agronomy

MDPI

Article

A New Approach on Making European Agriculture More Efficient under Uncertainty Conditions

Romeo Victor Ionescu [1], Monica Laura Zlati [2] and Valentin Marian Antohi [2,3,*]

[1] Department of Administrative Sciences and Regional Studies, Dunarea de Jos University of Galati, 800008 Galati, Romania
[2] Department of Business Administration, Dunarea de Jos University of Galati, 800008 Galati, Romania
[3] Department of Finance, Accounting and Economic Theory, Transylvania University of Brasov, 500036 Brasov, Romania
* Correspondence: valentin_antohi@yahoo.com

Abstract: Agriculture is a strategic sector of the European economy in the current economic, social, climatic, and geo-political conditions generated by global crisis and the war in Ukraine. The main objective of the research is to quantify the vulnerabilities of EU agricultural evolution and to assess the opportunities for development through the building of a scoreboard of viable agricultural development solutions in line with the needs expressed in the current unfavourable context. The importance of this research is related to smart agriculture as a solution to the food crisis generated by the same uncertainty conditions. The methods used are empirical literature review and econometric modelling of vulnerabilities based on the dynamic evolution of branch efficiency and effectiveness indicators under exogenous events (economic crisis, geo-political crisis, soil and climate crisis, health crisis), collected from official data sources. The outcome of the study is the identification of viable, implementable solutions to ensure the planned success of the sustainable development of the branch.

Keywords: sustainability; smart agriculture; vulnerabilities; solutions; econometric model

check for updates

Citation: Ionescu, R.V.; Zlati, M.L.; Antohi, V.M. A New Approach on Making European Agriculture More Efficient under Uncertainty Conditions. *Agronomy* **2022**, *12*, 2559. https://doi.org/10.3390/agronomy12102559

Academic Editor: Christos A. Dordas

Received: 1 September 2022
Accepted: 17 October 2022
Published: 19 October 2022

1. Introduction

The current socio-economic, climatic and geopolitical context has proven to be unfriendly to one of the most important branches (agriculture), which in 2022 has generated multiple challenges for agricultural holdings, amidst losses due to drought, reduction of livestock through diseases and lack of adequate feed resources for them. These have repercussions for the population, with limited access to food sources and increased food costs. Other challenges to the smooth running of agricultural holding companies are rising fuel and energy prices which have led to increased costs for specific operating activities and fertilisers.

In March 2022, the European Commission announced the distribution of an exceptional €500 million package to Member States to increase food security and support European farmers and consumers [1].

Moreover, the war in Ukraine has affected grain supply flows from that country by damaging port and rail transport infrastructure.

In the fight against the unfavourable cyclical effects for European agriculture, Member States have reduced VAT and encouraged operators to support retail prices. In addition, through the Fund for European Aid to the Most Deprived (FEAD), the same Member States have improved access to food and basic material assistance for the most vulnerable.

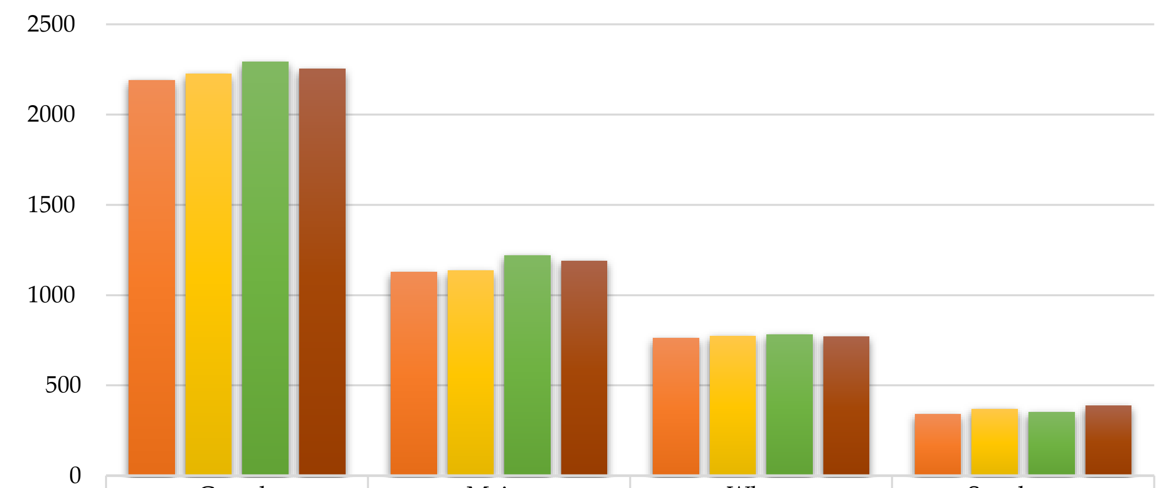
The European Food Security Crisis Preparedness and Response Mechanism (EFSCM) has been set up to mitigate risks that may arise along the agri-food supply chain. In addition, the European Commission has adopted specific measures dedicated to:

- a financial support package for the producers most affected by the serious consequences of the war in Ukraine;

- more advances of direct payments, payments on animals, and payments for rural development measures, to farmers as of 16 October 2022;
- support for the pig meat market in view of the difficult situation of this sector;
- temporary derogation to allow the production of any crops for food and feed purposes on fallow land;
- temporary flexibilities to existing import requirements on animal feed;
- a new, self-standing Temporary Crisis Framework that also covers farmers, fertiliser producers and the fisheries sector;
- communication of data on private stocks for food and feed on a monthly basis [2].

The EU is concerned to prevent the emergence of a food crisis, which is why it has defined a specific approach based on collaborative public–private principles to ensure food supply and food security, horizontal coordination at political and administrative level, monitoring of market imbalances, free movement of cross-border and seasonal workers in the food sector and permanent communication to stakeholders and the public.

