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The Impact of the Price Factor on Farmers' Incomes in Turbulent Conditions

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Abstract

Farmers face various types of risks that affect their behavioural strategies and well-being. In 2022, the main problem was the rapid and uncontrolled acceleration of inflation in the markets of raw materials, energy and food products. Farmers have faced price volatility in food, raw materials and energy. The purpose of the article was to analyse the impact of the price factor on farmers' incomes, including the total impact of prices on manufactured products and energy carriers. The regression-based analysis showed the negative nature of such an impact, which requires increased state support for farm income during the crisis period. As a result of the study, we proposed to reorient government support from simple subsidies to incentives for farmers to produce bioenergy from waste. This measure will increase farmers' energy independence, reduce income dependence on rising energy prices, and increase the efficiency of public spending.

Keywords

Bioenergy, energy independence, energy prices, farm income, governmental support, inflation, price shocks, price volatility, the price of agricultural products.

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Introduction

The problem of regulation and support of farm income is one of the main issues in European politics. Especially it became more complicated in the conditions of unprecedented acceleration of inflation in the markets of raw materials, energy carriers and foodstuffs practically in all countries. Large-scale Russian aggression in Ukraine has affected global food markets, value chains, agricultural supply chains, inflation and the financial environment for doing business. The disruptions exacerbated existing tensions in commodity markets following the recovery from the COVID-19 pandemic. As a result, commodity price volatility has risen sharply, and food prices reached their highest level since 2007-2008. Under such circumstances, the question arises of how farm incomes will behave. Will it increase because of rising prices or decrease as a result of rising prices for fertilizers and energy carriers? The political importance of this issue stems from the fact, that in the context of accelerating inflation in world commodity markets and tightening monetary policy against the backdrop of increased budget spending in EU countries to ensure national security, updated the task of increasing the efficiency of spending public funds to support the agricultural sector (Yurik et al., 2020).

The purpose of the article is to analyse the price factors that affect farmers' incomes in conditions of turbulence and to identify their cumulative impact.

In today's challenging environment, farmers face a variety of risks that affect their behaviour and well-being. First, in 2022, farmers faced volatile food prices, which are closely related to the crisis in the global food market. Price risk is the most economically sensitive and is associated with fluctuations in prices for finished products and resources. Therefore, farmers develop various strategies to cope with the consequences of exposure to risks, use the tools offered by the market, or diversify their sources of income.

The problem of the influence of prices on farm incomes is studied by many scientists. Assouto et al. (2020) argue that in agriculture, prices are subject

to sudden large fluctuations that make it impossible to build expectations and that quickly affect farm incomes. The significance of this price risk is mainly due to the delay between the production decision and the timing of the harvest, due to the elasticity of demand at a low price (Assouto et al. 2020; Mukaila, 2022).

Serra (2015) points to important volatility links between consumer and producer prices, who argue that price volatility for basic foodstuffs is one of the most complex factors influencing food security.

Increased price volatility means greater uncertainty about future prices for agricultural products, which can affect the welfare of producers, especially in the absence of a risk insurance mechanism (Rezitis and Stavropoulos, 2008).

Food price volatility affects smallholder farmers, who derive a significant portion of their income from food sales. Price fluctuations can distort the distribution of inputs, discourage investment in agriculture and reduce agricultural productivity growth, especially in the absence of effective risk-sharing mechanisms, with long-term consequences for poor consumers and farmers (Ceballos et al., 2017).

Jouf and Lawson (2022) concluded that rising agricultural prices have a statistically significant positive impact on agricultural production because in response to expected price changes, the crop mix is being adjusted qualitatively and quantitatively to achieve higher incomes.

Volatility in food prices has important economic and political implications. And in the context of additional volatility in energy prices, the total cost effect for farms is extremely difficult to determine, which increases their risks and can lead to a difficult situation in agricultural production. The multidirectional impact on farmers' incomes of food prices is upward, and that of energy prices is downward, which creates a situation of uncertainty and leads to insufficiently substantiated decisions in the field of agricultural policy. Policies to increase the responsiveness of supply and demand to changes in price, as well as to mitigate price risk and increase competition in agricultural markets, may be necessary to protect farmers' incomes. Therefore, it is important to investigate and determine the impact of the price factor on farm incomes, which will help stabilize farm incomes under turbulent conditions.

