

## Economic Impact of Food Loss and Waste

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### Abstract

Research background: The unproductive use of natural resources such as land and water, resulting from food loss and waste, constrains the pursuit of such tasks as overcoming hunger and poverty, ensuring adequate nutrition, increasing income and economic growth. Purpose of the article: According to the results of empirical research to identify the level of economic damage and lost revenue as a result of the food loss and waste, as well as to identify potential benefits for the agricultural land use in reducing those losses. Methods: The analysis was conducted in terms of regions and product types. The methodology proposed by FAO is used to calculate the food loss and waste for each type of product in Ukraine. Findings & Value added: Firstly, it has been empirically proven that food loss and waste result in significant economic damage and lost revenue. Secondly, the reduction of food loss and waste has positive environmental and social consequences.

### Keywords

Economic damage, food loss, food waste, cereal crops, potato, vegetables, fruits and fruits, meat, milk, regions, Ukraine.

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### Introduction

The unproductive use of natural resources such as land and water, resulting from food loss and waste, constrains the pursuit of such tasks as overcoming hunger and poverty, ensuring adequate nutrition, increasing income and economic growth. In subsistence farming systems of small producers, quantitative losses of food lead to a decrease in the physical availability of food and increase, thus, the level of food insecurity. Rural elderly are particularly vulnerable to such effects, as they often have less access to appropriate technology, infrastructure, storage and markets, than other groups. Lowering the quality of food products also leads to poor nutrition - low-quality foods can be dangerous because of their adverse effects on health, well-being and productivity of consumers.

Food loss is essentially a loss of economic value for food business entities. The value of food loss and waste at the global level is estimated at 1 trillion US dollars (SAVE FOOD, 2015). Today, food industry chains are becoming more and more globalized – certain foods are produced, processed and consumed in completely different parts of the world. Foods that are sold in international markets and lost in one part of the world can affect the availability of food and prices in another part.

For Ukraine, this issue is of particular importance for several reasons: firstly, Ukraine has joined the group of countries in implementing the Sustainable Development Goals 2016-2030; secondly, the actual production of major food groups in Ukraine is sufficient to provide a rational standard of nutrition, but the actual level of consumption does not correspond to rational standards for half of the specified product list; thirdly, most of the agricultural producers, as in the former Soviet Union, still prefer extensive and intensive management practices that create further environmental pressures on land without proper economic and social impact.

The aim of the study is to determine the amount of economic losses and foregone earnings resulting from food waste and food by-products in Ukraine (according to the results of the empirical study), as well as to identify potential social and environmental benefits from food waste and food by-products' reduction.

The object of the study is the effects of food loss and waste.

The subject of the study includes indicators of economic damage and lost revenue resulting from food loss and waste, including per 100 hectares of agricultural land and 100 people in terms

of regions of Ukraine and types of products (cereals, vegetables, potatoes, meat, milk, fruits and fruits).

## Materials and methods

The author's methodological approach to assessing the impact of food loss and waste on the level of economic damage and lost revenue is based on the following principles:

- (1) principle of purpose – assessment of the impact of food loss and waste on the level of utilization of land resources in Ukraine;
- (2) principle of unity – a time lag (2016) and a defined system of indicators of evaluation;
- (3) systematic principle – systematization of indicators by product and region;
- (4) scientific principle – the use of various methods of empirical research;
- (5) principle of maximum informativeness, including – visual perception.

In accordance with the purpose of the study and these principles, an appropriate system of indicators that has been developed to meet the following criteria:

- combine environmental, social and economic aspects;
- understandable and unambiguous interpretation for decision makers;
- have a quantitative expression;
- rely on the existing system of national statistics and do not require significant expenditures for the collection of information and calculations;
- are representative of interregional comparisons;

- have an opportunity to assess in time dynamics;
- have a limited number.

The system of indicators, their economic and inappropriate methods and calculation methods are given below.

The economic damage resulting from the food loss and waste (ED, formula 1) is calculated at constant prices for agricultural products to calculate the agricultural production index, approved by the State Statistics Committee of Ukraine dated 22.12.2011, No. 362 (State Statistics Service of Ukraine, 2011):

$$ED = FLW \cdot CP, \quad (1)$$

where  $FLW$  – volume of food loss and waste for a particular type of products, ths. tons;  $CP$  – constant price for a particular type of agricultural products, EUR per 1t: 1027.5 – for cereals; 1007.6 – for potatoes; 1793.8 – for vegetables; 2251.8 – for fruits; 12734.6 – for meat; 2486.6 – for milk.

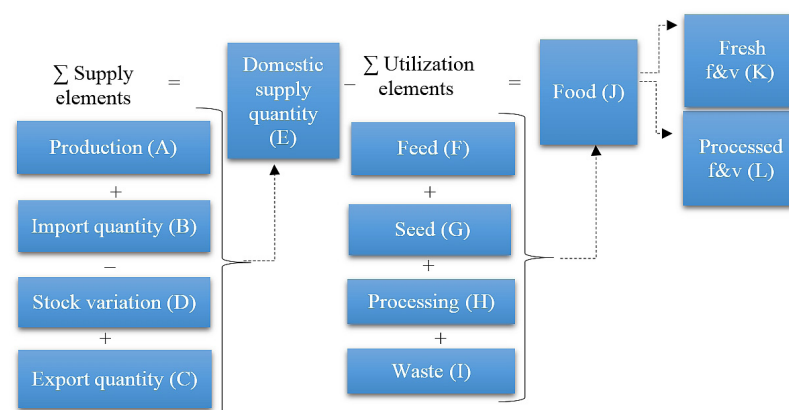
Lack of income due to food loss and waste (SI, formula 2) is calculated at actual prices in 2016 for agricultural products:

$$SI = FLW \cdot AP, \quad (2)$$

where  $AP$  – the actual price in 2016 for a particular type of agricultural product, EUR per 1 t: 3414.0 – for cereals; 2631.8 – for potatoes; 3924.2 – for vegetables; 5863.8 – for fruits; 22468.0 – for meat; 5461.8 – for milk.

Accordingly, the amounts of these indicators by type of product or region are correspond to the total economic damage and lost revenue.

Author used methodology, proposed by FAO (Figure 1), in order to calculate food loss and waste for each type of product in Ukraine.



Source: FAO (2011. p. 33-35)

Figure 1: Method for calculation of food loss and waste.

$$A + B + C - D = E - (F + G + H + I) = J = K + L$$

Example: Calculations on losses and waste of milk in Ukraine. The below shows the mass flow of total milk (thousand tons) in the 2016.

Waste percentage in each step of the FSC:

Agricultural production = 3.5%

Postharvest handling and storage = 0.5%

Processing and packaging = 1.2%

Distribution (fresh & processed) = 0.5%

Consumption (fresh & processed) = 7%

Calculations on primary equivalent milk losses and waste in each step of the FSC:

Agricultural production:  $(0.035 / (1 - 0.035)) * 10382 = 376.5$  thousand tons

Postharvest handling and storage:  $0.005 * 10382 = 51.9$  thousand tons

Processing and packaging =  $0.012 * (2850 + 6090) = 107.3$  thousand tons

Distribution (fresh):  $0.005 * 58 = 0.3$  thousand tons

Distribution (processed):

$0.005 * (2850 + 6090 - 107.7) = 44.2$  thousand tons

Consumption (fresh):

$0.07 * (58 - 0.3) = 4.0$  thousand tons

Consumption (processed):

$0.07 * (2850 + 6090 - 107.3 - 44.2) = 615.2$  thousand tons

Conversion factors:

peeling by hand = 1.0;

industrial peeling = 1.0;

mean = 0.1

Calculations on edible milk losses and waste in each step of the FSC:

Agricultural production:

$376.5 * 1.0 = 376.5$  thousand tons

Postharvest handling and storage:

$51.9 * 1.0 = 51.9$  thousand tons

Processing and packaging:

$107.3 * 1.0 = 107.3$  thousand tons

Distribution:

$(0.3 * 1.0) + (44.2 * 1.0) = 44.5$  thousand tons

Consumption:

$(4.0 * 1.0) + (615.2 * 1.0) = 619.2$  thousand tons

Physical mass of food produced for human consumption and of food lost and wasted throughout the food supply chain in Ukraine have been quantified, using available data (State Statistics Service of Ukraine, 2017). Results of food losses and waste in other countries were taken from FAO reports.

For each commodity group a mass flows model was used to account for food losses and waste in each step of the commodity's FSC. Model equations are provided in Graph 1.

The production volumes for all commodities were collected from the SSSU "Balances and consumption of the main food products by the population of Ukraine" 2017 (State Statistics Service of Ukraine, 2017).

Allocation factors have been applied to determine the part of the produce oriented to human consumption (and not for animal feed). "Conversion factors have been applied to determine the edible mass and are in accordance with the developed FAO. The different commodities addressed are grouped according to FAOSTAT's Food Balance Sheets and SSSU's Balances and consumption of the main food products by the population of Ukraine: 1. Cereals (excluding beer): wheat, rice (milled), barley, maize, rye, oats, millet, sorghum, other cereals. 2. Roots and Tubers: potatoes. 3. Fruit: apples (excl. cider), grapes (excl. wine), other fruit. 4. Vegetables: tomatoes, onions, other vegetables. 5. Meat: bovine meat, mutton/goat meat, pig meat, poultry meat, other meat, offals. 6. Dairy products: milk. As there are no balances for "Oilseeds and Pulses" and "Fish and Seafood" groups in Ukraine, so the calculations for these product groups have not being conducted.

At each stage of the Food Supply Chain, losses and waste were estimated using SSSU's Balances and consumption of the main food products by the population of Ukraine from the years 2015-2017 and results from a thorough calculations of global food waste.

The figures used are presented in Table 1.

The official data of the State Statistics Service of Ukraine for 2015-2017 were used as the information base in terms of regions and types of products.

| Type of production    | Agricultural Production | Postharvest handling and storage | Processing and packaging | Distribution: Supermarket Retail | Consumption |
|-----------------------|-------------------------|----------------------------------|--------------------------|----------------------------------|-------------|
| Cereals               | 2                       | 4                                | 0.5-10                   | 2                                | 25          |
| Roots and tubers      | 20                      | 9                                | 15                       | 7                                | 17          |
| Oilseeds and pulses   | 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: FAO (2011, p. 33-35)

Table 1: Weight percentages of food and waste losses (as a percentage of what is included at each stage) for Europe.

## Results

The study is based on empirical research methods as well as on the author's methods of assessment of economic impact of food loss and waste.

The problem of food loss and waste is extensively investigated by foreign scientists, in particular, in the EU and the USA. Among the most important studies that cover the national and global levels of the problem, the following works should be highlighted.

"Reducing Food Loss and Waste" (Lipinski et al., 2013) focuses on food loss and waste in global terms (according to 2009), defines the terms "loss of food" and "food waste" and also propose strategies to reduce food loss and waste.

The study "Global food losses and food waste - Extent, causes and prevention" (FAO, 2011) covers losses that occur along the food chain, and estimates their value; also, the causes of food losses and possible ways of their prevention are determined.

"Food Initiative on Food Loss and Waste Reduction" (SAVE FOOD, 2015) addresses the issues of "food loss" and "food waste" terminology, the conditions for the emergence and consequences of food and food waste loss, as well as - strategies to reduce food loss and waste in a globalized world.

"Food Waste Footprint: Impacts on Natural Resources" (FAO, 2013) study provides a global assessment of the environmental consequences of food and food waste loss at each stage of the food chain, focusing on the impacts on climate, water, land and biodiversity, as well as economic a quantitative estimate based on world producer prices. The paper answers two main questions: what are the consequences of a loss of nutrition on natural resources, and where these consequences are coming from. As a result, researchers identify

"hot spots of the environment" and thus determine the directions and measures to reduce their impact.