At EU level, forecasts for cereal production trends in the agricultural year 2022–2023 show a decrease compared to the previous year [3] (see Figure 1).



	Cereals	Maize	Wheat	Soyabeans
2019/2020	2190	1127	762	341
2020/2021	2225	1136	774	369
2021/2022	2292	1220	781	351
2022/2023	2252	1189	770	386

Figure 1. Trend of the agriculture output (million tonnes) Source: realised by authors after [3].

In order to support agricultural activity and ensure food security for European citizens, the EU pursues an active policy of securing agricultural stocks [3], (see Figure 2).

From Figure 2, it can be seen that current stocks of cereals, maize, and wheat are lower than in 2021. The exception is barley stocks.

It is noted that, at EU level, there are elements of damage to the agricultural sector due to economic, health, pedo-climatic and geo-political risks, which impact the activity of agricultural producers, with an effect on food security and the quality of life of consumers. It is therefore important to identify viable solutions for the recovery of the sector by means of financial and organisational levers, which support the measures already promoted by the EU.

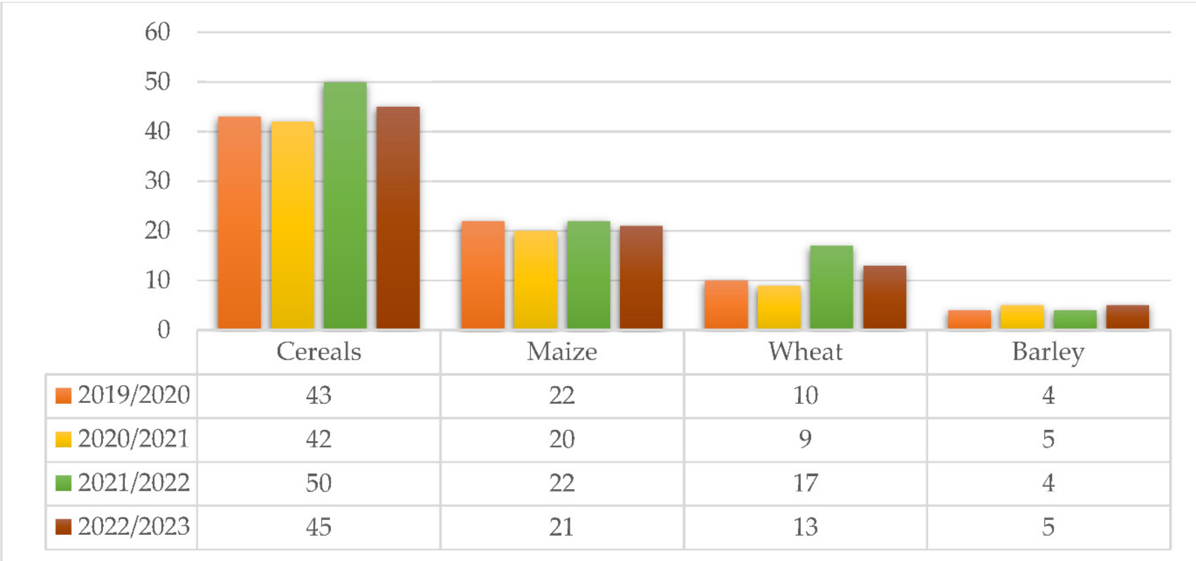


Figure 2. Evolution of agricultural stocks at EU level (million tonnes) Source: realised by authors after [3].

We aim to develop a financial model to balance the activity of agricultural holding companies based on the management of the financing of operational needs. In carrying out this approach, we propose the following *research objectives*:

O1. Identifying vulnerability components of the context in which European farmers operate.
O2. Assessing development opportunities and limiting vulnerabilities in the European agricultural sector.
O3. Developing a scoreboard of viable agricultural development solutions in line with the needs expressed in the current unfavourable context.

The present scientific approach continues with a study of the literature, description of the methodology, results, discussions and ends with conclusions and proposals for future research development.

Literature Review

Sustainable agricultural land use in line with the 2015 Paris Climate Agreement is the subject of a paper by Kissinger et al. [4]. The analysis covers 40 developing countries of Nationally Determined Contributions and is focused on land use, land-use change and forestry sectors (LULUCF). The issue of financing sustainable agriculture is also analysed in connection with the need to adapt and/or modify dedicated fiscal policies.

The existence of small agricultural firms and their impact on the nutrition and living conditions of the population is the subject of a research realised by Noack and Larsen [5]. The authors find that increasing stable incomes from agriculture and food production in developing countries can reduce global poverty. Even if the analysis is carried out at the level of an African country, its results are universally valid, namely agricultural incomes increase with farm size.

There is a direct connection between macroeconomic growth rates and agricultural development, a point also made by Martin [6]. The authors consider that an increase in demand for agricultural resources also leads to an increase in demand for livestock products. The analysis covers issues related to agricultural production, trade policy, and the increased volatility of world prices.

The impact of the Common Agricultural Policy (CAP) on the development of European agriculture is analysed by Kiryluk-Dryjska and Baer-Nawrocka [7] in terms of possible scenarios for reforming this policy. According to the authors and types of the intervention, these scenarios target welfare effect and lead to an approach based on the partial equilibrium model (CAPRI) and the Theory of Moves (TOM) to quantify the degree to which CAP reform can be accepted or not. A consequence of this analysis is the idea that removing the first pillar of the CAP will negatively affect the socio-political acceptance of the CAP. A similar approach to the CAP in Italian agriculture was also carried out by Biagini et al. [8].

A study on EU12 agriculture by Sándor and Zoltan [9] considers the following indicators: the output value of the agricultural industry, productivity of input, agricultural gross value added, subsidies on production, agricultural labour input and agricultural income per annual working unit. The authors use dedicated software for this purpose—Special Program for Social Sciences (IBM-SPSS 25, accessed from Romania). The main conclusion of the analysis is that there is a direct connection between the income growth per annual working unit and the development of agricultural production technology.