Materials and methods

Our goal was to assess the impact of the price factor associated with the dynamics of food and energy prices on farmers' incomes. For this, we used the data FAO, Eurostat Database, World Bank Data.

Using the data processing method and the graphical method of data series analysis, graphs were constructed illustrating the dynamics of changes in prices and incomes of farmers over time. This helped to track trends and identify dependencies between the studied indicators.

A factorial regression analysis of farm incomes was carried out and the hypothesis of mutually compensating influence of prices for energy resources and agricultural products on farm incomes was tested. The World Bank consumer energy price index is constructed explicitly, using surveys of the cost of a defined basket of consumer goods and services. The Laspeyres formula is generally used. Data are period averages. World Bank Energy price index is represented by weights coal (4.7 %), crude oil (84.6 %), and natural gas (10.8 %). To improve the results of the analysis of the profitability of farms and the profitability of labour, real indicators were used, clear of the price effect.

The conducted correlation-regression analysis made it possible to trace the relationship between farm income and a set of factors. One of the most common methods for estimating the parameters of multiple linear regression is the least squares method, the essence of which is to minimize the sum of squared deviations of the observed values of the dependent variable Y from the values, obtained on the basis of the constructed regression equation. The use of correlation-regression analysis made it possible to quantify the dependence of the volume of farm income on specific factors and to determine the most important indicators that affect the variable.

The general appearance of a multiple regression model can be seen in the formula:

$$y = a + b_1 X_1 + b_2 X_2 + \ \ldots + b_n X_n + \varepsilon$$

Where:

y – the dependent variable;

a – the y-intercept;

b – beta coefficient;

X_n – factors (the independent variables);

ε – the error term.

To measure the strength of linear relationships of different pairs of variables, a correlation matrix was calculated. In particular, it is taken into account that for each individual pair of variables, the linkage is influenced by links with other variables.

The coefficients of multiple correlations of the connection of the regression analysis indicate a fairly close relationship between the dependent variable and the factor values (multiple R is 0.8704). The calculated value of the coefficient of determination R Square = 0.7576 indicates a close relationship between the signs (the difference from unity is 0.2424). The value of R Square shows that the variation in farm income is 75.76 % determined by the factors selected above, and only 24.24 % is accounted for by other unaccounted quantities or factors. The conclusion about the adequacy of the model can be made on the basis of the calculated value of the Fisher significance F. The calculated value of Fisher's F-test – 0.1013 indicates that the model parameters are statistically significant.

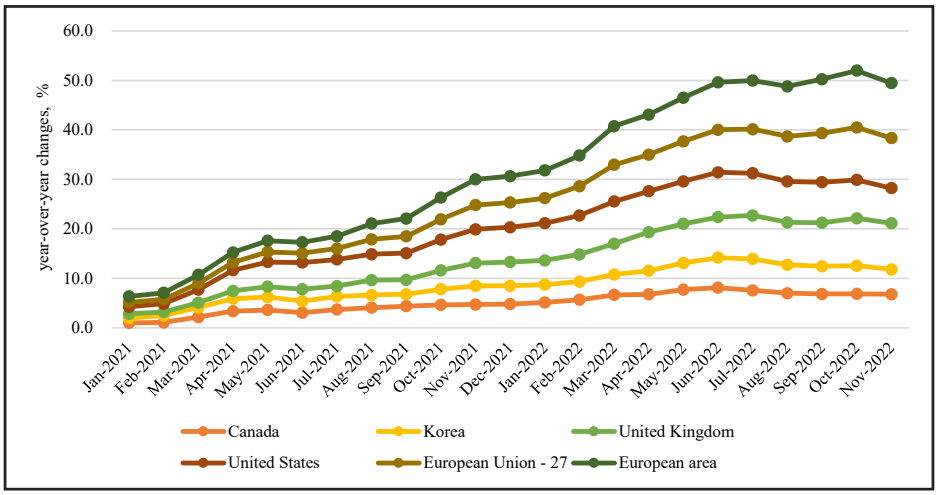
Results and discussion

The state of global food markets is extremely important for the inflationary dynamics in the EU and the income of their farms. The stagflation shock of 2022 is of a global nature associated with the consequences of Covid-19 and the fall in grain exports from Ukraine and Russia. The main feature of the war in Ukraine and the early spikes in food prices is the rise in food prices due to the impact of energy and fertilizer price volatility. In most countries, since February 2022, a significant surge in prices has been recorded against the background of a decrease in economic activity.