"Business Case for Reducing Food Loss and Waste" (Hanson and Mitchell, 2016) presents the results of interviews with government and business leaders, which resulted in a set of strategic but non-financial motivators for reducing food loss and waste related to food security, waste management, environmental sustainability, stakeholder relations and ethical responsibility. Therefore, the authors propose a business criterion for reducing the losses of food and waste for the public and private sectors, built on the principle: goals – objective – actions.

Schuster Monica and Torero Máximo in the "Toward a sustainable food system: Reducing food loss and waste" (Schuster and Torero, 2018) investigate the issues of terminology and methodology for measuring food and food waste losses, as well as developing an effective policy to solve the problem in within the food chain.

Martin Julius Chegere in "Post-harvest losses reduction by small-scale maize farmers: The role of handling practices" (Chegere, 2018) has shown that reducing post-harvest losses is a key component complementing the efforts to address problems of food safety and increase of incomes of agricultural enterprises, especially for low-income households. The research analyzes the role of recommended methods of harvest handling when it is reduced, and evaluates the losses and benefits associated with the practice of food loss reduction during storage.

Wondimagegn Tesfaye and Tirivayi, N. in the "The impacts of postharvest storage innovations on food security and welfare in Ethiopia" (Tesfaye and Tirivayi, 2018) analyzed the impact of advanced storage technologies, safety and welfare of food through

national representative data from Ethiopia. The study found that the use of advanced food storage technologies increases dietary diversity and reduces child malnutrition. Overall, research shows that improved storage technologies can improve food and nutrition security and can play a key role in mitigating nutrition problems of the growing population.

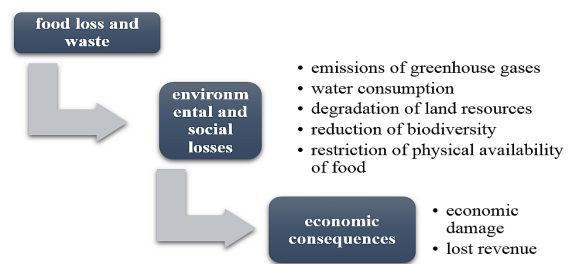
Timothy J. Richards and Stephen F. Hamilton in "Food waste in the sharing economy" (Richards and Hamilton, 2018) explore the potential for commercial peer-to-peer network interactions (CPMS) or enterprises that use shared economic resources, to enter the market as a platform for the exchange of surplus food. Scientists' findings suggest that secondary markets have key elements needed to succeed CPMS, and policy tools aimed at facilitating transactions in secondary markets can be very effective in reducing food waste.

"Future of food safety and nutrition – Seeking win-wins, coping with trade-offs" (Mylona et al., 2018) devoted to research the possible effects of global trends such as climate change and resource scarcity for food security. The document is based on the results of the study on safety and food in the EU by 2050.

Scientific paper "Food counts. Measuring food consumption and expenditures in household consumption and expenditure surveys (HCES). Introduction to the special issue" (Zezza et al., 2017) presents the results of an international multidisciplinary research project on measuring food intake in national household's surveys. The paper synthesized case studies in developing countries and OECD countries.

The article "Food Loss and Waste in Sub-Saharan Africa" (Sheahan and Barrett, 2018) explores current approaches to mitigate the effects of food loss and waste in Africa.

The synthesis of research results leads to the conclusion that the potential benefits of reducing food loss and waste are concentrated in three areas: environmental (rational use of resources to reduce anthropogenic load on the environment), social (increased food availability, poverty reduction and gender inequality, especially in rural areas) and economic (prevention of economic losses, saving money and resources), provided that sufficient food supplies are maintained (Figure 2).



Source: own work

Figure 2: Economic consequences of food loss and waste.

Our research focuses on economic aspects, in particular: economic damage and lost revenue in a result of food loss and waste in Ukraine.

The consequence of environmental and social losses in the result of food loss and waste is economic damage and lost revenue. We have defined the volumes of these indicators in Ukraine in terms of groups of cultures.

According to the calculations made, the losses from food waste and food by-products in Ukraine from 2015 to 2017 amounted to 5793.8 thousand tons of grain, 14014.6 thousand tons of potatoes, 9173.6 thousand tons of vegetables, 3050.7 thousand tons of fruits, 2450.1 thousand tons of meat and 5408,3 thousand tons of milk (Table 2). In relation to the volumes of production, the largest are losses from food waste and food by-products in fruits (42%), meat (35%) and vegetables (31%), and the smallest are in grain (3%).

It is important to note that the amount of food waste and food by-products' losses do not practically change at runtime, but the largest are in 2016, especially in grain that is determined to be the main indicator of food security. It is inappropriate to calculate over a longer period, as, according to previous studies (Babych and Kovalenko, 2018), the level of production and consumption of food per capita in Ukraine over the past 5 years has not changed substantially. That is why further calculations are carried out according to the data of 2016. Such insignificant fluctuations can be explained by the fact that production and consumption of the main products' types as well as technologies of production, storage and processing of agricultural products remain almost unaltered.

Thus, economic damage and lost revenue in the result of food loss and waste on grain in Ukraine in 2016 amounted respectively to 90.5 and 300.6 million EUR (Table 3). The largest amount of losses was found



in Poltava and Vinnytsya regions (correspondingly, 11.5 and 10.3 million EUR), and the smallest in Chernivtsy region (0.1 million EUR). In this case, the actual amount of grain consumed, taking into account lost food and food waste, is 34.5 centners per 1 hectare, i.e., from each hectare of crops was lost 1.8 centners of grain.

Economic damage and lost revenue in the result of food loss and waste of potatoes in Ukraine in 2016 amounted to 155.0 and 404.8 million EUR, respectively (Table 4). The largest amount of losses was found in Kyiv region (16.9 million EUR), and the smallest in Kherson region (2.5 million EUR). In fact, the consumed amount of potatoes, taking into account food loss and waste, is 130.4 centners per 1 hectare, i.e. from each hectare of crops was lost 35.4 centners of potatoes.

Economic damage and lost revenue in the result of food loss and waste on vegetables in Ukraine in 2016 amounted to 187.4 and 410.0 million EUR respectively (Table 5). The largest amount of losses was found in Kherson region (23.2 million EUR), and the smallest in Chernihiv region (4.5 million EUR). In fact, the amount of vegetables consumed,

taking into account food loss and waste, is 153.0 centners per 1 hectare, i.e., from each hectare of crops was lost 70.6 centners of vegetables.

Economic damage and lost revenue in the result of food loss and waste of fruits in Ukraine in 2016 amounted to 73.4 and 191.2 million EUR respectively (Table 6). The largest amount of losses was found in Kyiv and Odesa regions (7.1 and 8.5 million EUR respectively), and the smallest in Sumy and Chernihiv regions (respectively, 0.8 and 0.7 million EUR). In fact, the amount of fruits consumed, taking into account food loss, is 71.2 centners per 1 hectare, i.e., from each hectare of plantations was lost 50.1 centners of fruits.

Economic damage and lost revenue in the result of food loss and waste of meat in Ukraine in 2016 amounted respectively to 344.4 and 607.7 million EUR (Table 7). The largest losses recorded in Dnipro and Kyiv regions (37.0 and 38.8 million EUR respectively), while the smallest in Mykolayiv and Chernivtsi regions (5.4 million and 5.7 EUR million respectively).

| Step of the FSC                               | Meat   |       |       | Milk   |        |        | Fruits |       |        | Cereals (grain crops) |        |        | Roots (potatoes) |        |        | Vegetables |        |        |
|---|--------|-------|-------|--------|--------|--------|--------|-------|--------|-----------------------|--------|--------|------------------|--------|--------|------------|--------|--------|
|   | 2015   | 2016  | 2017  | 2015   | 2016   | 2017   | 2015   | 2016  | 2017   | 2015                  | 2016   | 2017   | 2015             | 2016   | 2017   | 2015       | 2016   | 2017   |
| Agricultural production                       | 74.3   | 74.3  | 74.2  | 385.0  | 376.5  | 372.9  | 215.0  | 208.7 | 215.0  | 429.5                 | 371.6  | 442.3  | 1943.2           | 1903.2 | 1943.2 | 850.5      | 874.8  | 850.5  |
| in percentages relative to data on losses     | 9.1    | 9.1   | 9.1   | 22.0   | 22.0   | 19.2   | 20.8   | 21.2  | 20.8   | 26.5                  | 14.6   | 27.3   | 41.5             | 41.0   | 41.5   | 28.4       | 27.7   | 28.2   |
| Postharvest handling and storage              | 16.3   | 16.3  | 16.2  | 53.1   | 51.9   | 51.4   | 4.3    | 4.2   | 4.3    | 84.2                  | 72.8   | 86.7   | 70.0             | 68.5   | 70.0   | 17.0       | 17.5   | 17.0   |
| in percentages relative to data on losses     | 2.0    | 2.0   | 2.0   | 3.0    | 3.0    | 2.7    | 0.4    | 0.4   | 0.4    | 5.2                   | 2.9    | 5.3    | 1.5              | 1.5    | 1.5    | 0.6        | 0.6    | 0.6    |
| Processing and packaging                      | 192.9  | 192.8 | 192.7 | 182.2  | 178.2  | 209.6  | 43.2   | 41.4  | 43.1   | 524.7                 | 995.9  | 517.6  | 1165.2           | 1166.3 | 1165.2 | 108.4      | 114.8  | 109.4  |
| in percentages relative to data on losses     | 23.6   | 23.6  | 23.6  | 10.4   | 10.4   | 10.8   | 4.2    | 4.2   | 4.2    | 32.3                  | 39.1   | 31.9   | 24.9             | 25.1   | 24.9   | 3.6        | 3.6    | 3.6    |
| Distribution: Supermarket Retail              | 146.6  | 146.5 | 146.4 | 75.9   | 74.3   | 87.5   | 284.7  | 269.6 | 283.9  | 44.1                  | 83.7   | 43.5   | 462.2            | 462.6  | 462.2  | 745.8      | 792.7  | 754.3  |
| in percentages relative to data on losses     | 17.9   | 17.9  | 17.9  | 4.3    | 4.3    | 4.5    | 27.5   | 27.4  | 27.5   | 2.7                   | 3.3    | 2.7    | 9.9              | 10.0   | 9.9    | 24.9       | 25.1   | 25.0   |
| Consumption                                   | 387.1  | 386.9 | 386.6 | 1057.3 | 1034.4 | 1218.2 | 486.9  | 460.9 | 485.4  | 539.9                 | 1024.8 | 532.6  | 1043.9           | 1044.9 | 1043.9 | 1275.3     | 1355.5 | 1289.9 |
| in percentages relative to data on losses     | 47.4   | 47.4  | 47.4  | 60.3   | 60.3   | 62.8   | 47.1   | 46.8  | 47.1   | 33.3                  | 40.2   | 32.8   | 22.3             | 22.5   | 22.3   | 42.6       | 43.0   | 42.7   |
| In total                                      | 817.1  | 816.9 | 816.1 | 1753.4 | 1715.3 | 1939.6 | 1034.1 | 984.8 | 1031.8 | 1622.3                | 2548.9 | 1622.6 | 4684.6           | 4645.4 | 4684.6 | 2997.1     | 3155.3 | 3021.2 |
| In total for 2015-2017                        | 2450.1 |       |       | 5408.3 |        |        | 3050.7 |       |        | 5793.8                |        |        | 14014.6          |        |        | 9173.6     |        |        |
| In percentages relative to data on production | 35.2   | 35.2  | 35.2  | 16.5   | 16.5   | 18.9   | 42.1   | 41.3  | 42.0   | 2.7                   | 4.9    | 2.6    | 21.1             | 21.4   | 21.1   | 30.8       | 31.6   | 31.1   |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 2: Food loss and waste of the main food groups in Ukraine, thousand tons.