Tensions between urban sprawl and agricultural and rural areas are the subject of analysis by Sroka et al. [10], who highlights the negative impact of this correlation on farm families and the level of agricultural activities. Socio-economic factors (exogenous) and economic factors related to the development potential of agricultural holdings (endogenous) contribute to a large extent to structural and volume changes in agricultural activities in the context of expanding urban development.

CAP in the context of the Income Stabilization Tool (IST) is reviewed by Severini et al. [11] and focuses on the effects of this financial instrument on income inequality in the farming population. The analysis is carried out at the level of Italian agriculture and concludes that IST is able to stabilize farm incomes and reduce income disparities under the condition that farmers pay contributions to mutual funds that are proportional to their income compared to the case of flat rate contributions.

The situation of European agriculture in the context of the economic crisis is presented by Loizou et al. [12], who put forward the potential for integrated development of agriculture and other economic sectors in a regional approach. The analysis tool is Input-Output analysis which is integrated into a regional model that allows an examination of the contribution of the primary sector to the regional economy and the impact of the CAP on local economies. The new CAP has a direct impact on the whole economy, helping to limit unemployment and increase regional incomes. The authors consider agriculture as an important driver of growth, and analysed the contribution of regional GDP in the case of Greece.

The connection between factors influencing agricultural development in rural areas and the CAP is analysed by Kiryluk-Dryjska et al. [13] for Polish agriculture using linear regression models. In this case, the implementation of EU rural development policy in Poland is based on well-structured agricultural holdings, which contributes to increasing regional disparities. These disparities are directly proportional to the amount of EU funds attracted in rural areas.

The lack of a unified approach to the concept of sustainable agricultural development is presented by Streimikis and Baležentis [14] in a paper highlighting the multitude of concepts and targets related to this development. The analysis is based on a literature review (meta-analysis) and concludes with proposals for new indicators for sustainable agricultural development. These indicators make the link between sustainable agriculture, overall development goals, environmental, climate and rural development policies.

The number of agricultural holding companies and their structure has a serious impact on the development of sustainable agriculture in the view of Burja et al. [15]. Excessive land fragmentation is a major threat to contemporary agriculture and rural development. Moreover, the authors highlight the negative effect of this process including on the environment and economic rationality. As a result, the implementation of CAP-compliant national policies becomes essential.

The introduction of the smart concept and approach in agriculture is reviewed by Streimikis et al. [16], in the context of environmental pressures. The authors focus on energy efficiency and productivity growth in the EU agriculture and use a sample covering several Member States representative of agricultural production. The link with sustainable development is made by introducing specific indicators into the analysis, such as: smart technology, smart energy consumption and decreasing greenhouse gas emissions. The Luenberger productivity indicator is calculated using them. The analysis shows that the highest increases in agricultural productivity during the period under review were achieved in Lithuania, Denmark, Belgium and Romania.

The influence of the CAP through subsidies is quantified in a paper by Guth et al. [17]. The authors carry out the analysis in the context of the development of a sustainable European agriculture based on an algorithm comprising the following steps: applying the income gap ratio; establishing income differentiation between farms; and quantifying the statistically significant CAP schemes that shape agricultural income in farms. The analysis shows that European subsidies favour large holding companies, leading to increased disparities in the sector.

The sustainable development of the food and agriculture sector in terms of the necessary investments is the subject of an interesting analysis by Negra et al. [18]. The authors note the heterogeneity of the activities under analysis and their fragmentation, which makes new types of investment difficult. Moreover, the same authors note the lack of robust scientific research in the field, which does not allow collaborative co-development of decision tools in these sectors. As a result, the paper itself is a call to the scientific community to integrate the food system sustainability into management and capital allocation.

Rural development is largely dependent on the geographical distribution of rural development funded projects. As a result, Maier et al. [19] believe that access to European funds is restricted by two elements. The first element is the natural and administrative conditions related to agricultural land, while the second element is the degree of concentration of agricultural activities in terms of the size of agricultural holdings.

The efficiency of agricultural activity in the European context is analysed by Feher et al. [20], based on historical data covering more than 20 years and using three indicators. The authors propose a regression model which they apply to agriculture in Germany, Romania, France and the EU average and conclude that the performance of Romanian agriculture in 2040 will be below the European average.

The above literature review supports our scientific approach and points out the need for a new approach to European agriculture in the context of current challenges.

2. Data and Methods

2.1. Indicators

The literature review highlighted the fact that in the current unfavourable conditions, against the background of drought and dwindling water sources, the energy crisis and the fertiliser crisis affected by the war in Ukraine, food sources for Europe's population have become scarcer and more expensive.

Western states through press releases announce recessionary periods for the cold season of 2022–2023. These premises support the objective of the present research which the authors have addressed through a set of *working hypotheses* that we have correlated with studies in the literature:

H1. *The predictability of incomes in agriculture is affected by economic crises and unfavourable environmental conditions, and efforts are needed to improve inputs in agriculture by increasing investments with an impact on the sustainable development of agriculture (maximising organic farming less dependent on the chemical and petro-chemical industry). The hypothesis is supported by Noack and Larsen; Biagini et al.; Sándor and Zoltan; Guth et al.* [5,8,9,17].

H2. *The sustainability and predictability of agricultural production is less vulnerable than that of income in terms of economic predictability and multi-year dynamics, but is still influenced by adverse environmental and pedo-climatic conditions. The hypothesis is supported by Noack and Larsen; Sándor and Zoltan; Severini et al.; Loizou et al.; Streimikis and Baležentis; Streimikis et al.; Negra et al.* [5,9,11,12,14,16,18].

H3. *Agricultural land use is a sensitive component of the development of the agricultural sector, the dynamics of which are influenced by agricultural policies and the cyclical interest of organisations. The hypothesis is also supported by research conducted by Kissinger et al.; Sándor and Zoltan; Sroka et al.; Burja et al.; Maier et al.* [4,9,10,15,19].