In particular, in the EU-27, consumer price growth in 2022 increased from 5.1% in January to 10.1% in November, in the US – from 7.5% to 7.1%, in the UK – from 4 .9% to 9.3%, Canada – from 5.1% to 6.8%, Korea – from 3.6% to 5.0%. Global inflation in 2022 is projected at 6.2%, up 2.25% from the original forecast (Figure 1).

The growth of world inflation is largely determined by the following factors:

- disruption of product supply chains as a result of hostilities in Ukraine and sanctions imposed against Russia;
- renewed supply disruptions as a result of new quarantine restrictions imposed in China;
- rising prices due to commodity shocks in many regional markets caused by a reduction in the supply of gas, oil, wheat, fertilizers and other materials as a result of the war in Ukraine. Prices for goods whose supply is limited are rising both directly (the increase in world food prices is caused by a drop in the supply of wheat, barley, corn, rapeseed and oil from Ukraine) and through inter-industry relations (for example, oil is an intermediate product that affects the cost of a large quantity of goods and services at the expense of raw materials and transportation costs);
- a gradual increase in demand for certain groups of goods as a result of the recovery of economic activity in the countries



Source: Authors´ own processing based on OECD Database

Figure 1: Growth rate of the consumer price index, % compared to the corresponding month last year.

of the world after the lifting of anti-COVID restrictions;

- decline in grain production in developing countries due to lack of fertilizers, the main suppliers of which were Ukraine and Russia;
- termination of gas supplies by Russia to some EU countries (Poland, Bulgaria, Denmark, etc.);
- rising oil prices due to bans on Russian oil imports imposed by countries of the sanction's coalition (USA, EU, UK). The price of Brent crude rose 20% to $139 per barrel (the highest level since 2008);
- tightening labour markets in many countries (USA, UK, Canada and Australia) due to labour shortages caused by the pandemic. This threatens to create a wage-price spiral where, with limited labour supply, businesses must pay higher wages to get the skilled workers they need, further pushing up prices.

These trends have led to significant increases in government spending to keep food supply chains functioning, help producers overcome disruptions, and provide additional food assistance to poor consumers. Figure 2 shows that in 2020 and 2021, governments spent an additional USD 55 billion and USD 70 billion, respectively, representing 10% and 13% of all budget support in those years. And these data represent only the lower bound of the actual additional costs during the pandemic. And extra budget expenditures serve as an additional factor in increasing inflation.

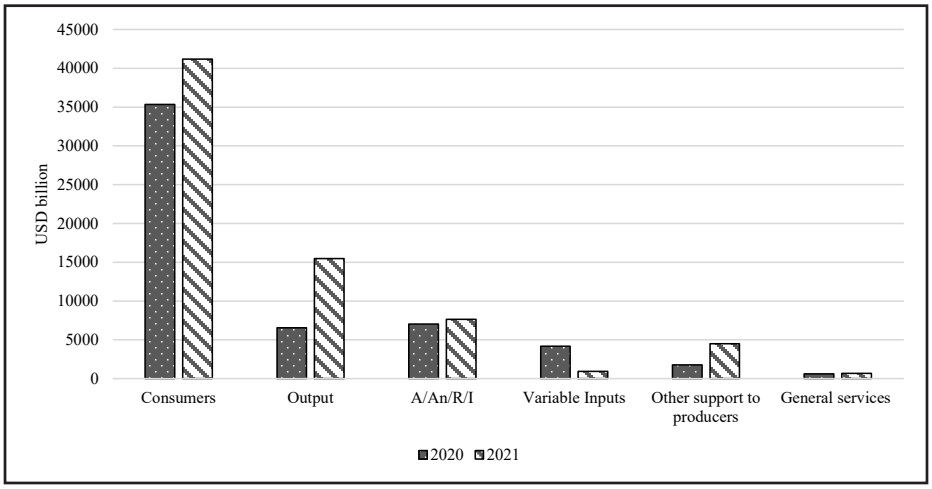
Volatility in energy prices drives up food costs and lowers farm incomes, which the current increase in food prices may not be enough to offset. As a result, the EU countries will enter a new level of food market conditions, with higher prices, but with an unchanged level of food supply and falling real incomes of farmers. This is an unfavourable prospect.