| Region           | Gross production, ths. tons |   |                         | Yield, centners of 1 ha |   |                         | Gross products, mln. EUR |   |                         | Economic losses, mln. EUR | Lost revenue, mln. EUR |
|------------------|-----------------------------|---|-------------------------|-------------------------|---|-------------------------|--------------------------|---|-------------------------|---------------------------|------------------------|
|                  | In fact                     | taking into account the lost production |                         | In fact                 | taking into account the lost production |                         | In fact                  | taking into account the lost production |                         |                           |                        |
|                  |                             | In total                                | at the production stage |                         | In total                                | at the production stage |                          | In total                                | at the production stage |                           |                        |
| Ukraine          | 52022.2                     | 49473.3                                 | 51650.6                 | 36.3                    | 34.5                                    | 36.0                    | 1770.0                   | 1679.5                                  | 1757.3                  | 90.5                      | 300.6                  |
| Vinnyska         | 4648.6                      | 4345.6                                  | 4615.4                  | 53.6                    | 50.1                                    | 53.2                    | 158.2                    | 147.9                                   | 157.0                   | 10.3                      | 34.3                   |
| Volynska         | 659.1                       | 609.8                                   | 654.4                   | 22.4                    | 20.7                                    | 22.2                    | 22.4                     | 20.7                                    | 22.3                    | 1.7                       | 5.6                    |
| Dnipropetrovska  | 2211.2                      | 2173.5                                  | 2195.4                  | 20.2                    | 19.9                                    | 20.1                    | 75.2                     | 74.0                                    | 74.7                    | 1.3                       | 4.3                    |
| Donetska         | 1294.8                      | 1248.2                                  | 1285.6                  | 23.8                    | 23.0                                    | 23.7                    | 44.1                     | 42.5                                    | 43.7                    | 1.6                       | 5.3                    |
| Zhytomiryska     | 1807.6                      | 1673.7                                  | 1794.7                  | 46.2                    | 42.8                                    | 45.9                    | 61.5                     | 56.9                                    | 61.1                    | 4.6                       | 15.1                   |
| Zakarpatska      | 153.7                       | 138.1                                   | 152.6                   | 16.7                    | 15.0                                    | 16.6                    | 5.2                      | 4.7                                     | 5.2                     | 0.5                       | 1.8                    |
| Zaporizka        | 1966.9                      | 1894.8                                  | 1952.9                  | 22.3                    | 21.5                                    | 22.1                    | 66.9                     | 64.5                                    | 66.4                    | 2.5                       | 8.1                    |
| Ivano-Frankivska | 482.1                       | 446.3                                   | 478.7                   | 31.9                    | 29.5                                    | 31.6                    | 16.4                     | 15.2                                    | 16.3                    | 1.2                       | 4.0                    |
| Kyivska          | 2958.8                      | 2768.4                                  | 2937.7                  | 52.2                    | 48.8                                    | 51.8                    | 100.7                    | 94.2                                    | 100.0                   | 6.5                       | 21.5                   |
| Kirovohradska    | 2982.6                      | 2779.1                                  | 2961.3                  | 36.9                    | 34.4                                    | 36.6                    | 101.5                    | 94.6                                    | 100.8                   | 6.9                       | 23.0                   |
| Luhanska         | 1035.1                      | 1003.1                                  | 1027.7                  | 27.3                    | 26.4                                    | 27.1                    | 35.2                     | 34.1                                    | 35.0                    | 1.1                       | 3.6                    |
| Lvivska          | 972.1                       | 900.7                                   | 965.2                   | 32.0                    | 29.6                                    | 31.8                    | 33.1                     | 30.6                                    | 32.8                    | 2.4                       | 8.1                    |
| Mykolaivska      | 1888.3                      | 1828.8                                  | 1874.8                  | 22.6                    | 21.9                                    | 22.5                    | 64.2                     | 62.2                                    | 63.8                    | 2.0                       | 6.7                    |
| Odeska           | 3319.8                      | 3216.1                                  | 3296.1                  | 27.8                    | 26.9                                    | 27.6                    | 113.0                    | 109.4                                   | 112.1                   | 3.5                       | 11.7                   |
| Poltavska        | 4779.9                      | 4440.5                                  | 4745.8                  | 51.1                    | 47.5                                    | 50.7                    | 162.6                    | 151.1                                   | 161.5                   | 11.5                      | 38.4                   |
| Rivnenska        | 881.3                       | 845.5                                   | 875.0                   | 32.7                    | 31.4                                    | 32.5                    | 30.0                     | 28.8                                    | 29.8                    | 1.2                       | 4.0                    |
| Sumska           | 3578.0                      | 3356.3                                  | 3552.4                  | 55.4                    | 52.0                                    | 55.0                    | 121.7                    | 114.2                                   | 120.9                   | 7.5                       | 25.1                   |
| Ternopil'ska     | 1920.8                      | 1835.2                                  | 1907.1                  | 41.3                    | 39.4                                    | 41.0                    | 65.4                     | 62.4                                    | 64.9                    | 2.9                       | 9.7                    |
| Kharkiv'ska      | 3025.8                      | 2929.0                                  | 3004.2                  | 30.8                    | 29.8                                    | 30.6                    | 102.9                    | 99.7                                    | 102.2                   | 3.3                       | 10.9                   |
| Kherson'ska      | 1390.7                      | 1348.8                                  | 1380.8                  | 21.0                    | 20.3                                    | 20.8                    | 47.3                     | 45.9                                    | 47.0                    | 1.4                       | 4.7                    |
| Khmelnytska      | 2693.5                      | 2503.9                                  | 2674.3                  | 50.4                    | 46.8                                    | 50.0                    | 91.6                     | 85.2                                    | 91.0                    | 6.5                       | 21.4                   |
| Cherkaska        | 3614.0                      | 3410.7                                  | 3588.2                  | 54.8                    | 51.8                                    | 54.4                    | 123.0                    | 116.0                                   | 122.1                   | 6.9                       | 23                     |
| Chernivetska     | 186.5                       | 182.8                                   | 185.2                   | 15.2                    | 14.9                                    | 15.1                    | 6.3                      | 6.2                                     | 6.3                     | 0.1                       | 0.4                    |
| Chernihiv'ska    | 3571.0                      | 3484.0                                  | 3545.5                  | 54.6                    | 53.3                                    | 54.2                    | 121.5                    | 118.5                                   | 120.6                   | 3.0                       | 9.8                    |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 3: Economic losses as a result of food loss and waste in Ukraine in 2016 by grain crops.

| Region          | Gross production, ths. tons |   |                         | Yield, centners of 1 ha |   |                         | Gross products, mln. EUR |   |                         | Economic losses, mln. EUR | Lost revenue, mln. EUR |
|-----------------|-----------------------------|---|-------------------------|-------------------------|---|-------------------------|--------------------------|---|-------------------------|---------------------------|------------------------|
|                 | In fact                     | taking into account the lost production |                         | In fact                 | taking into account the lost production |                         | In fact                  | taking into account the lost production |                         |                           |                        |
|                 |                             | In total                                | at the production stage |                         | In total                                | at the production stage |                          | In total                                | at the production stage |                           |                        |
| Ukraine         | 21750.5                     | 17105.1                                 | 19847.3                 | 165.8                   | 130.4                                   | 151.3                   | 725.7                    | 570.7                                   | 662.2                   | 155.0                     | 404.8                  |
| Vinnitska       | 1848.5                      | 1472.7                                  | 1686.8                  | 170.8                   | 136.1                                   | 155.9                   | 61.7                     | 49.1                                    | 56.3                    | 12.5                      | 32.7                   |
| Volynska        | 1132.4                      | 943.8                                   | 1033.3                  | 157.3                   | 131.1                                   | 143.5                   | 37.8                     | 31.5                                    | 34.5                    | 6.3                       | 16.4                   |
| Dnipropetrovska | 602.1                       | 419.6                                   | 549.4                   | 113.0                   | 78.7                                    | 103.1                   | 20.1                     | 14.0                                    | 18.3                    | 6.1                       | 15.9                   |
| Donetska        | 409.1                       | 254.5                                   | 373.3                   | 114.6                   | 71.3                                    | 104.6                   | 13.6                     | 8.5                                     | 12.5                    | 5.2                       | 13.5                   |
| Zhytomyrsk      | 1316.6                      | 1031.2                                  | 1201.4                  | 189.4                   | 148.4                                   | 172.9                   | 43.9                     | 34.4                                    | 40.1                    | 9.5                       | 24.9                   |
| Zakarpatska     | 534.3                       | 429.4                                   | 487.5                   | 158.1                   | 127.0                                   | 144.2                   | 17.8                     | 14.3                                    | 16.3                    | 3.5                       | 9.1                    |
| Zaporizka       | 263.7                       | 181.2                                   | 240.6                   | 120.4                   | 82.7                                    | 109.9                   | 8.8                      | 6.0                                     | 8.0                     | 2.8                       | 7.2                    |
| Ivano-Frankivsk | 975.1                       | 781.3                                   | 889.8                   | 164.2                   | 131.5                                   | 149.8                   | 32.5                     | 26.1                                    | 29.7                    | 6.5                       | 16.9                   |
| Kyivsk          | 1703.1                      | 1197.8                                  | 1554.1                  | 179.5                   | 126.2                                   | 163.8                   | 56.8                     | 40.0                                    | 51.9                    | 16.9                      | 44.0                   |
| Kirovohradska   | 603.4                       | 445.7                                   | 550.6                   | 148.3                   | 109.5                                   | 135.3                   | 20.1                     | 14.9                                    | 18.4                    | 5.3                       | 13.7                   |
| Luhansk         | 252.8                       | 153.0                                   | 230.7                   | 147.0                   | 89.0                                    | 134.1                   | 8.4                      | 5.1                                     | 7.7                     | 3.3                       | 8.7                    |
| Lvivsk          | 1618.9                      | 1319.4                                  | 1477.2                  | 172.4                   | 140.5                                   | 157.3                   | 54.0                     | 44.0                                    | 49.3                    | 10.0                      | 26.1                   |
| Mykolaivsk      | 268.5                       | 188.8                                   | 245.0                   | 141.3                   | 99.4                                    | 128.9                   | 9.0                      | 6.3                                     | 8.2                     | 2.7                       | 6.9                    |
| Odeska          | 541.1                       | 403.5                                   | 493.8                   | 148.7                   | 110.9                                   | 135.7                   | 18.1                     | 13.5                                    | 16.5                    | 4.6                       | 12.0                   |
| Poltavsk        | 1065.4                      | 891.3                                   | 972.2                   | 196.6                   | 164.4                                   | 179.4                   | 35.5                     | 29.7                                    | 32.4                    | 5.8                       | 15.2                   |
| Rivnensk        | 1249.4                      | 1035.4                                  | 1140.1                  | 178.7                   | 148.1                                   | 163.1                   | 41.7                     | 34.5                                    | 38.0                    | 7.1                       | 18.6                   |
| Sumsk           | 1065.6                      | 838.4                                   | 972.4                   | 185.3                   | 145.8                                   | 169.1                   | 35.6                     | 28.0                                    | 32.4                    | 7.6                       | 19.8                   |
| Ternopilsk      | 987.0                       | 810.6                                   | 900.6                   | 168.4                   | 138.3                                   | 153.7                   | 32.9                     | 27.0                                    | 30.0                    | 5.9                       | 15.4                   |
| Kharkivsk       | 1077.7                      | 834.6                                   | 983.4                   | 175.2                   | 135.7                                   | 159.9                   | 36.0                     | 27.8                                    | 32.8                    | 8.1                       | 21.2                   |
| Khersonsk       | 279.6                       | 204.3                                   | 255.1                   | 117.5                   | 85.8                                    | 107.2                   | 9.3                      | 6.8                                     | 8.5                     | 2.5                       | 6.6                    |
| Khmelnytsk      | 1320.5                      | 1085.5                                  | 1205.0                  | 200.7                   | 165.0                                   | 183.1                   | 44.1                     | 36.2                                    | 40.2                    | 7.8                       | 20.5                   |
| Cherkask        | 839.2                       | 660.7                                   | 765.8                   | 164.2                   | 129.3                                   | 149.9                   | 28.0                     | 22.0                                    | 25.5                    | 6.0                       | 15.6                   |
| Chernivetsk     | 594.7                       | 470.7                                   | 542.7                   | 175.4                   | 138.8                                   | 160.1                   | 19.8                     | 15.7                                    | 18.1                    | 4.1                       | 10.8                   |
| Chernihivsk     | 1201.8                      | 1051.4                                  | 1096.6                  | 151.4                   | 132.4                                   | 138.1                   | 40.1                     | 35.1                                    | 36.6                    | 5.0                       | 13.1                   |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 4: Economic losses as a result of food loss and waste in Ukraine in 2016 on potatoes.

