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Economic and Environmental Aspects of Agri-food System in the EU Member States and Ukraine in Context of the European Green Deal Objectives

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***Abstract* — The main objective of the European Green Deal is to achieve full climate neutrality of the EU by 2050, including the agri-food system, which occupies a prominent place in the community economy. Producing zero net greenhouse gas emissions and promoting the sustainable development of the sector in the long term means a green transformation of all components of the EU agri-food system, primarily agricultural production and food industry. It has been determined that agricultural production is one of the main GHG emitters in the agri-food system of the EU and Ukraine, ahead of the food and processing industry. It has also been revealed that the amount of GHG (in carbon dioxide equivalent) from agricultural production per one US dollar of value added significantly exceeds the same value from the food and processing industry. This proves the fact that production of finished food is more sustainable than production of agricultural raw materials. Thus, progress in addressing the issue of achieving climate neutrality and ensuring sustainable development of the EU agri-food system largely depends on the greening of agriculture and the deepening of the degree of processing of agricultural raw materials. It is substantiated that in the context of Ukraine's integration into the EU, it is advisable to pay significant attention to the development of its own food and processing industry, which is not only beneficial from an economic side, but should also contribute to better achieving the European Green Deal purpose. It was clarified that in Ukraine and the EU, household food consumption and food waste disposal account for a relatively high percentage of GHG in the structure of the agri-food system. The study is based on 2022 data.**

Keywords* — *Agri-food system, European Green Deal, GHG emissions, value added.

I. INTRODUCTION

The implementation of the «Farm to Fork» strategy, which occupies a prominent place in the European Green Deal, provides for a sustainable agri-food system. The latter should provide Europeans with healthy, affordable and sustainable food, protect the environment and preserve biodiversity, promote increased organic farming, guarantee fair economic profits in the food chain and fight climate change [1].

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Since global climate change is closely related to GHG emissions, it is obvious that modern agri-food systems that produce about 1/3 of all GHG are serious culprits. At the same time, a deeper degree of processing of agricultural raw materials should contribute to an increase in the added value in the food chain. However, it still remains unclear how the issue of increasing the gross added value of the agri-food system with GHG emissions is consistent.

II. MATERIALS AND METHODS

The study is based on the current statistical database (2022) of the Food and Agriculture Organization of the United Nations (FAOSTAT), in particular in the section "Climate Change: Agri-food systems emissions." The theoretical basis was formed by the scientific works of Ukrainian and foreign scientists. Also, the strategy "From farm to fork" for a fair, healthy and environmentally-friendly food system was taken as a methodological basis.

The scientific research was conducted using the following general scientific methods: a comparison method that made it possible to compare generalized and derived economic and environmental indicators of the development of agri-food systems in the EU Member States and Ukraine; method of analysis, which made it possible to study the structure of agri-food systems according to the criteria for the formation of gross added value and GHG emissions.

At the same time, the article used several specific scientific methods, in particular: statistical methods of grouping and ranking - to establish the rank of EU member states in terms of gross value added created in the agri-food system per hectare of agricultural land; method of structural analysis - in the process of a detailed study of the specific gravity of each element of the agri-food system in terms of GHG emissions; method of economic analysis - to detect the fact of exceeding the GHG emissions (in carbon dioxide equivalent) from agricultural production per one US dollar of the added value of the corresponding indicator value in the food and processing industry; tabular and graphical methods in order to improve the analytical perception of statistical data and build correct research conclusions.

III. RESULTS AND DISCUSSIONS

Bartłomiej Bajan, Joanna Łukasiewicz, Aldona Mrówczyńska-Kamińska and Lukáš Čechura confirm that one decade before the European Green Deal announcement the total amount of GHG emissions from the agri-food production system in the EU Member States decreased while the share of the agri-food system in total GHG emissions increased. Moreover, the scientists revealed that the intensities between EU countries were varied and independent of economic development. Also, they observed the highest emission intensity at agricultural production stage [2].

In turn, Francisco José Castillo-Díaz, Luis J. Belmonte-Ureña, María J. López-Serrano and Francisco Camacho-Ferre revealed that more significant economic progress of the EU agricultural activity was associated with a lower quality of environmental indicators [3].

There are also many studies in which scientists reveal various aspects of the influence and interaction of economic and environmental criteria for the development of agri-food systems including in the EU [4] – [8].

Well-known, agri-food systems are all the interconnected activities and actors involved in getting food from field to fork. Their main components are agricultural production, food processing, food distribution, food consumption and food wate management [9]. Economic dimension of agri-food systems can be assessed by the different indicators, particularly by value added. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources [10]. It should be noted that added value generated by the EU agri-food system in 2022 was 900 billion Euro [11].

In order to compare the value added of the agri-food systems between the EU Member States and Ukraine, its ratio to the area of agricultural land was calculated. In 2022 the average meaning of this indicator in EU was 3505,24 USD (current USD). Among the Member States, Netherlands, Malta and Belgium had the highest level of agri-food value added – 19297; 13802 and 9523 USD accordingly (Fig.1). At the same time, more than half of the EU countries had below the average of this indicator. Mostly, these were Central and Eastern European countries, Balkan and Baltic countries. It should be noted that Ukraine, as a candidate country for accession to the EU, which has an international agri-food specialization and a high level of competitive advantages in this industry, demonstrated the lowest value added of the agri-food system per hectare of land - only 417 USD.