Analysis of farmers' income factors

We analysed the dependence of the farmer's income on the main factors (prices, labour productivity, production volumes, costs), the nature of which has changed in the conditions of turbulence of recent years. The farmer's income is also influenced by the technological factor and financial assets, but in this case their influence did not make a significant impact on the results of our research.

In 2022, a significant reduction in grain and fuel supplies to the world markets was observed, resulting in an increase in prices for these groups of goods. The food market deficit and rising prices theoretically imply an increase in demand for farmers' products, which should create favourable conditions for increasing their incomes in nominal terms. However, such an increase may occur to a much lesser extent than expected. The cause of this is the divergent influence of price dynamics on energy carriers and food on farmers' incomes, the rise in fuel and fertilizer prices in the short- and medium-term perspective:

- on the one hand, it will exert upward pressure on agricultural prices that will be offset



Source: Authors´ own processing based on OECD Database

Figure 2: Distribution of estimated agricultural support in response to COVID-19, 2020-2021 year, USD billion.

by a decline in real incomes,

- on the other hand, it will lead to a partial loss of the income gain achieved by farmers due to the increase in the cost of agricultural production and transport costs.

This assumption is confirmed by the correlation coefficients of the real incomes of peasant households with production factors and prices. Thus, the real income factor of peasant households per unit of annual labour is negatively correlated with the index of prices for energy carriers (correlation coefficients is 0.37) and the index of prices for agricultural products (correlation coefficients is 0.25), while the net entrepreneurial income of peasant households is weakly positively correlated with the index prices of energy carriers and agricultural products (correlation coefficients were 0.023 and 0.116 respectively).

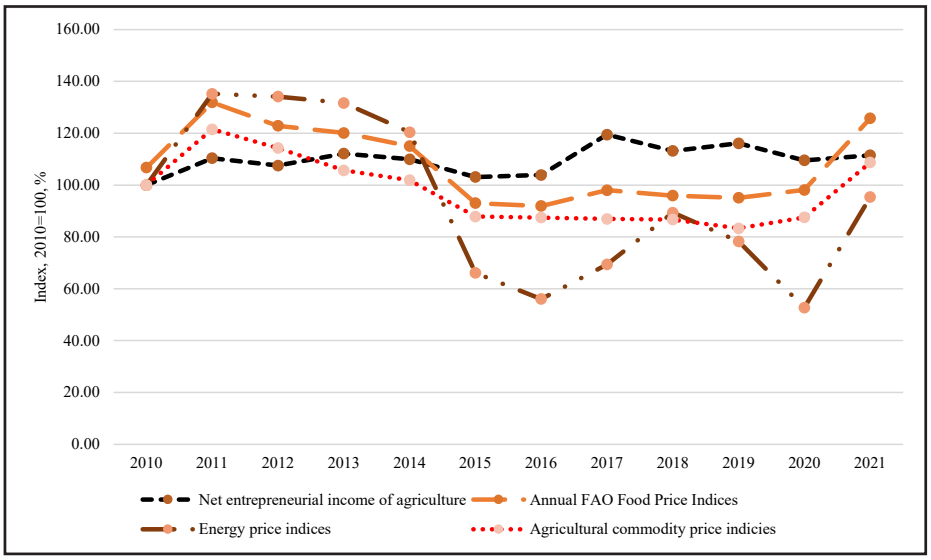
At the same time, the influence of energy prices on the incomes of farms is more significant and negative than on their cost, which to some extent explains the traditional orientation of CAP measures to support incomes.

The dynamics of net entrepreneurial income of agriculture and prices of agricultural products and energy carriers according to the FAO and the World Bank for the past years are shown in Figure 3.

Figure 3 shows that the food price index declined in 2015-2016 and 2018-2020, resulting in a positive gap between the price index and the net income in agriculture. However, the surge in prices due to COVID-19 in 2020-2021 has increased the rate of growth of net income in the agro-industrial complex to 125.08 versus 111.5%. Overall, since 2012, the growth rate of net income in agriculture has been showing a leading trend compared to food prices. At the same time, labour productivity was growing faster than the net income of farmers (Figure 4). This may be the result of improvement of the farm equipment and at the same time create the preconditions for the decrease in motivation for further increase in labour productivity due to its underestimation. The extensive factor of income is the volume of production, as evidenced by Figure 4.

