofuels)	✓ awareness of the composition of waste streams ✓ assessment of the possibility of ensuring the stability of the process over time (for example, seasonality) ✓ detailed information on the origin of waste

Source: according to data from [12].

Conclusions. According to the results of the conducted research, we can affirm the need to introduce in Ukraine a methodology for accounting for food losses and waste, which should be based on the following principles:

1) introduction of the methodology for accounting for food losses and waste, recommended by the FAO in Ukraine. Recognizing the fundamental role of food losses and waste in the formation of a sustainable food system, the EU has made significant progress in solving the problem of accounting for food losses and waste. However, food waste accounting is still in the development stage and a consolidated system for quantifying food losses and waste in the EU is still an open question. At this stage, accounting for food losses and waste developed by FAO is appropriate for Ukraine;

2) the use of the mass flow analysis method. Mass flow analysis is an appropriate method of analysis in the food losses and waste accounting system. This approach is also useful from the point of view of the implementation of waste management and recycling policy, as it allows mapping and quantifying flows across product groups at different stages of the life cycle (food chain);

3) systematization of data sources of information provision for monitoring food losses and waste. Information provision for accounting and analysis of the process of food losses and waste depends on the task and level of research and is based on data from official statistics, direct surveys and the results of scientific research. The State Statistics Service of Ukraine does accounting for only primary data that can be used to calculate food losses and waste. According to SDG12.2, the actual value is provided for only two indicators. According to the calculations, if the established dynamics of

the share of post-harvest losses in the total production of grain crops are maintained, ceteris paribus, the target values of SDG12.2 in 2025 and 2030 will not be reached: the target indicators are exceeded by 0.6 and 1.0 %, respectively. A similar conclusion is also confirmed by calculations regarding the share of post-harvest losses in the total production of vegetables and melon crops.

The application of a unified methodology of the food losses and waste accounting system will allow accurate quantitative assessment of food losses and waste in Ukraine, which will be suitable for international comparison, tracking progress in achieving the target indicators of the SDG12, developing relevant policies and applying effective frameworks for reduction of food losses and waste in Ukraine. This work emphasizes the need for further empirical research aimed at the quantitative analysis of food losses and waste in Ukraine, as well as the assessment of the losses caused by the russian federation in the agricultural sector and in the reduction of the food potential of our country, which is a significant component of reparations and contributions from the aggressor state.

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