| Region           | Gross production, ths. tons |   |                         | Yield, centners of 1 ha |   |                         | Gross products, mln. EUR |   |                         | Economic losses, mln. EUR | Lost revenue, mln. EUR |
|------------------|-----------------------------|---|-------------------------|-------------------------|---|-------------------------|--------------------------|---|-------------------------|---------------------------|------------------------|
|                  | In fact                     | taking into account the lost production |                         | In fact                 | taking into account the lost production |                         | In fact                  | taking into account the lost production |                         |                           |                        |
|                  |                             | In total                                | at the production stage |                         | In total                                | at the production stage |                          | In total                                | at the production stage |                           |                        |
| Ukraine          | 9997.9                      | 6842.6                                  | 9123.1                  | 223.6                   | 153.0                                   | 204.1                   | 593.9                    | 406.4                                   | 541.9                   | 187.4                     | 410.0                  |
| Vinnyska         | 506.9                       | 358.8                                   | 462.5                   | 233.6                   | 165.3                                   | 213.1                   | 30.1                     | 21.3                                    | 27.5                    | 8.8                       | 19.2                   |
| Volynska         | 288.7                       | 206.4                                   | 263.4                   | 218.7                   | 156.4                                   | 199.5                   | 17.1                     | 12.3                                    | 15.6                    | 4.9                       | 10.7                   |
| Dnipropetrovska  | 765.4                       | 542.3                                   | 698.4                   | 214.4                   | 151.9                                   | 195.6                   | 45.5                     | 32.2                                    | 41.5                    | 13.3                      | 29.0                   |
| Donetska         | 228.1                       | 63.6                                    | 208.1                   | 153.1                   | 42.7                                    | 139.7                   | 13.5                     | 3.8                                     | 12.4                    | 9.8                       | 21.4                   |
| Zhytomyrska      | 298.9                       | 207.3                                   | 272.7                   | 255.5                   | 177.2                                   | 233.1                   | 17.8                     | 12.3                                    | 16.2                    | 5.4                       | 11.9                   |
| Zakarpatska      | 267.2                       | 185.4                                   | 243.8                   | 207.1                   | 143.7                                   | 189.0                   | 15.9                     | 11.0                                    | 14.5                    | 4.9                       | 10.6                   |
| Zaporizka        | 437.0                       | 301.0                                   | 398.8                   | 244.1                   | 168.2                                   | 222.8                   | 26.0                     | 17.9                                    | 23.7                    | 8.1                       | 17.7                   |
| Ivano-Frankivska | 172.2                       | 107.8                                   | 157.1                   | 164.0                   | 102.7                                   | 149.6                   | 10.2                     | 6.4                                     | 9.3                     | 3.8                       | 8.4                    |
| Kyivska          | 641.7                       | 382.1                                   | 585.6                   | 223.6                   | 133.1                                   | 204.0                   | 38.1                     | 22.7                                    | 34.8                    | 15.4                      | 33.7                   |
| Kirovohradska    | 256.2                       | 181.2                                   | 233.8                   | 150.7                   | 106.6                                   | 137.5                   | 15.2                     | 10.8                                    | 13.9                    | 4.5                       | 9.7                    |
| Luhanska         | 180.1                       | 106.4                                   | 164.3                   | 191.6                   | 113.2                                   | 174.8                   | 10.7                     | 6.3                                     | 9.8                     | 4.4                       | 9.6                    |
| Lvivska          | 505.7                       | 336.6                                   | 461.5                   | 199.1                   | 132.5                                   | 181.7                   | 30.0                     | 20.0                                    | 27.4                    | 10.0                      | 22.0                   |
| Mykolaivska      | 528.3                       | 365.2                                   | 482.1                   | 276.6                   | 191.2                                   | 252.4                   | 31.4                     | 21.7                                    | 28.6                    | 9.7                       | 21.2                   |
| Odeska           | 380.4                       | 238.7                                   | 347.1                   | 156.5                   | 98.2                                    | 142.8                   | 22.6                     | 14.2                                    | 20.6                    | 8.4                       | 18.4                   |
| Poltavska        | 546.6                       | 395.8                                   | 498.8                   | 223.1                   | 161.6                                   | 203.6                   | 32.5                     | 23.5                                    | 29.6                    | 9.0                       | 19.6                   |
| Rivnenska        | 236.2                       | 163.9                                   | 215.5                   | 196.8                   | 136.6                                   | 179.6                   | 14.0                     | 9.7                                     | 12.8                    | 4.3                       | 9.4                    |
| Sumska           | 208.5                       | 145.3                                   | 190.3                   | 196.7                   | 137.1                                   | 179.5                   | 12.4                     | 8.6                                     | 11.3                    | 3.8                       | 8.2                    |
| Ternopilska      | 259.5                       | 181.5                                   | 236.8                   | 221.8                   | 155.1                                   | 202.4                   | 15.4                     | 10.8                                    | 14.1                    | 4.6                       | 10.1                   |
| Kharkivska       | 759.4                       | 547.9                                   | 693.0                   | 248.2                   | 179.1                                   | 226.5                   | 45.1                     | 32.5                                    | 41.2                    | 12.6                      | 27.5                   |
| Khersonska       | 1504.1                      | 1114.1                                  | 1372.5                  | 368.7                   | 273.1                                   | 336.4                   | 89.3                     | 66.2                                    | 81.5                    | 23.2                      | 50.7                   |
| Khmelnyska       | 229.0                       | 158.6                                   | 209.0                   | 206.3                   | 142.9                                   | 188.3                   | 13.6                     | 9.4                                     | 12.4                    | 4.2                       | 9.1                    |
| Cherkaska        | 367.9                       | 261.6                                   | 335.7                   | 179.5                   | 127.6                                   | 163.8                   | 21.9                     | 15.5                                    | 19.9                    | 6.3                       | 13.8                   |
| Chernivetska     | 237.4                       | 161.2                                   | 216.6                   | 194.6                   | 132.1                                   | 177.5                   | 14.1                     | 9.6                                     | 12.9                    | 4.5                       | 9.9                    |
| Chernihivska     | 192.5                       | 129.9                                   | 175.7                   | 179.9                   | 121.4                                   | 164.2                   | 11.4                     | 7.7                                     | 10.4                    | 3.7                       | 8.1                    |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 5: Economic losses as a result of food loss and waste in Ukraine in 2016 by vegetable.

| Region           | Gross production, ths. tons |  |                            | Yield, centners of 1 ha |  |                            | Gross products, mln. EUR |  |                            | Economic losses,<br>mln. EUR | Lost revenue, mln.<br>EUR |
|------------------|-----------------------------|--|----------------------------|-------------------------|--|----------------------------|--------------------------|--|----------------------------|------------------------------|---------------------------|
|                  | In fact                     | taking into account the lost<br>production |                            | In fact                 | taking into account the lost<br>production |                            | In fact                  | taking into account the lost<br>production |                            |                              |                           |
|                  |                             | In total                                   | at the production<br>stage |                         | In total                                   | at the production<br>stage |                          | In total                                   | at the production<br>stage |                              |                           |
| Ukraine          | 2385.1                      | 1400.3                                     | 2176.4                     | 121.3                   | 71.2                                       | 110.6                      | 177.8                    | 104.4                                      | 162.3                      | 73.4                         | 191.2                     |
| Vinnyska         | 273.2                       | 184.5                                      | 249.3                      | 123.1                   | 83.1                                       | 112.3                      | 20.4                     | 13.8                                       | 18.6                       | 6.6                          | 17.2                      |
| Volynska         | 37.3                        | 20.0                                       | 34.0                       | 79.4                    | 42.6                                       | 72.3                       | 2.8                      | 1.5  | 2.5                        | 1.3                          | 3.4                       |
| Dnipropetrovska  | 154.5                       | 91.6                                       | 141.0                      | 115.3                   | 68.4                                       | 105.2                      | 11.5                     | 6.8  | 10.5                       | 4.7                          | 12.2                      |
| Donetska         | 90.5                        | 47.7                                       | 82.6                       | 139.2                   | 73.4                                       | 127.1                      | 6.7                      | 3.6  | 6.2                        | 3.2                          | 8.3                       |
| Zhytomyrska      | 41.8                        | 23.8                                       | 38.1                       | 113.0                   | 64.3                                       | 103.0                      | 3.1                      | 1.8  | 2.8                        | 1.3                          | 3.5                       |
| Zakarpatska      | 153.3                       | 105.9                                      | 139.9                      | 123.6                   | 85.4                                       | 112.8                      | 11.4                     | 7.9  | 10.4                       | 3.5                          | 9.2                       |
| Zaporizka        | 67.2                        | 35.9                                       | 61.3                       | 85.1                    | 45.4                                       | 77.6                       | 5.0                      | 2.7  | 4.6                        | 2.3                          | 6.1                       |
| Ivano-Frankivska | 49.5                        | 27.0                                       | 45.2                       | 58.2                    | 31.8                                       | 53.2                       | 3.7                      | 2.0  | 3.4                        | 1.7                          | 4.4                       |
| Kyivska          | 71.5                        | -24.2                                      | 65.2                       | 82.2                    | -27.8                                      | 74.9                       | 5.3                      | -1.8                                       | 4.9                        | 7.1                          | 18.6                      |
| Kirovohradska    | 30.7                        | 15.2                                       | 28.0                       | 62.7                    | 31.0                                       | 57.1                       | 2.3                      | 1.1  | 2.1                        | 1.2                          | 3.0                       |
| Luhanska         | 27.4                        | 6.6  | 25.0                       | 57.1                    | 13.8                                       | 52.1                       | 2.0                      | 0.5  | 1.9                        | 1.5                          | 4.0                       |
| Lvivska          | 109.0                       | 65.8                                       | 99.5                       | 86.5                    | 52.2                                       | 79.0                       | 8.1                      | 4.9  | 7.4                        | 3.2                          | 8.4                       |
| Mykolaivska      | 87.5                        | 50.7                                       | 79.8                       | 182.3                   | 105.6                                      | 166.3                      | 6.5                      | 3.8  | 6.0                        | 2.7                          | 7.1                       |
| Odeska           | 316.3                       | 202.6                                      | 288.6                      | 390.5                   | 250.1                                      | 356.3                      | 23.6                     | 15.1                                       | 21.5                       | 8.5                          | 22.1                      |
| Poltavska        | 79.1                        | 50.8                                       | 72.2                       | 138.8                   | 89.1                                       | 126.7                      | 5.9                      | 3.8  | 5.4                        | 2.1                          | 5.5                       |
| Rivnenska        | 77.9                        | 55.1                                       | 71.1                       | 118.0                   | 83.5                                       | 107.7                      | 5.8                      | 4.1  | 5.3                        | 1.7                          | 4.4                       |
| Sumska           | 15.8                        | 5.2  | 14.4                       | 54.5                    | 17.9                                       | 49.7                       | 1.2                      | 0.4  | 1.1                        | 0.8                          | 2.1                       |
| Ternopilska      | 73.7                        | 47.9                                       | 67.3                       | 124.9                   | 81.2                                       | 114.1                      | 5.5                      | 3.6  | 5.0                        | 1.9                          | 5.0                       |
| Kharkivska       | 79.1                        | 29.6                                       | 72.2                       | 125.6                   | 47.0                                       | 114.6                      | 5.9                      | 2.2  | 5.4                        | 3.7                          | 9.6                       |
| Khersonska       | 91.2                        | 56.2                                       | 83.2                       | 123.2                   | 75.9                                       | 112.4                      | 6.8                      | 4.2  | 6.2                        | 2.6                          | 6.8                       |
| Khmelnyska       | 201.1                       | 140.5                                      | 183.5                      | 142.6                   | 99.6                                       | 130.1                      | 15.0                     | 10.5                                       | 13.7                       | 4.5                          | 11.8                      |
| Cherkaska        | 51.3                        | 26.3                                       | 46.8                       | 95.0                    | 48.7                                       | 86.7                       | 3.8                      | 2.0  | 3.5                        | 1.9                          | 4.9                       |
| Chernivetska     | 191.4                       | 130.4                                      | 174.7                      | 119.6                   | 81.5                                       | 109.2                      | 14.3                     | 9.7  | 13.0                       | 4.5                          | 11.8                      |
| Chernihivska     | 14.8                        | 5.2  | 13.5                       | 46.3                    | 16.3                                       | 42.2                       | 1.1                      | 0.4  | 1.0                        | 0.7                          | 1.9                       |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 6: Economic losses as a result of food loss and waste in Ukraine in 2016 on fruits.