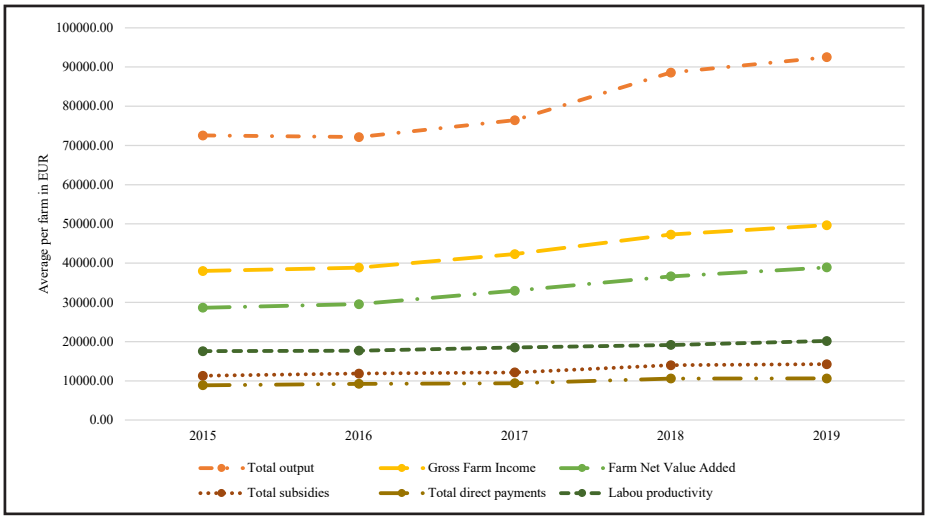
High yields increase the supply on the food markets and exert a downward pressure on prices. This somewhat neutralizes their positive impact on farmers' incomes and reduces the motivation to increase production volumes. It should be noted that in the absence of significant changes in labour productivity in recent years, the growth of agricultural production has been positively correlated with income. The reason for this is government subsidies, which weakened the dependence of farmers' incomes on the market situation in the EU.

The level of income of farms depends on production costs, including labour costs. From 2000 to 2017, the share of intermediate consumption and wages in the EU was 58% and 10% (on average) of the value of agricultural production respectively. The impact of the growth of agricultural expenses on the incomes of farmers is to a lesser extent



Source: Authors´ own processing based on Eurostat Database, FAO and World Data Bank

Figure 3: Indices of income in agriculture and food and energy prices.



Source: Authors´ own processing based on Eurostat Database

Figure 4: Dynamics of the main indicators of economic results in agriculture.

compensated by CAP. At the present stage, due to the rise in food and fuel prices, the growth of fuel and delivery costs, as well as the need to increase the wages of farmers and hired workers, there will be a negative impact of costs on farm incomes.

Thus, the volatility and instability of incomes in the agrarian sector are becoming a circumstance that provokes the outflow of labour resources and requires an appropriate response from the state. Structural changes in agriculture affect the outflow of labour from the agricultural sector in the EU (Figure 5).

The low labour force in agriculture means that agricultural income is shared among fewer people, which in turn increases income per person, although not symmetrically across sectors as their income differs.

Significant annual income volatility in rural areas, as well as their significant undervaluation compared to the average income level in the economic system (overall 40.0%), creates the need for government funding to address such structural inequalities in income.

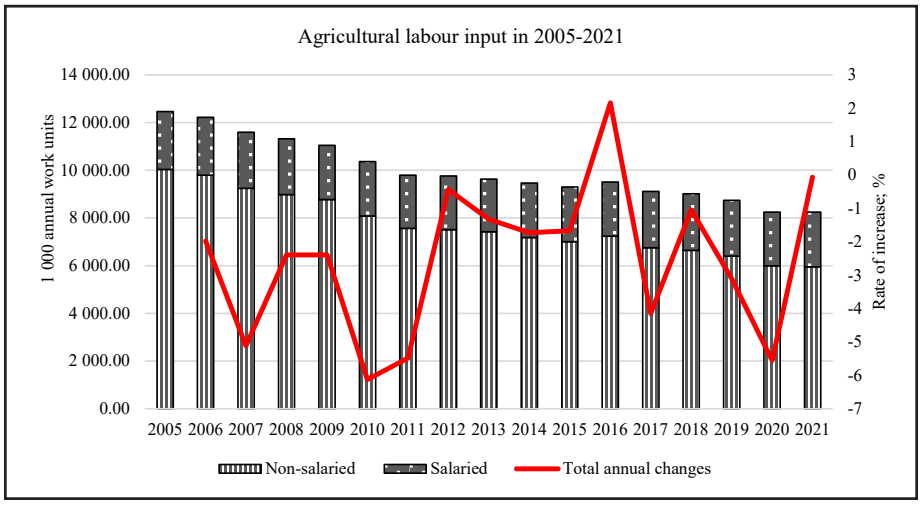
For a more specific factorial analysis of farm income, we built linear regression models with logarithmic transformations, regression coefficient was 75.76% and statistically significant (Table 1).