H4. *At EU level, there is a trend towards a reduction in the predictability of sales and output prices, which is strongly influenced by economic conditions and elements of uncertainty. The hypothesis is also supported by research conducted by Martin; Biagini et al.; Sándor and Zoltan;* [6,8,9].

In order to demonstrate these working hypotheses and to build the dashboard for the sustainable development of the agricultural sector in Europe, we proceeded to consolidate a database for further modelling, which was composed of the study of the dynamics of the following *indicators*:

AINCOME—Economic accounts for agriculture—agricultural income [21]
APRO—Crop production in EU standard humidity [22]
AQUANTITIES—Unit value statistics for agricultural products: quantities (1000 t) [23]
UAA—Utilised agricultural area (UAA) managed by low-, medium- and high-input farms [24]
APRI—Selling prices of crop products (absolute prices)—annual price [25]
APRIO—Price indices of agricultural products, output (2010 = 100)—annual data [26].

These indicators have been collected from the Eurostat platform for the period 2011–2021, tracking the dynamic evolution of gross and weighted values with the EU27 average, according to the formulas:

$$\overline{\mathrm{AINCOME}_i} = \frac{\mathrm{AINCOME}_i}{\sum_{i=1}^{27}\mathrm{AINCOME}_i};\sum_{i=1}^{27}\overline{\mathrm{AINCOME}_i} = 1 \tag{1}$$

$$\overline{\mathrm{APRO}_i} = \frac{\mathrm{APRO}_i}{\sum_{i=1}^{27}\mathrm{APRO}_i};\sum_{i=1}^{27}\overline{\mathrm{APRO}_i} = 1 \tag{2}$$

$$\overline{\mathrm{AQUANTITIES}_i} = \frac{\mathrm{AQUANTITIES}_i}{\sum_{i=1}^{27}\mathrm{AQUANTITIES}_i};\sum_{i=1}^{27}\overline{\mathrm{AQUANTITIES}_i} = 1 \tag{3}$$

$$\overline{\mathrm{UAA}_i} = \frac{\mathrm{UAA}_i}{\sum_{i=1}^{27}\mathrm{UAA}_i};\sum_{i=1}^{27}\overline{\mathrm{UAA}_i} = 1 \tag{4}$$

$$\overline{\mathrm{APRI}_i} = \frac{\mathrm{APRI}_i}{\sum_{i=1}^{27}\mathrm{APRI}_i};\sum_{i=1}^{27}\overline{\mathrm{APRI}_i} = 1 \tag{5}$$

$$\overline{\mathrm{APRIO}_i} = \frac{\mathrm{APRIO}_i}{\sum_{i=1}^{27}\mathrm{APRIO}_i};\sum_{i=1}^{27}\overline{\mathrm{APRIO}_i} = 1 \tag{6}$$

where: i—EU Member States.

Our analysis is supported by IBM-SPSS 25 (US) and Gretl 2018A softwares.

2.2. Linear Regression

We applied the linear regression method to determine the regression correlations between economic accounts for agriculture—agricultural income, as the dependent variable, and the rest of the indicators expressed in Equations (1)–(6), as regression variables, obtaining the econometric representation of a multi-criteria regression model:

$$\hat{}\overline{\mathrm{AINCOME}}_{it} = \alpha_{1_{it}} * \overline{\mathrm{APRO}}_{it} + \alpha_{2_{it}} * \overline{\mathrm{AQUANTITIES}}_{it} + \alpha_{3_{it}} * \overline{\mathrm{UAA}}_{it} + \alpha_{4_{it}} * \overline{\mathrm{APRI}}_{it} + \alpha_{5_{it}} * \overline{\mathrm{APRIO}}_{it} + \varepsilon_{it} \tag{7}$$

where: $\alpha_{j_{it}}$—regression coefficients of the function, $j \in [1,\ 5]$, ε_{it}—residual variable, $t \in [2011, 2021]$.

The application of the methodology was carried out using the statistically consolidated database through the process of pivoting 2115 records transformed into averages by referring to European statistics for the analysed indicators (Equations (1)–(6)).

The modelling results allowed us to determine the regression coefficients of the econometric function as follows:

$$\hat{\overline{\text{AINCOME}}}_{i2011} = -0.968 * \overline{\text{APRO}}_{i2011} + 0.227 * \overline{\text{AQUANTITIES}}_{i2011} + 0.265 * \overline{\text{UAA}}_{i2011} + 0.601 * \overline{\text{APRI}}_{i2011} + 0.670 * \overline{\text{APRIO}}_{i2011} + \varepsilon_{i2011} \quad (8)$$

$$\hat{\overline{\text{AINCOME}}}_{i2012} = 0.636 * \overline{\text{APRO}}_{i2012} + 0.117 * \overline{\text{AQUANTITIES}}_{i2012} + 0.198 * \overline{\text{UAA}}_{i2012} + 0.477 * \overline{\text{APRI}}_{i2012} + 0.346 * \overline{\text{APRIO}}_{i2012} + \varepsilon_{i2012} \quad (9)$$

$$\hat{\overline{\text{AINCOME}}}_{i2013} = 0.0315 * \overline{\text{APRO}}_{i2013} + 0.211 * \overline{\text{AQUANTITIES}}_{i2013} + 0.338 * \overline{\text{UAA}}_{i2013} + 0.454 * \overline{\text{APRI}}_{i2013} + 0.116 * \overline{\text{APRIO}}_{i2013} + \varepsilon_{i2013} \quad (10)$$

$$\hat{\overline{\text{AINCOME}}}_{i2014} = 0.426 * \overline{\text{APRO}}_{i2014} + 0.269 * \overline{\text{AQUANTITIES}}_{i2014} + 0.672 * \overline{\text{UAA}}_{i2014} + 0.0744 * \overline{\text{APRI}}_{i2014} - 0.364 * \overline{\text{APRIO}}_{i2014} + \varepsilon_{i2014} \quad (11)$$