| Region           | Gross production, ths. tons |  |                               | Gross products, mln. EUR |  |                               | Economic losses,<br>mln. EUR | Lost revenue, mln.<br>EUR |
|------------------|-----------------------------|--|-------------------------------|--------------------------|--|-------------------------------|------------------------------|---------------------------|
|                  | In fact                     | taking into account the lost<br>production |                               | In fact                  | taking into account the lost<br>production |                               |                              |                           |
|                  |                             | In total                                   | at the<br>production<br>stage |                          | In total                                   | at the<br>production<br>stage |                              |                           |
| Ukraine          | 2323.6                      | 1506.7                                     | 2249.3                        | 979.8                    | 635.4                                      | 948.4                         | 344.4                        | 607.7                     |
| Vinnyska         | 324.3                       | 238.6                                      | 313.9                         | 136.7                    | 100.6                                      | 132.4                         | 36.1                         | 63.8                      |
| Volynska         | 122.4                       | 90.9                                       | 118.5                         | 51.6                     | 38.3                                       | 50.0                          | 13.3                         | 23.4                      |
| Dnipropetrovska  | 239.7                       | 152.0                                      | 232.0                         | 101.1                    | 64.1                                       | 97.8                          | 37.0                         | 65.2                      |
| Donetska         | 86.2                        | 28.0                                       | 83.4                          | 36.3                     | 11.8                                       | 35.2                          | 24.5                         | 43.3                      |
| Zhytomyrska      | 53.3                        | 36.9                                       | 51.6                          | 22.5                     | 15.6                                       | 21.8                          | 6.9                          | 12.2                      |
| Zakarpatska      | 51.3                        | 35.8                                       | 49.7                          | 21.6                     | 15.1                                       | 21.0                          | 6.5                          | 11.5                      |
| Zaporizka        | 57.1                        | 32.0                                       | 55.3                          | 24.1                     | 13.5                                       | 23.3                          | 10.6                         | 18.7                      |
| Ivano-Frankivska | 80.0                        | 57.0                                       | 77.4                          | 33.7                     | 24.0                                       | 32.6                          | 9.7                          | 17.1                      |
| Kyivska          | 198.7                       | 106.8                                      | 192.3                         | 83.8                     | 45.0                                       | 81.1                          | 38.8                         | 68.4                      |
| Kirovohradska    | 52.1                        | 35.9                                       | 50.4                          | 22.0                     | 15.1                                       | 21.3                          | 6.8                          | 12.1                      |
| Luhanska         | 21.2                        | 2.9  | 20.5                          | 8.9                      | 1.2  | 8.6                           | 7.7                          | 13.6                      |
| Lvivska          | 123.0                       | 77.3                                       | 119.1                         | 51.9                     | 32.6                                       | 50.2                          | 19.3                         | 34.0                      |
| Mykolaivska      | 31.0                        | 18.3                                       | 30.0                          | 13.1                     | 7.7  | 12.6                          | 5.4                          | 9.4                       |
| Odeska           | 46.2                        | 21.1                                       | 44.7                          | 19.5                     | 8.9  | 18.8                          | 10.6                         | 18.7                      |
| Poltavska        | 80.2                        | 52.5                                       | 77.6                          | 33.8                     | 22.1                                       | 32.7                          | 11.7                         | 20.6                      |
| Rivnenska        | 55.0                        | 37.5                                       | 53.2                          | 23.2                     | 15.8                                       | 22.4                          | 7.4                          | 13.0                      |
| Sumska           | 45.5                        | 30.3                                       | 44.0                          | 19.2                     | 12.8                                       | 18.6                          | 6.4                          | 11.3                      |
| Ternopil'ska     | 52.6                        | 34.2                                       | 50.9                          | 22.2                     | 14.4                                       | 21.5                          | 7.8                          | 13.7                      |
| Kharkivska       | 95.1                        | 55.3                                       | 92.1                          | 40.1                     | 23.3                                       | 38.8                          | 16.8                         | 29.6                      |
| Khersonska       | 41.5                        | 26.2                                       | 40.2                          | 17.5                     | 11.0                                       | 17.0                          | 6.5                          | 11.4                      |
| Khmelnyska       | 66.0                        | 44.8                                       | 63.9                          | 27.8                     | 18.9                                       | 26.9                          | 8.9                          | 15.8                      |
| Cherkaska        | 323.6                       | 243.4                                      | 313.2                         | 136.5                    | 102.6                                      | 132.1                         | 33.8                         | 59.7                      |
| Chernivetska     | 42.0                        | 28.4                                       | 40.7                          | 17.7                     | 12.0                                       | 17.2                          | 5.7                          | 10.1                      |
| Chernihivska     | 35.6                        | 20.7                                       | 34.5                          | 15.0                     | 8.7  | 14.5                          | 6.3                          | 11.1                      |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 7: Economic losses as a result of food loss and waste in Ukraine in 2016 for meat.

Economic damage and lost revenue in the result of food loss and waste on milk in Ukraine in 2016 amounted to 141.2 and 310.2 million EUR, respectively (Table 8). The largest amount of losses was established in Vinnytsya and Kyiv regions (respectively 9.9 and 10.9 million EUR), and the smallest in Zakarpattia, Luhansk and Chernivtsy regions (respectively 3.3, 3.2 and 3.0 million EUR).

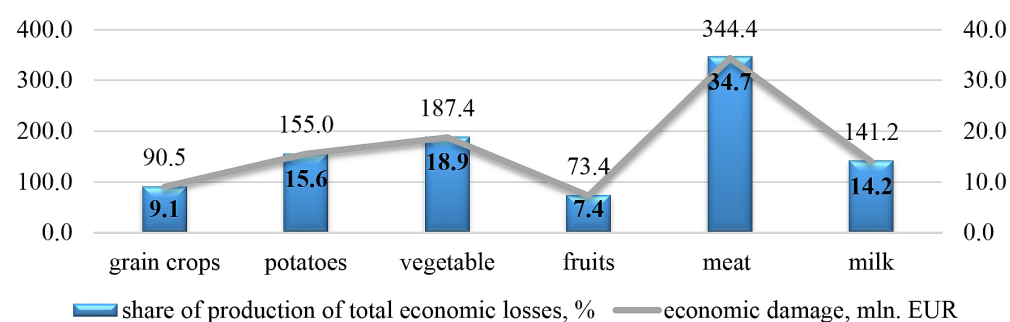
Such indicators are totally unacceptable, given the fact that the level of profitability of agricultural production in Ukraine in 2016 amounted to 37.8 % for cereals, 19.7 % for vegetables, 18.2 % for milk, and potato and meat production was generally unprofitable.

On a global scale, the amount of economic losses and income foregone, in 2016, respectively, amounted to 991.9 and 2224.5 million EUR. Figure 3 and 4 show that meat (34.7%) is the main

source of economic damage and lost revenue in the result of food loss and waste in Ukraine in 2016, on second place – vegetables, on the third – potatoes, on the fourth – milk, on the fifth – grain, on the last position – fruits.

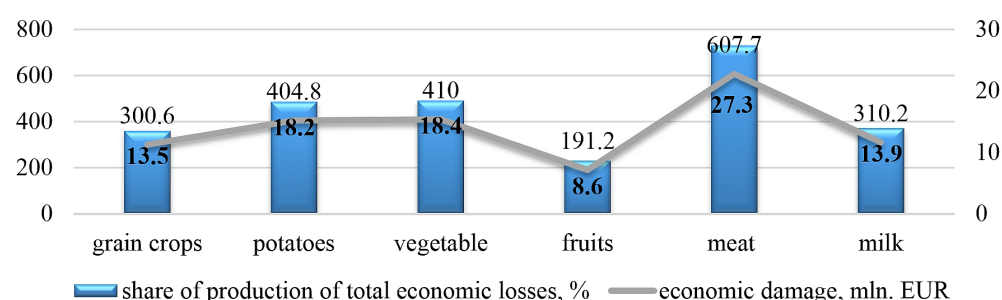
By regions and by economic damage in the result of food loss and waste, the leading position on meat remains in virtually all regions except for six: Donetsk and Sumy regions have the highest share of economic losses on potatoes (respectively 28.1 and 24.3%); Mykolayiv and Kherson regions – on vegetables (respectively, 35.8 and 57.9 %); Chernihiv region – by milk (25.2 %); Kirovohrad region – by grain (24.4 %) (Table 9).

Figure 5 data show that the contribution of regions to the total amount of economic damage in the result of food loss and waste in Ukraine in 2016 ranges from 2.1 % in the Luhansk region to 9.6 % in Kyiv region.