Analysis of the results of the regression showed that the most significant factor influencing income was output – with its increase by 1%, income increased by 2.02 per cent. Budget payments also had a positive effect on income – according to our calculations, an increase in payments by 1% gives an increase in income by 0.58%. An increase in interest payments and rent payments by 1% increases income by 0.98 and 0.35%, respectively. The price factor has a negative effect – a 1% increase in food and energy prices reduces income by 0.32 and 0.28%, respectively. The growth of labour productivity also does not have a positive impact, given its downward trend and spasmodic nature. The rather large explanatory coefficient illustrates a general downward trend in farm incomes, signalling that drastic measures must be taken immediately.

Thus, our assumption was confirmed: the rise in prices of food and fuels has a negative impact on farmers' incomes, but the degree of the negative influence of fuel prices increase turned out to be lower than we expected. It is possible that the effect of transferring the cost of fuels to the price of products and the presence of time lags are manifested here. In general, we observe the fact of absence of an increase, and on the contrary – a decrease in farmers' incomes in the situation when prices of food and fuel rise simultaneously.

In general, the absence of the traditional positive impact on income from the price factor and labour productivity may indicate a violation of the market mechanisms for the functioning of the agricultural spheres. The deformation of market mechanisms is compensated by state payments.

Figure 6 illustrates the importance of government payments for farmers' incomes: farmers' incomes



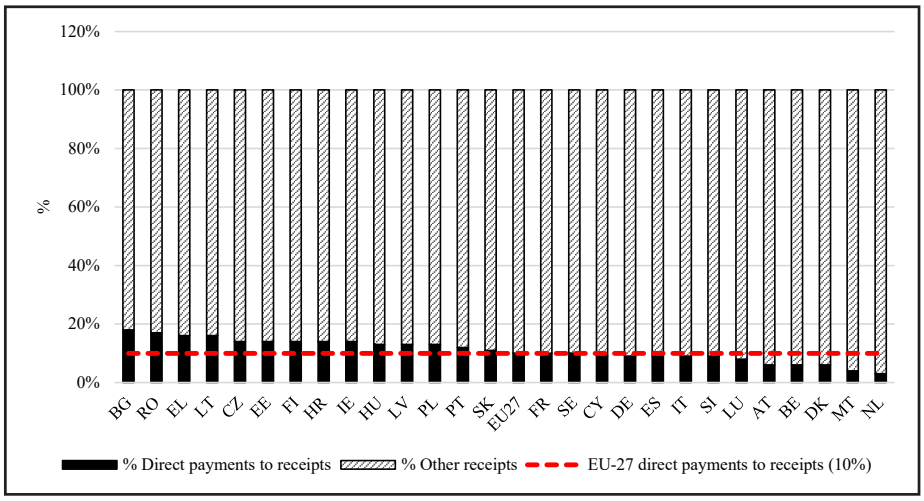
Source: Authors´ own processing based on Eurostat Database

Figure 5: Agricultural labour input in 2005-2021.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-7.359270	5.063214	-1.453480	0.189406	-19.3319	4.613332	-19.3319	4.613332
Agricultural output	2.021217	1.477478	1.368019	0.2136	-1.47246	5.514897	-1.47246	5.514897
Total Inputs	0.294893	1.656784	0.177991	0.863771	-3.62278	4.212563	-3.62278	4.212563
Total direct payments	0.586502	0.695067	0.843806	0.42667	-1.05707	2.230075	-1.05707	2.230075
FAO Food Price Index	-0.326190	0.69875	-0.466810	0.654813	-1.97847	1.326094	-1.97847	1.326094
Labour productivity in agriculture	-0.186250	0.532329	-0.349870	0.736725	-1.44501	1.072512	-1.44501	1.072512
Interest paid	0.098951	0.510555	0.193811	0.851828	-1.10832	1.306221	-1.10832	1.306221
Rent paid	0.347512	0.9134	0.380459	0.714886	-1.81234	2.507359	-1.81234	2.507359
World Bank Energy price index	-0.282590	0.344869	-0.819400	0.439559	-1.09807	0.532898	-1.09807	0.532898

Source: Own processing based on FADN Database, FAO and Worl Bank Data

Table 1: Results of regression analysis of farm income.