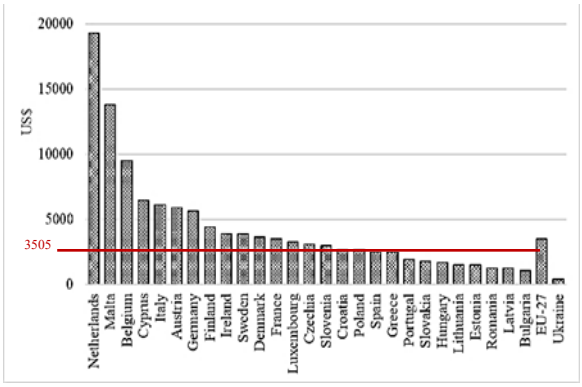

Fig. 1. Agri-food value added in the EU Member States and Ukraine in 2022, USD per 1 ha of agricultural land
Source: complied by the authors based on [12]

However, the Ukrainian agri-food system emitted in 3 times less CO2eq than the European system, particularly 2,2 t per 1 hectare of agricultural land. This indicates a higher level of greening of the agri-food system in Ukraine towards achieving the Green Deal objective. Among the main components, agricultural production was the leader

by GHG emissions not only in Ukraine but in the EU Member States too. Thus, if in the candidate country for accession the share of agriculture in total emissions equeled 30,3% then the meaning of indicator in EU – 37,9% (Fig.2).

Furthermore, among the activities of agricultural production, synthetic fertilizers using in the Ukrainian agricultural enterprises occupied the highest share in GHG emissions – 7,3% while the EU farmers produced the biggest part of emissions by enteric fermentation – 15,1%. It means that mostly agriculture of Ukraine specializes in crop cultivation, and European - in animal husbandry.

Globally, among the three components of agrifood systems in 2020, farm-gate emissions were nearly half of the total (7.4 Gt CO2eq), followed by emissions from pre- and post-production (5.6 Gt CO2eq) and land-use change (3.1 Gt CO2eq) [13].

The share of GHG emissions from food processing in Ukraine and the EU was only 4,7 and 12,6% accordingly.

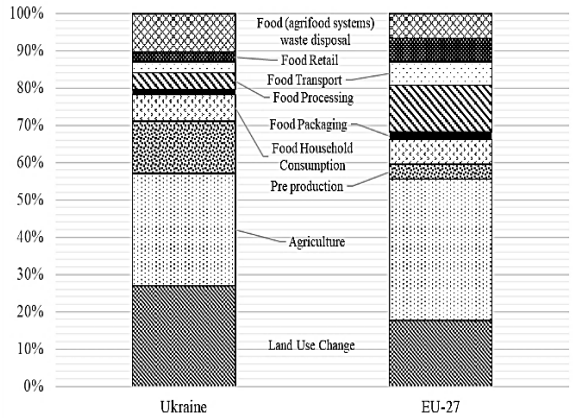

Fig.2. The structure of GHG emissions (CO_2 eq) in the EU and Ukrainian agri-food systems in 2022, %
Source: complied by the authors based on [12]

It should be noted that France and Italy were the leading states by this indicator – 25% and 29%. In contrast Latvia, Lithuania and Sweden had the smallest share – 1,7; 1,6 and 1,2 % accordingly.

Also, it was clarified that in Ukraine and the EU, food consumption and food waste disposal account for a relatively high percentage of carbon dioxide equivalent emissions in the structure of the agri-food systems. Particularly, the biggest share of GHG emissions from food household consumption was in Germany – 15,2%; Czechia – 13,2% and Portugal – 12,3%. In turn, Greece and Malta were the leaders by the share of carbon dioxide equivalent emissions from food (agri-food systems) waste disposal – 25,2% and 22,6% accordingly.

It has also been revealed that the amount of GHG (in carbon dioxide equivalent) from agricultural production per one US dollar of value added exceeds the same value from the food and processing industry. By the method of induction, it can be assumed that such a pattern will be inherent in other countries as well. However, it should be studied.