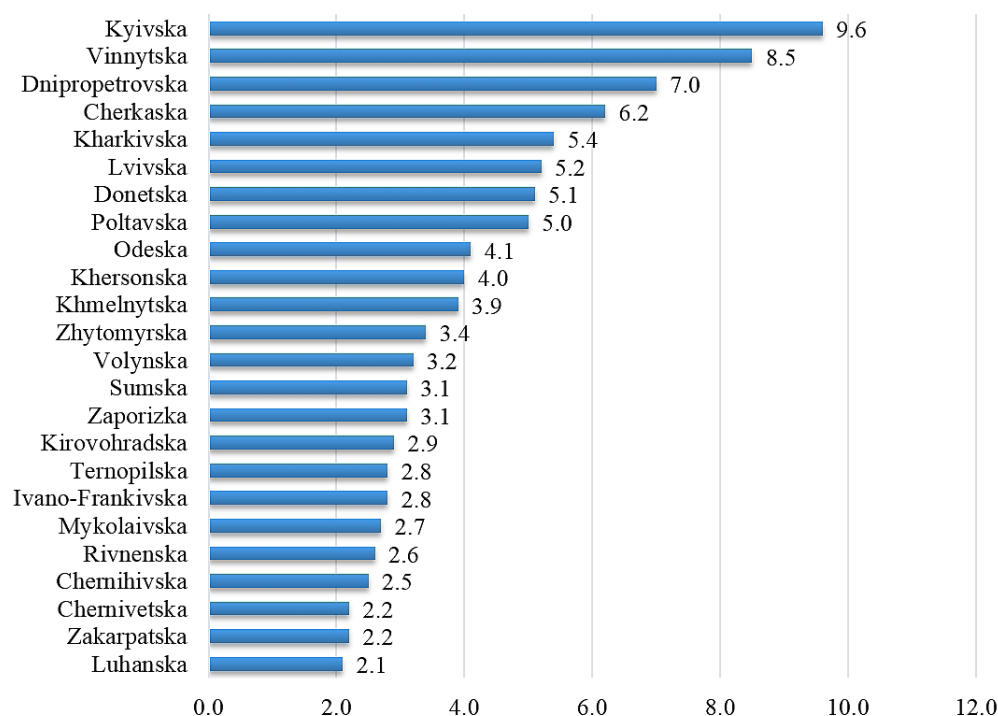
Source: own calculations based on State Statistics Service of Ukraine (2016).

Figure 3: Contribution of each type of product to economic losses as a result of food loss and waste in Ukraine in 2016.



Source: own calculations based on State Statistics Service of Ukraine (2016).

Figure 4: The contribution of each type of product to the lost revenue as a result of food loss and waste in Ukraine in 2016.



Source: own calculations based on State Statistics Service of Ukraine (2016).

Figure 5: Contribution of each region to economic losses as a result of food loss and waste in Ukraine in 2016, %.

| Region           | In total | Including:          |                     |                     |                     |                     |                     |                     |                     |                     |                     |                     |                     |
|------------------|----------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|                  |          | grain crops         |                     | potatoes            |                     | vegetable           |                     | fruits              |                     | meat                |                     | milk                |                     |
|                  |          | share of the region | share of production | share of the region | share of production | share of the region | share of production | share of the region | share of production | share of the region | share of production | share of the region | share of production |
| Ukraine          | 100.0    | 100.0               | 9.1                 | 100.0               | 15.6                | 100.0               | 18.9                | 100.0               | 7.4                 | 100.0               | 34.7                | 100.0               | 14.2                |
| Vinnitska        | 8.5      | 11.4                | 12.2                | 8.1                 | 14.9                | 4.7                 | 10.4                | 9.0                 | 7.8                 | 10.5                | 42.9                | 7.0                 | 11.8                |
| Volynska         | 3.2      | 1.9                 | 5.3                 | 4.1                 | 20.0                | 2.6                 | 15.6                | 1.8                 | 4.1                 | 3.9                 | 42.3                | 2.8                 | 12.7                |
| Dnipropetrovska  | 7.0      | 1.4                 | 1.8                 | 3.9                 | 8.8                 | 7.1                 | 19.1                | 6.4                 | 6.7                 | 10.7                | 53.2                | 5.1                 | 10.4                |
| Donetska         | 5.1      | 1.8                 | 3.1                 | 3.3                 | 10.1                | 5.2                 | 19.2                | 4.3                 | 6.3                 | 7.1                 | 48.2                | 4.7                 | 13.1                |
| Zhytomyrska      | 3.4      | 5.0                 | 13.4                | 6.1                 | 28.1                | 2.9                 | 16.0                | 1.8                 | 4.0                 | 2.0                 | 20.4                | 4.3                 | 18.1                |
| Zakarpatska      | 2.2      | 0.6                 | 2.4                 | 2.3                 | 15.7                | 2.6                 | 21.8                | 4.8                 | 15.9                | 1.9                 | 29.4                | 2.3                 | 14.8                |
| Zaporizka        | 3.1      | 2.7                 | 8.1                 | 1.8                 | 9.0                 | 4.3                 | 26.5                | 3.2                 | 7.7                 | 3.1                 | 34.7                | 3.0                 | 14.0                |
| Ivano-Frankivska | 2.8      | 1.3                 | 4.4                 | 4.2                 | 23.2                | 2.0                 | 13.7                | 2.3                 | 6.0                 | 2.8                 | 34.8                | 3.5                 | 17.8                |
| Kyivska          | 9.6      | 7.2                 | 6.8                 | 10.9                | 17.6                | 8.2                 | 16.1                | 9.7                 | 7.5                 | 11.3                | 40.5                | 7.7                 | 11.4                |
| Kirovohradska    | 2.9      | 7.7                 | 24.4                | 3.4                 | 18.5                | 2.4                 | 15.7                | 1.6                 | 4.1                 | 2.0                 | 24.1                | 2.7                 | 13.3                |
| Luhanska         | 2.1      | 1.2                 | 5.1                 | 2.1                 | 15.6                | 2.3                 | 20.5                | 2.1                 | 7.3                 | 2.2                 | 36.2                | 2.3                 | 15.2                |
| Lvivska          | 5.2      | 2.7                 | 4.7                 | 6.4                 | 19.2                | 5.4                 | 19.3                | 4.4                 | 6.2                 | 5.6                 | 37.0                | 5.0                 | 13.6                |
| Mykolaivska      | 2.7      | 2.2                 | 7.5                 | 1.7                 | 9.8                 | 5.2                 | 35.8                | 3.7                 | 10.1                | 1.6                 | 19.8                | 3.2                 | 17.0                |
| Odeska           | 4.1      | 3.9                 | 8.6                 | 3.0                 | 11.2                | 4.5                 | 20.5                | 11.5                | 20.7                | 3.1                 | 25.8                | 3.8                 | 13.2                |
| Poltavska        | 5.0      | 12.8                | 23.3                | 3.7                 | 11.7                | 4.8                 | 18.1                | 2.9                 | 4.3                 | 3.4                 | 23.5                | 6.7                 | 19.2                |
| Rivnenska        | 2.6      | 1.3                 | 4.7                 | 4.6                 | 27.4                | 2.3                 | 16.5                | 2.3                 | 6.5                 | 2.1                 | 28.3                | 3.1                 | 16.6                |
| Sumska           | 3.1      | 8.3                 | 24.1                | 4.9                 | 24.3                | 2.0                 | 12.0                | 1.1                 | 2.5                 | 1.9                 | 20.5                | 3.7                 | 16.5                |
| Ternopilska      | 2.8      | 3.2                 | 10.4                | 3.8                 | 21.0                | 2.5                 | 16.5                | 2.6                 | 6.9                 | 2.3                 | 27.7                | 3.5                 | 17.6                |
| Kharkivska       | 5.4      | 3.6                 | 6.1                 | 5.2                 | 15.1                | 6.7                 | 23.3                | 5.0                 | 6.9                 | 4.9                 | 31.2                | 6.7                 | 17.5                |
| Khersonska       | 4.0      | 1.6                 | 3.6                 | 1.6                 | 6.3                 | 12.4                | 57.9                | 3.6                 | 6.5                 | 1.9                 | 16.1                | 2.7                 | 9.6                 |
| Khmelnitska      | 3.9      | 7.1                 | 16.8                | 5.1                 | 20.5                | 2.2                 | 10.9                | 6.2                 | 11.8                | 2.6                 | 23.3                | 4.5                 | 16.6                |
| Cherkaska        | 6.2      | 7.6                 | 11.2                | 3.8                 | 9.6                 | 3.4                 | 10.2                | 2.5                 | 3.0                 | 9.8                 | 54.8                | 4.9                 | 11.1                |
| Chernivetska     | 2.2      | 0.1                 | 0.6                 | 2.7                 | 18.7                | 2.4                 | 20.5                | 6.2                 | 20.6                | 1.7                 | 25.9                | 2.2                 | 13.7                |
| Chernihivska     | 2.5      | 3.3                 | 11.8                | 3.2                 | 20.1                | 2.0                 | 14.9                | 1.0                 | 2.9                 | 1.8                 | 25.1                | 4.5                 | 25.2                |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 9: Contribution of each region and product type to economic losses as a result of food loss and waste in Ukraine in 2016, %.

However, in terms of product types, there are significantly higher fluctuations, except for milk, for which the ratio between the highest and lowest values is 1:3.5. Thus, in the total amount of economic losses caused by food loss and waste in Ukraine in 2016, the largest contribution was made by the Poltava region (12.8%), potatoes – Kyiv region (10.9 %), vegetables – Kherson (12.4 %), fruits – Odesa (11.5 %), milk – Kyiv (7.7 %), for meat almost equal shares in Vinnytsya (10.5 %), Dnipro (10.7 %) and Kyiv (11.3 %) region.

Economic damage resulting from food loss and waste per 100 hectares of agricultural land in Ukraine in 2016 amounted to about 2.8 thousand EUR, of which almost 589.4 EUR at the production stage (Table 10).

Among the 24 regins of Ukraine, half has higher losses per 100 hectares of agricultural land compared to averaged data on Ukraine, in particular: in Vinnytsya, Volyn, Dnipro, Donetsk, Zakarpattia, Ivano-Frankivsk, Kyiv, Lviv, Rivne, Ternopil, Cherkasy and Chernivtsi regions. At the same time, at the production stage, 14 regions have higher losses per 100 hectares of agricultural land compared to averaged data on Ukraine, in particular: in Vinnytsya, Volyn, Zhytomyr,

Zakarpattia, Ivano-Frankivsk, Kyiv, Lviv, Poltava, Rivne, Ternopil, Kherson, Khmelnytsky, Cherkasy and Chernivtsi regions. More than 5 thousand EUR of economic damage were recorded in Zakarpattia, Ivano-Frankivsk, Kyiv, Lviv and Chernivtsi regions; less than 2 thousand EUR – in Zaporizhia, Kirovohrad, Mykolayiv, Luhanska, Odeska and Chernihiv regions.

Economic damage due to food loss and waste per 100 people in Ukraine in 2016 amounted to about 2.5 thousand EUR, of which almost 520 EUR at the production stage (Table 11).