Source: Authors´ own processing based on Agridata Database

Figure 6: Dynamics of subsidies to farmers in relation to total receipts by Member State in 2020.

could fall more than 17% if CAP payments were abolished, which would have the greatest impact on sectors where farmers' incomes are heavily dependent on subsidies.

Thus, farm products are not adequately valued in the market, so direct government payments have been introduced to support farmers' incomes. The focus on improving state payments on the needs of farmers is indicated by the results of studies of the impact of such support on various areas of agriculture. Studies by M`barek et al. (2017) have confirmed the conclusions that the main impact of the CAP is not on the level of production, but on a smoother model of structural adjustment in agriculture, a balanced regional distribution of production and a reduction in the burden on the environment. Thus, the state support of the farm holdings within the CAP mainly played the role of a compensator and shock absorber of the disparities in income between the types of economic activities, not having a significant impact on overcoming the factors of low incomes of the farmers. This means some cushioning in softening the effect of today's crisis on farmers' incomes, but will not protect them from the general decrease in incomes in the future.

Radically changing the influence of the price factor on farmers' incomes can be achieved by changing the structure of the cost of farm products in the direction of reducing the proportion of purchased energy carriers due to the reduction of the energy dependence of farms. We are talking about switching to green energy sources and processing waste into bioenergy. It is in this direction that state support and policy should work. In this connection, the task of changing the forms of financial assistance to farms from direct subsidies to financing the development of innovative agrotechnology, and green technologies for using waste to produce biofuel is relevant. These types of activities are able to help diversify farm income, increase the resilience of the latter to crisis shocks and correspond to the concept of "green economy" development in Europe.

Conclusion

It was determined, that in recent years in the agricultural sector of the EU there has been a situation, despite the important role of the agricultural sector in the economic system, when farmers' incomes were below the average wage in the EU, which required government action to support them. In 2022 combination of increased price and production risks increase pressure on farm incomes. The specificity of the influence of the price factor on the formation of farm income in modern conditions, when the negative effect of rising energy prices outweighs the positive rise in prices for manufactured products, is revealed. Given the chronicity of the problem of slow productivity growth and low incomes of farmers, compared with the average for the economy, direct budget expenditures can support farmers' incomes only in the short term, without creating a basis for further sustainable income growth based on the balanced development of the agricultural sector. Therefore, at the present stage, the priority of the actions of the EU governments in the agricultural sector should be to stimulate farmers to increase energy independence and diversify incomes through the transition to more technologically advanced and profitable production. In other words, the current crisis should be used as an opportunity for reform and prioritize the non-short-term goals of maintaining farmer incomes (while maintaining the minimum required level) in favour of the strategic goals of technological re-equipment and more active adoption of biotechnologies as more productive and profitable.

The main measures in this context should be the following:

- Refocus fiscal support to stimulate the transition of farmers towards renewable energy sources but maintain targeted income support to farms that need it most.
- Implement an efficient pricing and financing system for those farms that develop bioenergy production.
- Develop a set of measures to achieve significant recycling of agricultural waste.
- Review the system for purchasing products from those farms that use bioenergy.

Much attention should be directed to the processing of waste from crop production, animal husbandry, processing enterprises, biomass and the production of biogas from it. Biogas can be used to replace imported natural gas, fuel and electricity generation. Thus, the environmental problem of processing agricultural waste and the energy problem of meeting the country's needs for energy resources will be solved. An additional positive effect will be a reduction in inflationary pressure from energy

prices and an additional source of income for farms.

The use of public funds for the technological re-equipment of agriculture and the introduction of biotechnologies will reduce the negative dependence of farmers' income on prices and will have a triple environmental, social and economic effect, and therefore will be the most effective direction of budget spending.

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