TABLE 1 $CO_{2\ EQ}$ EMISSIONS PER VALUE ADDED IN AGRICULTURE AND FOOD PROCESSING BETWEEN THE EU MEMBER STATES AND UKRAINE IN 2022

№	Country	Value added (current bln US$)		CO_2eq emissions, Mt		CO_2eq per value added, kg per 1 US$	
		Agriculture[1]	*Food Processing*[2]	*Agriculture*	*Food Processing*	*Agriculture*	*Food Processing*
1	Austria	6,5	8,8	8,5	1,3	1,3	0,1
2	Belgium	4,1	8,8	10,6	3,8	2,6	0,4
3	Bulgaria	3,3	2,0	3,8	1,2	1,2	0,6
4	Croatia	2,4	1,8	3,2	0,6	1,3	0,3
5	Cyprus	0,4	0,4	0,6	0,2	1,5	0,5
6	Czechia	6,3	4,6	8,3	2,6	1,3	0,6
7	Denmark	3,2	6,3	11,5	1,6	3,6	0,3
8	Estonia	0,9	0,5	1,6	0,5	1,8	1,0
9	Finland	6,3	3,7	5,3	0,6	0,8	0,2
10	France	49,3	50,1	79,6	42,5	1,6	0,8
11	Germany	41,8	62,2	60,4	16,9	1,4	0,3
12	Greece	8,2	6,0	8,2	1,6	1,0	0,3
13	Hungary	5,5	3,1	7,9	2,1	1,4	0,7
14	Ireland	6,0	10,9	23,0	1,4	3,8	0,1
15	Italy	39,8	40,1	42,7	39,8	1,1	1,0
16	Latvia	1,9	0,6	2,6	0,2	1,4	0,3
17	Lithuania	2,8	1,6	3,6	0,4	1,3	0,3
18	Luxembourg	0,2	0,2	0,7	0,06	3,5	0,3
19	Malta	0,1	-	0,1	0,03	1,0	*
20	Netherlands	17,2	17,6	29,3	6,5	1,7	0,4
21	Poland	19,5	18,2	36,6	10,5	1,9	0,6
22	Portugal	4,9	5,0	8,7	1,2	1,8	0,2
23	Romania	11,3	4,9	16,8	1,8	1,5	0,4
24	Slovakia	2,2	1,1	2,6	0,4	1,2	0,4
25	Slovenia	1,0	0,8	1,8	0,2	1,8	0,3
26	Spain	33,4	32,7	50,2	6,1	1,5	0,2
27	Sweden	6,0	6,1	7,3	0,6	1,2	0,1
	EU-27	284,7	298,2	436,1	144,1	1,5	0,5
	Ukraine	13,9	3,6	27,8	4,3	2,0	1,2

Source: compiled by the authors on based [12]

Note: [1] - Agriculture, forestry, and fishing; [2] – Food, beverages and tobacco.

In formalized form, this could be written by:

$$\frac{EM^i_{agr}}{VA^i_{agr}} > \frac{EM^i_{food}}{VA^i_{food}} \quad (1)$$

where EM^{i}_{agr} – GHG emissions (carbon dioxide equivalent) in agriculture in country i;

EM^{i}_{food} – GHG emissions (carbon dioxide equivalent) in food processing in country i;

VA^{i}_{agr} – value added in agriculture in country i;

VA^{i}_{food} - value added in food processing in country i;

For example, in Luxembourg, Austria and Ireland it was in 12, 13 and 38 times over. However, the average level of GHG emissions in the EU agriculture per 1 USD of value added was in 3 times bigger than relative indicator in food processing. In turn, in Ukraine the difference was less here (table 1).

Generally, this proves the fact that production of finished food is more sustainable than production of agricultural raw materials. As rule, it should be explained by relatively smaller carbon dioxide emissions from food processing industry. Obviously, in Austria, Finland, Ireland, Sweden, Spain and Portugal this component of agri-food system has been the most sustainable where the volume of GHG emissions per 1 USD of value added was between 0,1 to 0,2 kg. In contrast, Estonia, Italy and Ukraine demonstrated the lowest level of the indicator – approximately, 1 kg CO_2 eq emissions per 1 USD of value added.

Also, it should be noted that particularly agriculture mostly met sustainability criteria by the dimension in Finland, Greece and Italy. Another situation could be noticed in Belgium, Denmark, Ireland and Luxembourg.

In terms of the EU integration Ukraine has not enough level sustainability (first of all, economical dimension) of agri-food system totally and, particularly, agricultural production and food processing. Therefore, it should be the key direction in the transforming of the Ukrainian agri-food sector under conditions of negotiation process on EU accession.

IV. Conclusions

As a result of analysis which is based on the current statistical database (2022) of the Food and Agriculture Organization of the United Nations, it was determined that agricultural production has been being one of the main GHG emitters in the agri-food system of the EU and Ukraine, ahead of the food and processing industry.

It was revealed that the amount of GHG emissions (carbon dioxide equivalent) from agricultural production per one US dollar of value added, as rule, exceeds the same value from the food and processing industry in the EU and Ukraine. This proves the fact that finished food production is more sustainable process than production of agricultural raw materials.

It was found that the Ukrainian agri-food system ahead of the EU system by CO2eq emissions per 1 USD of value added in agricultural production and food processing and indicates the weaker sustainability of these parts of agri-food chain in Ukraine.

Among the EU Member States, relatively, the highest level of sustainability of agriculture was in Finland, Greece and Malta while more sustainable food processing was in Sweden, Ireland and Austria.

It was substantiated that in terms of the Ukraine's integration into the EU, it is advisable to develop, mostly, its own food and processing industry, which is not only beneficial from an economic dimension, but should also contribute to better achieving the European Green Deal objectives.

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