$$\hat{\overline{\text{AINCOME}}}_{i2015} = -0.317 * \overline{\text{APRO}}_{i2015} + 0.106 * \overline{\text{AQUANTITIES}}_{i2015} + 0.378 * \overline{\text{UAA}}_{i2015} + 0.559 * \overline{\text{APRI}}_{i2015} + 0.416 * \overline{\text{APRIO}}_{i2015} + \varepsilon_{i2015} \quad (12)$$

$$\hat{\overline{\text{AINCOME}}}_{i2016} = -1.02 * \overline{\text{APRO}}_{i2016} + 0.970 * \overline{\text{AQUANTITIES}}_{i2016} + 0.437 * \overline{\text{UAA}}_{i2016} + 0.198 * \overline{\text{APRI}}_{i2016} + 0.633 * \overline{\text{APRIO}}_{i2016} + \varepsilon_{i2016} \quad (13)$$

$$\hat{\overline{\text{AINCOME}}}_{i2017} = 1.95 * \overline{\text{APRO}}_{i2017} - 0.374 * \overline{\text{AQUANTITIES}}_{i2017} - 0.123 * \overline{\text{UAA}}_{i2017} + 0.754 * \overline{\text{APRI}}_{i2017} - 0.846 * \overline{\text{APRIO}}_{i2017} + \varepsilon_{i2017} \quad (14)$$

$$\hat{\overline{\text{AINCOME}}}_{i2018} = 0.303 * \overline{\text{APRO}}_{i2018} + 0.762 * \overline{\text{AQUANTITIES}}_{i2018} + 0.213 * \overline{\text{UAA}}_{i2018} + 0.385 * \overline{\text{APRI}}_{i2018} - 0.529 * \overline{\text{APRIO}}_{i2018} + \varepsilon_{i2018} \quad (15)$$

$$\hat{\overline{\text{AINCOME}}}_{i2019} = 0.926 * \overline{\text{APRO}}_{i2019} - 0.0984 * \overline{\text{AQUANTITIES}}_{i2019} - 0.300 * \overline{\text{UAA}}_{i2019} + 1.08 * \overline{\text{APRI}}_{i2019} - 0.342 * \overline{\text{APRIO}}_{i2019} + \varepsilon_{i2019} \quad (16)$$

$$\hat{\overline{\text{AINCOME}}}_{i2020} = 1.42 * \overline{\text{APRO}}_{i2020} + 0.575 * \overline{\text{AQUANTITIES}}_{i2020} + 1.43 * \overline{\text{UAA}}_{i2020} - 0.777 * \overline{\text{APRI}}_{i2020} - 1.71 * \overline{\text{APRIO}}_{i2020} + \varepsilon_{i2020} \quad (17)$$

$$\hat{\overline{\text{AINCOME}}}_{i2021} = -4.42 * \overline{\text{APRO}}_{i2021} + 6.44 * \overline{\text{AQUANTITIES}}_{i2021} + 1.99 * \overline{\text{UAA}}_{i2021} - 1.17 * \overline{\text{APRI}}_{i2021} - 1.87 * \overline{\text{APRIO}}_{i2021} + \varepsilon_{i2021} \quad (18)$$

From the regression equations above, it appears that for the APRO indicator, the best correlations with the dependent variable AINCOME were achieved in the years 2017, 2019 and 2020, years in which this indicator made a significant contribution to agricultural income.

Under the influence of the outbreak of the pandemic, and the economic crisis (2020–2021), the indicator tends to destabilize farm incomes, with an inversely proportional variation. The worst performance (revenue neutrality) is recorded in 2013, when the correlation coefficient value reflects an impact of only 3% on agricultural revenue.

As far as the AQUANTITIES indicator is concerned, there is a maximum impact on agricultural incomes in 2016, 2018 and 2021, with a proportionality inflection with the evolution of incomes in 2017, when the value of the correlation coefficient is negative (the inverse proportional influence of the indicator on incomes reaches 37%). As in the case of the first indicator, the annual variation of the correlation coefficients demonstrates the vulnerability of agricultural policies as regards the correlation between AQUANTITIES and farm incomes.

In the case of the agricultural land use indicator (UAA), the average rate of economic efficiency of agricultural land use in relation to income is subunitary, except in 2020 and

2021, when this indicator actually contributed to the dynamization of agricultural income. The neutrality point is in the period 2017–2019, when the contribution of land use to agricultural efficiency is maximum 10%.

The APRI indicator underwent important variations that confirm the vulnerabilities of agricultural policy in Europe in the context of regional economic disparities, with the mention that towards the end of the period (2019–2021) this indicator stabilizes, obtaining significant correlation scores for the impact on agricultural incomes.

The APRIO indicator has a predominantly inverse evolution proportional to the income obtained from agriculture towards the end of the analysis horizon, showing that the economic yield of the branch tends to decrease under conditions of uncertainty, while the value of production tends to increase due to the impact of inflation and rising energy and raw material prices.

3. Results and Discussions

3.1. Modelling Results

The proposed models were applied to the consolidated database presented in the methodology section consisting of the six indicators, obtaining the following modelling results per year (see Table 1):

Table 1. Model 2011: OLS, using observations 1–28 (Dependent variable: AINCOME2011).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2011	−0.968452	0.409108	−2.367	0.0267	Yes (**)
AQUANTITIES2011	0.226684	0.260886	0.8689	0.3939	No
UAA2011	0.264675	0.172440	1.535	0.1385	No
APRI2011	0.601323	0.208895	2.879	0.0085	Yes (***)
APRIO2011	0.669875	0.230780	2.903	0.0080	Yes (***)
Mean dependent var		103.7993	S.D. dependent var		16.60433
Sum squared resid		4414.117	S.E. of regression		13.85345
Uncentered R-squared		0.985721	Centered R-squared		0.407024
F(5, 23)		317.5417	*p*-value(F)		2.02×10^{-20}
Log-likelihood		−110.5753	Akaike criterion		231.1506
Schwarz criterion		237.8116	Hannan–Quinn		233.1869
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 1.18265			Test statistic: LM = 24.0834		
with *p*-value = 0.553593			with *p*-value = P(Chi-square(20) > 24.0834) = 0.238768		

(**)—statistical significant; (***)—high statistical significant.