Almost half of the 24 regions have higher rates of loss per 100 population compared to averaged data on Ukraine, in particular: Vinnytsya, Volyn, Zhytomyr, Kyiv, Kirovohrad, Poltava, Sumy, Ternopil, Kherson, Khmelnytsky and Cherkasy regions. At the same time, at the production stage, 15 regions have higher losses per hectare of 100 hectares of agricultural land compared to averaged data on Ukraine, in particular: Vinnytsya, Volyn, Zhytomyr, Kyiv, Kirovohrad, Mykolayiv, Poltava, Rivne, Sumy, Ternopil, Kherson, Khmelnytsky, Cherkasy, Chernivtsi and Chernihiv regions.

| Region           | Cost of gross output per 100 hectares of farmland: |   |                     |   |                         |   |
|------------------|--|---|---------------------|---|-------------------------|---|
|                  | In fact  |   | Food loss and waste |   |                         |   |
|                  | thousand<br>EUR                                    | in percentages relative<br>to data on Ukraine | thousand<br>EUR     | in percentages relative<br>to data on Ukraine | at the production stage |   |
|                  |  |   |                     |   | EUR                     | in percentages relative<br>to data on Ukraine |
| Ukraine          | 14.6   | 100.0   | 2.8                 | 100.0   | 589.4                   | 100.0   |
| Vinnitska        | 26.0   | 177.9   | 4.6                 | 161.7   | 973.5                   | 165.0   |
| Volynska         | 19.9   | 136.3   | 3.8                 | 132.9   | 970.2                   | 164.9   |
| Dnipropetrovska  | 12.7   | 87.1  | 3.2                 | 111.4   | 523.2                   | 88.6  |
| Donetska         | 7.3  | 50.2  | 2.9                 | 100.9   | 284.8                   | 48.1  |
| Zhytomyrska      | 15.1   | 103.8   | 2.6                 | 92.6  | 662.3                   | 112.1   |
| Zakarpatska      | 25.4   | 173.8   | 5.7                 | 202.3   | 1450.3                  | 245.8   |
| Zaporizka        | 7.2  | 49.0  | 1.4                 | 50.5  | 258.3                   | 43.8  |
| Ivano-Frankivska | 27.4   | 187.5   | 5.6                 | 198.9   | 1351.0                  | 229.2   |
| Kyivska          | 21.2   | 145.2   | 6.3                 | 222.5   | 890.7                   | 151.3   |
| Kirovohradska    | 10.4   | 71.3  | 1.6                 | 55.9  | 314.6                   | 53.6  |
| Luhanska         | 4.4  | 30.3  | 1.2                 | 44.0  | 162.3                   | 27.6  |
| Lvivska          | 22.0   | 150.6   | 5.2                 | 181.6   | 1145.7                  | 194.3   |
| Mykolaivska      | 8.6  | 58.7  | 1.5                 | 53.6  | 337.7                   | 57.3  |
| Odeska           | 10.3   | 70.3  | 1.9                 | 65.5  | 367.5                   | 62.6  |
| Poltavska        | 18.3   | 125.3   | 2.7                 | 95.2  | 602.6                   | 102.5   |
| Rivnenska        | 19.1   | 130.8   | 3.3                 | 116.4   | 970.2                   | 164.7   |
| Sumska           | 15.5   | 106.1   | 2.2                 | 76.0  | 486.8                   | 82.4  |
| Ternopil'ska     | 18.5   | 126.6   | 2.9                 | 102.2   | 748.3                   | 127.0   |
| Kharkiv'ska      | 12.5   | 85.7  | 2.5                 | 86.8  | 509.9                   | 86.8  |
| Kherson'ska      | 10.9   | 74.8  | 2.2                 | 79.1  | 615.9                   | 104.7   |
| Khmelnitska      | 16.2   | 111.1   | 2.6                 | 90.9  | 649.0                   | 110.4   |
| Cherkaska        | 27.0   | 185.1   | 4.7                 | 165.2   | 874.2                   | 148.3   |
| Chernivetska     | 21.7   | 148.4   | 5.0                 | 176.0   | 1278.1                  | 217.1   |
| Chernihiv'ska    | 13.4   | 91.7  | 1.4                 | 50.3  | 433.8                   | 73.4  |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 10: Economic losses as a result of food loss and waste per 100 hectares of agricultural land in Ukraine in 2016.

| Region           | Cost of gross output per 100 hectares of farmland: |   |                     |   |                         |   |
|------------------|--|---|---------------------|---|-------------------------|---|
|                  | In fact  |   | Food loss and waste |   |                         |   |
|                  | thousand<br>EUR                                    | in percentages relative<br>to data on Ukraine | thousand<br>EUR     | in percentages relative<br>to data on Ukraine | at the production stage |   |
|                  |  |   |                     |   | EUR                     | in percentages relative<br>to data on Ukraine |
| Ukraine          | 12.9   | 100.0   | 2.5                 | 100.0   | 519.9                   | 100.0   |
| Vinnitska        | 30.0   | 233.3   | 5.3                 | 212.0   | 1125.8                  | 216.3   |
| Volynska         | 15.9   | 123.7   | 3.0                 | 120.7   | 778.1                   | 149.6   |
| Dnipropetrovska  | 8.7  | 67.3  | 2.2                 | 86.0  | 354.3                   | 68.4  |
| Donetska         | 3.1  | 23.9  | 1.2                 | 47.9  | 119.2                   | 22.8  |
| Zhytomyrska      | 15.8   | 122.5   | 2.7                 | 109.3   | 688.7                   | 132.2   |
| Zakarpatska      | 7.8  | 60.7  | 1.8                 | 70.7  | 447.0                   | 85.8  |
| Zaporizka        | 8.7  | 68.0  | 1.8                 | 70.0  | 314.6                   | 60.7  |
| Ivano-Frankivska | 9.8  | 76.1  | 2.0                 | 80.7  | 483.4                   | 92.9  |
| Kyivska          | 18.5   | 143.8   | 5.5                 | 220.3   | 778.1                   | 149.7   |
| Kirovohradska    | 19.3   | 150.1   | 2.9                 | 117.5   | 586.1                   | 112.7   |
| Luhanska         | 4.4  | 30.3  | 1.2                 | 44.0  | 162.3                   | 27.6  |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 11: Economic losses as a result of food loss and waste per 100 population in Ukraine in 2016 (to be continued).

| Region       | Cost of gross output per 100 hectares of farmland: |  |                     |  |                         |  |
|--------------|--|--|---------------------|--|-------------------------|--|
|              | In fact  |  | Food loss and waste |  |                         |  |
|              | thousand EUR                                       | in percentages relative to data on Ukraine | thousand EUR        | in percentages relative to data on Ukraine | at the production stage |  |
|              |  |  |                     |  | EUR                     | in percentages relative to data on Ukraine |
| Lvivska      | 8.8  | 68.1                                       | 2.1                 | 82.1                                       | 457.0                   | 87.8                                       |
| Mykolaivska  | 13.2   | 102.9                                      | 2.4                 | 94.0                                       | 523.2                   | 100.4                                      |
| Odeska       | 9.5  | 73.8                                       | 1.7                 | 68.7                                       | 341.1                   | 65.7                                       |
| Poltavska    | 23.5   | 183.0                                      | 3.5                 | 139.0                                      | 778.1                   | 149.6                                      |
| Rivnenska    | 13.0   | 100.7                                      | 2.2                 | 89.6                                       | 658.9                   | 126.8                                      |
| Sumska       | 20.3   | 157.8                                      | 2.8                 | 113.1                                      | 635.8                   | 122.5                                      |
| Ternopilska  | 16.9   | 131.2                                      | 2.6                 | 105.9                                      | 682.1                   | 131.5                                      |
| Kharkivska   | 10.1   | 78.7                                       | 2.0                 | 79.7                                       | 413.9                   | 79.7                                       |
| Khersonska   | 18.4   | 143.3                                      | 3.8                 | 151.6                                      | 1043.0                  | 200.4                                      |
| Khmelnytska  | 18.7   | 145.6                                      | 3.0                 | 119.1                                      | 751.7                   | 144.5                                      |
| Cherkaska    | 28.9   | 224.7                                      | 5.0                 | 200.4                                      | 933.8                   | 179.8                                      |
| Chernivetska | 10.6   | 82.1                                       | 2.4                 | 97.3                                       | 622.5                   | 120.0                                      |
| Chernihivska | 22.7   | 176.3                                      | 2.4                 | 96.7                                       | 731.8                   | 141.0                                      |

Source: own calculations based on State Statistics Service of Ukraine (2016).

Table 11: Economic losses as a result of food loss and waste per 100 population in Ukraine in 2016 (continuation).

More than 5 thousand EUR of economic losses were recorded in Vinnytsya, Kyiv and Cherkasy regions; less than 2 thousand EUR – in Donetsk, Zakarpanska, Zaporizka, Luhansk and Odeska regions.

In relation to the volume of manufactured goods in the region, the largest are economic losses in the Donetsk region (39.1%), and the smallest – in Chernihiv region (10.7%).

The calculations confirm the thesis of the significant potential benefits of reducing food loss and waste, in particular as a strategy to meet the food deficit, which is projected to occur in 2050 with 9.3 billion people.

### Discussions

Domestic scientists devote insufficient attention to this problem: Ukraine does not have full-scale studies of food and food waste losses at the regional or national level.

Undoubtedly, there are scholarly works dealing with certain aspects of the problem under study, but they are local and unsystematic. There is no study of the impact of food and food waste on the level of degradation of land resources in Ukraine at all.

The vast majority of scientific works, in which the issue of food and food waste is studied in one way or another, belongs to a foreign scientific school. However, in the global food loss and waste calculations conducted by FAO, Ukraine does

not appear to be a separate country but classified as "Europe". It is obvious that the averaged indicators of this group are not close to the realities of Ukraine, and therefore – proposals for reducing food loss and waste, developed on the basis of such analytical data, can not be fully representative for our country, which required the corresponding calculations according to actual data (Babych, 2018).

The results obtained are of the utmost importance in shaping the food security policy on the basis of sustainable development of the agro-food sector in Ukraine. Firstly, it has been empirically proven, that food loss and waste results in significant economic damage and lost revenue. Secondly, the reduction of food loss and waste has positive environmental and social consequences: the expansion of physical access to food; reducing poverty and gender inequality, especially among the rural population; reduction of greenhouse gas emissions; reducing the load on water and land resources. This conclusion is especially important for agricultural producers, the vast majority of whom believe that additional profit can be obtained using extensive (through the expansion of cultivated areas) or intensive (through increased use of mineral fertilizers and plant protection products) farming methods.

The results of calculating economic losses at the stage of production are unexpected: they account for only 20.7% of the total amount

in the food price chain and are significantly lower than those at the stage of sales. Such indicators arose due to the fact, that FAO attributed Ukraine to a group of European countries, where weight percentages of food loss and waste, especially cereals, milk and meat, are very low, compared to Ukraine. Such indicators correspond to the level of technology of the developed countries, but are not yet available to Ukraine: the degree of wear of fixed assets in agriculture, forestry and fisheries makes up 37.3 % in 2016 (State Statistics Service of Ukraine, 2016); 57.7 % of livestock production in 2016 was produced by households without special equipment for mechanized milking, special refrigerated milk storage cells and specialized slaughter equipment. On the other hand, Ukraine has developed and adopted relevant laws that require compliance with European norms in the production of milk and meat, including mechanized milking and special areas for slaughter of animals, which significantly reduces the rates of food and food waste at this stage and they will indeed correspond to the FAO.

Another controversial issue is the weight percentages of food and food waste identified by FAO at the consumption stage. On the one hand, Ukrainians really have a habit since the Soviet Union, when there was a total deficit, including food, to the accumulation of food "in stock", which eventually leads to its loss due to spoilage. On the other hand, the vast majority of Ukrainians cannot afford to buy surplus products due to economic constraints: low wages and pensions at European prices for most types of food, especially in the winter because of the lack of infrastructure for processing and storage of products.

In our opinion, it is these studies – the clarification of weight percentages of food loss and waste for Ukraine – should be carried out in the future.

## Conclusion

The article assesses the level of economic losses caused by food loss and waste in Ukraine. The analysis was conducted in terms of regions and product types. The author's methodological approach to assessing the impact of food loss and waste on the economic losses is based on the following principles: objectives; unity; systematic; scientific knowledge; maximum informativeness.