At the 2011 level, the significance level of the econometric model was 98.6%, showing that the change in income from agriculture is significantly represented by the change in the regression variables, with the largest influences having the APRO, APRI and APRIO indicators. The one-sided critical likelihood test shows that the error is normally distributed and the alternative hypothesis is validated, while the null hypothesis is rejected, confirming the validity and homogeneity of the model for 2011.

The picture of vulnerabilities in 2011 is given by the poor reflection of production in agricultural incomes, which was generated by the poor results of storage and valorisation of products, the instability of distribution chains and changes in the consumption structure of the European population. Residual normality and heteroskedasticity tests yielded normal values, showing that, under the assumption that the error is normally distributed, heteroskedasticity is absent (see Table 2).

Table 2. Model 2012: OLS, using observations 1–28 (Dependent variable: AINCOME2012).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2012	0.636496	0.563205	1.130	0.2701	No
AQUANTITIES2012	0.116683	0.256785	0.4544	0.6538	No
UAA2012	0.198443	0.376173	0.5275	0.6029	No
APRI2012	0.477337	0.355286	1.344	0.1922	No
APRIO2012	−0.346336	0.345533	−1.002	0.3266	No
Mean dependent var		112.1432	S.D. dependent var		20.76597
Sum squared resid		10,470.48	S.E. of regression		21.33631
Uncentered R-squared		0.971217	Centered R-squared		0.100713
F(5, 23)		155.2170	*p*-value(F)		6.27×10^{-17}
Log-likelihood		−122.6678	Akaike criterion		255.3356
Schwarz criterion		261.9967	Hannan-Quinn		257.3720
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 2.2667			Test statistic: LM = 18.5219		
with *p*-value = 0.321953			with *p*-value = P(Chi-square(20) > 18.5219) = 0.55307		

For 2012, the statistical significance level of the model is 97.1%, down 1.5% from the previous year, confirming that the variation of the regression variables significantly influenced the variation of farm income, with the most important contributions recorded for APRO and APRI. The remaining variables had less significant correlations for the phenomenon studied, with increases in *p*-value and standard error.

Compared to 2011, there was an increase in the mean of the dependent variable by 8% and an increase in the sum of the residual squares, which indicates a vulnerable agricultural policy both in terms of the decrease in the land use correlation coefficient and the negative APRIO correlation coefficient.

As in 2011, the one-tailed critical probability test allows the validation of the alternative hypothesis and the rejection of the null hypothesis, which leads to the conclusion that for 2012 the model is valid, homogeneous and representative for the studied phenomenon. Absence of heteroskedasticity and normal distribution of errors by residuals normality test are presented here (see Table 3).

The analysis of the statistical distributions for 2013 shows a reduction of the coefficient of determination to 96.9%, 0.02% lower than in the previous year, but this level is still statistically significant and confirms that in 2013 the value of agricultural income is significantly determined by the evolution of the regression variables.

The decrease in statistical significance was followed by a decrease in the value of the regression coefficients indicating non-parametrisation of the Common Agricultural Policy (CAP) in almost all analysed indicators by regression correlation tests. The most significant non-parametrization is for APRO whose *p*-value is very high (0.95 compared to the allowed level of 0.05), showing that in this year the correlation between income and APRO is marginal, lowering the quality of economic predictability of the industry.

The mean of the dependent variable remained at the 2012 level, but the sum of the residual squares increased, which confirms the worsening of the vulnerability picture for 2013. As in previous years, tests of normality of residuals and heteroskedasticity confirm the absence of heteroskedasticity and normal distribution of errors (see Table 4).

2014 is the first year in which the share of agricultural land use increased in significance for farm income. The APRO coefficient recovered, against the background of the measures adopted by the EU, the vulnerability picture being represented by the low weight of the agricultural production efficiency indicator AQUANTITIES, the low value of the correlation coefficient of the APRI indicator with agricultural incomes and the negative correlation coefficient of APRIO. The statistical tests allow the validation of the model for this year, obtaining normal values in the case of the normality test of the residuals and in the case of the heteroscedasticity test.

Table 3. Model 2013: OLS, using observations 1–28 (Dependent variable: AINCOME2013).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2013	0.0314601	0.554940	0.05669	0.9553	No
AQUANTITIES2013	0.211359	0.262806	0.8042	0.4295	No
UAA2013	0.337874	0.300131	1.126	0.2719	No
APRI2013	0.453754	0.332429	1.365	0.1855	No
APRIO2013	0.115918	0.553976	0.2092	0.8361	No
Mean dependent var		112.0721	S.D. dependent var		22.56939
Sum squared resid		11,340.62	S.E. of regression		22.20519
Uncentered R-squared		0.968967	Centered R-squared		0.175419
F(5, 23)		143.6294	*p*-value(F)		1.48×10^{-16}
Log-likelihood		−123.7855	Akaike criterion		257.5709
Schwarz criterion		264.2320	Hannan-Quinn		259.6073
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 2.17183			Test statistic: LM = 18.1553		
with *p*-value = 0.337593			with *p*-value = P(Chi-square(20) > 18.1553) = 0.577179		

The mean of the dependent variable increased compared to the previous year, but the sum of the residual squares also increased, indicating the maintenance of some predictability vulnerabilities at the CAP level (see Table 5).

Table 4. Model 2014: OLS, using observations 1–28 (Dependent variable: AINCOME2014).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2014	0.426433	0.488214	0.8735	0.3914	No
AQUANTITIES2014	0.268791	0.325317	0.8262	0.4172	No
UAA2014	0.672484	0.404801	1.661	0.1102	No
APRI2014	0.0744243	0.448632	0.1659	0.8697	No
APRIO2014	−0.363719	0.527195	−0.6899	0.4972	No
Mean dependent var		114.1582	S.D. dependent var		23.71958
Sum squared resid		12,554.05	S.E. of regression		23.36297
Uncentered R-squared		0.966971	Centered R-squared		0.173570
F(5, 23)		134.6707	*p*-value(F)		3.03×10^{-16}
Log-likelihood		−125.2086	Akaike criterion		260.4172
Schwarz criterion		267.0782	Hannan-Quinn		262.4535
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 1.3407			Test statistic: LM = 24.732		
with *p*-value = 0.51153			with *p*-value = P(Chi-square(20) > 24.732) = 0.211877		

Table 5. Model 2015: OLS, using observations 1–28 (Dependent variable: AINCOME2015).

Indicators	Coefficient	Std. Error	T-Ratio	*p*-Value	High Significance
APRO2015	−0.317066	0.695275	−0.4560	0.6526	No
AQUANTITIES2015	0.106224	0.450614	0.2357	0.8157	No
UAA2015	0.377653	0.537068	0.7032	0.4890	No
APRI2015	0.559240	0.579764	0.9646	0.3448	No
APRIO2015	0.416054	0.705016	0.5901	0.5609	No
Mean dependent var		111.1450	S.D. dependent var		22.51190
Sum squared resid		13,008.31	S.E. of regression		23.78189
Uncentered R-squared		0.963823	Centered R-squared		0.049324
F(5, 23)		122.5523	*p*-value(F)		8.60×10^{-16}
Log-likelihood		−125.7062	Akaike criterion		261.4124
Schwarz criterion		268.0735	Hannan–Quinn		263.4488
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 0.733421			Test statistic: LM = 21.0764		
with *p*-value = 0.69301			with *p*-value = P(Chi-square(20) > 21.0764) = 0.392649		

In terms of income obtained in agriculture, 2015 was a weaker year than 2014, which is confirmed by the decreasing average of the dependent variable. Also, the statistically significant value of the model is 96.4%, which is the same as in the previous year, confirming the fact that from the regression point of view, income varied by a proportion of 96.4%, influenced by the variation of the regression indicators. The *p*-values are much higher than the significance threshold of 0.05, showing a vulnerability of agricultural policies, especially at the level of the fruitfulness of the quantities produced and APRIO.

From the point of view of statistical tests, it is observed that the error is normally distributed and heteroskedasticity is absent, which validates the alternative hypothesis and rejects the null hypothesis for the econometric function calculated at 2015 level (see Table 6).

In 2016, there was a decreasing level of statistical significance of the model, with the caveat that it remained in the highly statistically significant range, with a 95.3% representation of the change in income relative to the change in regression variables. For 2016 the feature was the stabilization of the production fructification policy, while APRI and APRIO remain the main segments where CAP vulnerabilities manifest themselves.

In 2016, the value of agricultural income continued to increase, with the average of the dependent variable being 0.7% higher than the previous year. The model is found to be valid, with the null hypothesis rejected by both the normality of residuals test and the heteroscedasticity test (see Table 7).

In 2017, there was a decrease in the level of statistical significance to 95.3%, the historical minimum of the model for the period 2011–2017, and a recovery of APRO, which reached a level of representativeness by falling within the allowed limit of the *p*-value (p-value < 0.1). It is noted that for the first time in the analysis history a reflexivity of the coefficients with the exception of APRO and APRI, these reaching negative values and correlation inversely proportional to the dependent variable. The average of the dependent variable is the maximum for the period 2011–2017, i.e., 126.3% compared to the average of 112% in previous years. The model is validated by rejecting the null hypothesis and maintaining the alternative hypothesis for both the residual and heteroscedasticity tests (see Table 8).

Table 6. Model 2016: OLS, using observations 1–28 (Dependent variable: AINCOME2016).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2016	−1.02381	0.811608	−1.261	0.2198	No
AQUANTITIES2016	0.970362	0.354996	2.733	0.0118	Yes (**)
UAA2016	0.437008	0.514698	0.8491	0.4046	No
APRI2016	0.198051	0.646533	0.3063	0.7621	No
APRIO2016	0.633251	0.995933	0.6358	0.5312	No
Mean dependent var		112.0093	S.D. dependent var		32.42338
Sum squared resid		17,828.94	S.E. of regression		27.84190
Uncentered R-squared		0.953042	Centered R-squared		0.371876
F(5, 23)		93.35888	*p*-value(F)		1.70×10^{-14}
Log-likelihood		−130.1195	Akaike criterion		270.2390
Schwarz criterion		276.9001	Hannan–Quinn		272.2754
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 3.94516			Test statistic: LM = 21.6787		
with *p*-value = 0.139098			with *p*-value = P(Chi-square(20) > 21.6787) = 0.358197		

(**)—statistical significant.

Table 7. Model 2017: OLS, using observations 1–28 (Dependent variable: AINCOME2017).

C Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2017	1.94869	1.09155	1.785	0.0874	Yes (*)
AQUANTITIES2017	−0.373748	0.347235	−1.076	0.2929	No
UAA2017	−0.122838	0.482634	−0.2545	0.8014	No
APRI2017	0.754218	0.506963	1.488	0.1504	No
APRIO2017	−0.846068	0.973493	−0.8691	0.3938	No
Mean dependent var		126.3046	S.D. dependent var		33.28816
Sum squared resid		22,333.60	S.E. of regression		31.16129
Uncentered R-squared		0.953140	Centered R-squared		0.253525
F(5, 23)		93.56398	*p*-value(F)		1.66×10^{-14}
Log-likelihood		−133.2733	Akaike criterion		276.5466
Schwarz criterion		283.2076	Hannan–Quinn		278.5829
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 3.86384			Test statistic: LM = 19.2981		
with *p*-value = 0.14487			with *p*-value = P(Chi-square(20) > 19.2981) = 0.502534		

(*)—medium statistical significant.