It has been established that the economic consequences of food loss and waste are expressed by significant economic losses, which equate to futile losses and inefficient investments, and lost

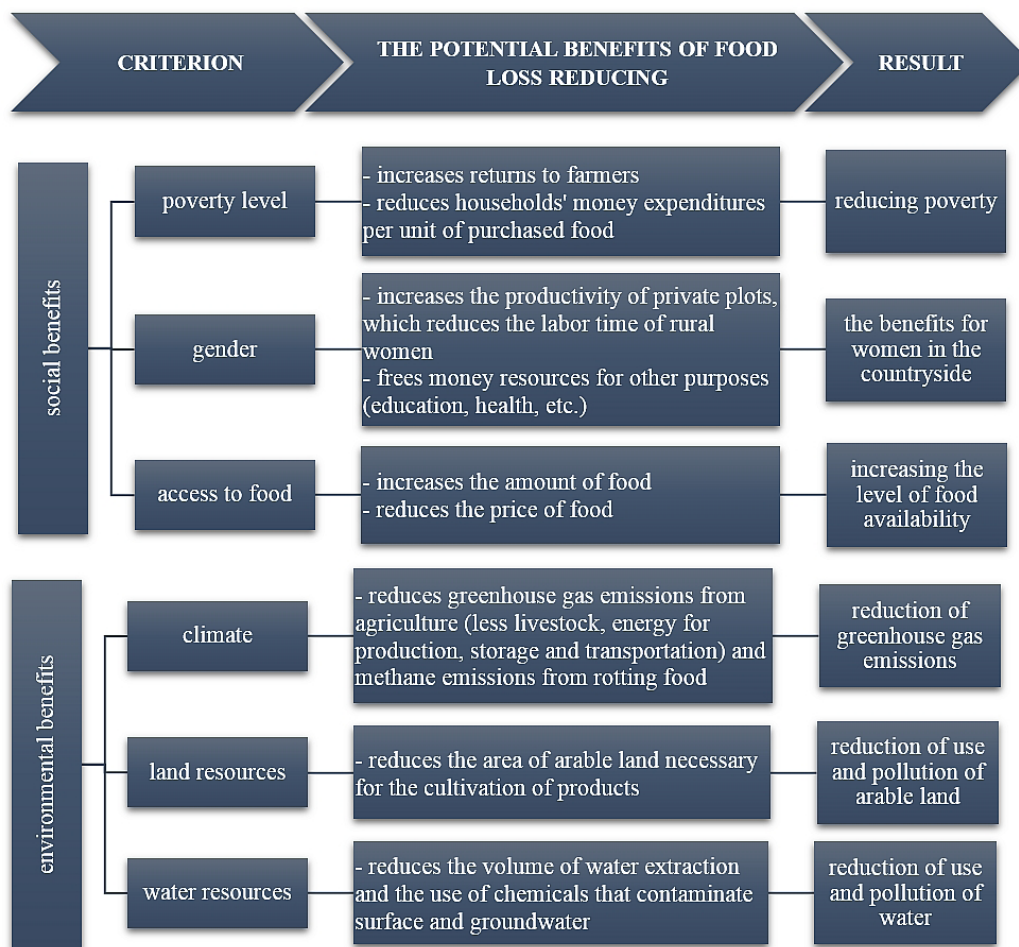
revenue, which reduces the economic well-being of all subjects in the chain of food value. The sum of economic losses in Ukraine in 2016 amounted to about 991.9 million EUR, which is 2.8 % of the budget of Ukraine in 2017, and a 2224.5 million EUR unsatisfied income. The main source of economic damage and lost revenue as a result of food loss and waste in Ukraine is meat, followed by vegetables, potatoes, milk, cereals, fruits and fruits. In 2016, per 100 hectares of agricultural land, economic losses as a result of food loss and waste in Ukraine amounted to about 2.8 thousand EUR against 6.9 thousand EUR of actual profits per 100 hectares of agricultural land, which is 40.6 % of the actual profits received; and economic losses as a result of food loss and waste in Ukraine per 100 people of the population amounted to 2.5 thousand EUR, which is almost 2% of the average annual salary of employees of agricultural enterprises.

It is substantiated that ensuring the physical and economic availability of food, reducing food loss and waste can significantly reduce poverty, provide gender benefits, reduce ecosystem pressure and climate. Reducing food loss and waste can be one of those rare strategies that will have the highest effect at a minimal cost. It should be understood that the potential advantages of food waste and food by-products' reduction are not limited to additional gross output and profits. Zero losses of food waste and food by-products will provide for significant social and environmental benefits (Figure 6).

The direct effect of reduction of economic losses (resulting from food waste and food by-products) upon poverty level lowering is undeniable: in such conditions, the manufactures have their profits rising, and the consumers receive the decrease in price.

In Ukraine, unlike member states of the European Union, agricultural producers should also include households of citizens, who grow and produce food products not only for their own consumption. Currently, this category of households produces far more crops of all types (with the exception of industrial crops) compared to farms. The volume of grown potatoes, vegetables and fruits is respectively 98, 86 and 82 % of their total harvested volume. Respective indicators in livestock production are high as well: 74 % of milk, 87 % of wool and 98 % of honey from their total harvested amount in 2016 was produced by households. Taking into account the number of such households and their role in provision of the population with certain crop and livestock products, *de facto* they are full members





Source: own work

Figure 6: Potential benefits of reducing food loss and waste in Ukraine.

of the food market as manufacturers, but de jure they are recognized only as products' consumers. The main workers in this category are women. Thus, for women, the reduction of economic losses (resulting from food waste and food by-products) will contribute to investment into education, health and other spheres of life.

Reduction of economic losses, resulting from food waste and food by-products, will decrease the production cost. Together with an increase in products' amount and as a result of zero losses, we will receive an increase in the level of physical and economic affordability of food for the population.

In Ukraine it is far more difficult to achieve environmental benefits. The problem is that, unlike the EU countries, Ukraine is still tending to increase production rate when it comes to food security. Taking into account the fact that the level of ploughness in Ukraine is 85.6% (in 14 regions this index exceeds the average data for the country),

the main source of volumes' increase is intensification, in particular the increase in introduction of chemical substances.

No global estimation of food waste and food by-products' losses as well as their environmental, social and economic consequences were carried out by domestic scientists so far. By objectively assessing the inadequate level of social responsibility of the overwhelming majority of domestic food manufacturers, the authors focus their attention on the economic consequences of food waste and food by-products' losses. At the moment, the most important task is to draw the attention of food manufacturers to the problem of food waste and food by-products. And the easiest way to achieve this is by using indicators understandable for them, namely income and profit. The next task is a reorientation from "increased production rate and increased losses" to "reduced losses and eco-efficient production".

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## References

- [1] Babych, M. and Kovalenko, A. (2018) "Food Security Indicators in Ukraine: Current State and Trends of Development", *Baltic Journal of Economic Studies*, Vol. 4, No. 1, pp. 8-15. ISSN 2256-0963. DOI 10.30525/2256-0742/2018-4-1-8-15.
- [2] Babych, M. (2018) "Losses of food and food waste on the basis of creating their value", *Poltava, CzFEND*, p. 16. UDK 33 (In Ukraine).
- [3] Chegere, M. J. (2018) "Post-harvest losses reduction by small-scale maize farmers: The role of handling practices", *Food Policy*, Vol. 77, pp. 103-115. ISSN 0306-9192. DOI 10.1016/j.foodpol.2018.05.001.
- [4] FAO (2011) "Global food losses and food waste – Extent, causes and prevention". FAO. [Online]. Available: <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf> [Accessed: 15 Apr. 2018].
- [5] FAO (2013) "Food Wastage Footprint: Impacts on Natural Resources", FAO. [Online]. Available: <http://www.fao.org/docrep/018/i3347e/i3347e.pdf> [Accessed: 15 Apr. 2018].
- [6] Hanson, C. and Mitchell, P. (2017) "The Business Case for Reducing Food Loss and Waste", *Champions 12.3: AIHW*. [Online]. Available: [http://www.wrap.org.uk/sites/files/wrap/Report\\_The%20Business%20Case%20for%20Reducing%20Food%20Loss%20and%20Waste.pdf](http://www.wrap.org.uk/sites/files/wrap/Report_The%20Business%20Case%20for%20Reducing%20Food%20Loss%20and%20Waste.pdf) [Accessed: 15 Apr. 2018].
- [7] Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L. and Searchinger, T. (2013) "Reducing Food Loss and Waste. Working Paper, Installment 2 of Creating a Sustainable Food Future". Washington, DC: World Resources Institute. [Online]. Available: <http://www.worldresourcesreport.org> [Accessed: 15 Apr. 2018].
- [8] Mylona, K., Maragkoudakis, P., Miko, L., Bock, A.-K., Wollgast, J., Caldeira, S. and Ulberth, F. (2017) "Viewpoint: Future of food safety and nutrition - Seeking win-wins, coping with trade-offs", *Food Policy*, Vol. 74, pp. 143-146. ISSN 0306-9192. DOI 10.1016/j.foodpol.2017.12.002.
- [9] Richards, T. J. and Hamilton, S. F. (2018) "Food waste in the sharing economy", *Food Policy*, Vol. 75, pp. 109-123. ISSN 0306-9192. DOI 10.1016/j.foodpol.2018.01.008.
- [10] SAVE FOOD (2015) "Global Initiative on Food Loss and Waste Reduction Food and Agriculture Organization of the United Nations", SAVE FOOD. [Online]. Available: <http://www.fao.org/3/a-i4068e.pdf> 25.02.2018 [Accessed: 15 Apr. 2018].
- [11] Schuster, M. and Torero, M. (2016) "Toward a sustainable food system: Reducing food loss and waste", In "2016 Global Food Policy Report". Washington, D.C.: International Food Policy Research Institute (IFPRI). [Online]. Available: <http://ebrary.ifpri.org/utills/getfile/collection/p15738coll2/id/130211/filename/130422.pdf> [Accessed: 15 Apr. 2018].
- [12] Sheahan, M. and Barrett, C. (2017) "Review: Food loss and waste in Sub-Saharan Africa", *Food Policy*, Vol. 70, pp. 1-12. ISSN 0306-9192. DOI 10.1016/j.foodpol.2017.03.012.
- [13] Tesfaye, W. and Tirivayi, N. (2018) "The impacts of postharvest storage innovations on food security and welfare in Ethiopia", *Food Policy*, Vol. 75, pp. 52-67. ISSN 0306-9192. DOI 10.1016/j.foodpol.2018.01.004.

- [14] Zezza, A., Carletto, C., Fiedler, J., Gennari, P. and Jolliffe, D. (2017) “Food counts. Measuring food consumption and expenditures in household consumption and expenditure surveys (HCES). Introduction to the special issue”, *Food Policy*, Vol. 72, pp. 1-6. ISSN 0306-9192. DOI 10.1016/j.foodpol.2017.08.007.
- [15] State Statistics Service of Ukraine (2017) “*Balances and consumption of the main food products by the population of Ukraine*”, State Statistics Service of Ukraine. [Online]. Available: <http://www.ukrstat.gov.ua/> [Accessed: 15 Apr. 2018].
- [16] State Statistics Service of Ukraine (2016) “*Agriculture, forestry and fishing. State Statistics Service of Ukraine*”. [Online]. Available: <http://www.ukrstat.gov.ua/> [Accessed: 15 Apr. 2018].
- [17] State Statistics Service of Ukraine (2016) “*On Approval of 2010 Constant Prices for Agricultural Products to Calculate the Agricultural Productivity Index*”. State Statistics Service of Ukraine. [Online]. Available: [https://ukrstat.org/uk/norm\\_doc/2011/362/362.htm](https://ukrstat.org/uk/norm_doc/2011/362/362.htm) [Accessed: 15 Apr. 2018].