Table 8. Model 2018: OLS, using observations 1–28 (Dependent variable: AINCOME2018).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2018	0.302708	1.13344	0.2671	0.7918	No
AQUANTITIES2018	0.762434	0.388521	1.962	0.0619	Yes (*)
UAA2018	0.213233	0.504415	0.4227	0.6764	No
APRI2018	0.384524	0.465997	0.8252	0.4178	No
APRIO2018	−0.528565	1.40144	−0.3772	0.7095	No
Mean dependent var		121.6543	S.D. dependent var		34.52418
Sum squared resid		28,313.29	S.E. of regression		35.08579
Uncentered R-squared		0.936599	Centered R-squared		0.120208
F(5, 23)		67.95413	*p*-value(F)		5.24×10^{-13}
Log-likelihood		−136.5946	Akaike criterion		283.1893
Schwarz criterion		289.8503	Hannan–Quinn		285.2256
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 2.37582			Test statistic: LM = 25.0483		
with *p*-value = 0.304858			with *p*-value = P(Chi-square(20) > 25.0483) = 0.199589		

(*)—medium statistical significant.

The year 2018 brought a significant decrease in the modelling parameters, being the first time that the level of the coefficient of determination R^2 fell below the average threshold of 95%, indicating a statistical significance of the model of 93.7%, the historical minimum of the period analysed (2011–2018). The value of the significance coefficients of the regression function is small, the level of variation of income in relation to APRO, UAA, APRI and APRIO being minimal or residual. Significant for the econometric variation of the regression is the value of the AQUANTITIES coefficient, showing for this year that for a 1% change in income, the change in output was 0.7%. For this indicator the *p*-value is within the accepted significance threshold (p-value < 0.1). The model is validated by rejecting the null hypothesis and admitting the alternative hypothesis, as confirmed by the two tests performed to validate the normality of the residuals and heteroskedasticity (see Table 9).

The year 2019 represents from the perspective of the proposed model a year with multiple vulnerabilities, registering reflectivity on most regression indicators and a range of *p*-values greater than the maximum allowed value of 0.1. Aspects of agricultural vulnerabilities were mainly manifested in terms of the valorisation of production, land use and APRIO. There was a new peak in the mean of the dependent variable, which reached 131.02, showing that in most Member States the average agricultural income threshold had been exceeded, in line with overall economic development.

The model is validated both by the level of statistical significance obtained of 94.7% and by the results obtained by applying the normality of residuals and heteroskedasticity tests (see Table 10).

The year 2020 is the year in which the level of the regression function coefficients improves, the *p*-values decrease, and the land use shows values within the maximum allowed limit of the error distribution (p-value <0.05). The greatest vulnerabilities are recorded in terms of the yield obtained, but also for the APRI and APRIO indicators, whose coefficients become negative and affect the evolution curve of the model.

Table 9. Model 2019: OLS, using observations 1–28 (Dependent variable: AINCOME2019).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2019	0.925642	0.917041	1.009	0.3233	No
AQUANTITIES2019	−0.0983778	0.391549	−0.2513	0.8038	No
UAA2019	−0.300189	0.683475	−0.4392	0.6646	No
APRI2019	1.08178	0.690180	1.567	0.1307	No
APRIO2019	−0.342206	1.11143	−0.3079	0.7609	No
Mean dependent var		131.0236	S.D. dependent var		34.89645
Sum squared resid		27,172.27	S.E. of regression		34.37154
Uncentered R-squared		0.947090	Centered R-squared		0.173582
F(5, 23)		82.34080	*p*-value(F)		6.65×10^{-14}
Log-likelihood		−136.0187	Akaike criterion		282.0375
Schwarz criterion		288.6985	Hannan–Quinn		284.0738
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 9.5755			Test statistic: LM = 19.6987		
with *p*-value = 0.0083312			with *p*-value = P(Chi-square(20) > 19.6987) = 0.476911		

In 2020, there is again a maximum in the mean of the dependent variable (135.71 points), with rising incomes in agriculture amid the onset of the pandemic and rising food consumption. The significance level of the function determined on the basis of the R^2 coefficient is 93.5% and points out the variation of the dependent variable in relation to the variation of the selected regression indicators (see Table 11).

Table 10. Model 2020: OLS, using observations 1–28 (Dependent variable: AINCOME2020).

Indicators	Coefficient	Std. Error	t-Ratio	*p*-Value	High Significance
APRO2020	1.42206	1.31868	1.078	0.2920	No
AQUANTITIES2020	0.574991	1.27602	0.4506	0.6565	No
UAA2020	1.42754	0.649063	2.199	0.0382	Yes (**)
APRI2020	−0.777136	0.672762	−1.155	0.2599	No
APRIO2020	−1.71065	1.67811	−1.019	0.3186	No
Mean dependent var		135.7129	S.D. dependent var		43.93218
Sum squared resid		37,141.78	S.E. of regression		40.18532
Uncentered R-squared		0.934588	Centered R-squared		0.287256
F(5, 23)		65.72368	*p*-value(F)		7.48×10^{-13}
Log-likelihood		−140.3944	Akaike criterion		290.7888
Schwarz criterion		297.4498	Hannan–Quinn		292.8251
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 0.474262			Test statistic: LM = 22.8845		
with *p*-value = 0.788888			with *p*-value = P(Chi-square(20) > 22.8845) = 0.294503		

(**)—statistical significant.

Table 11. Model 2021: OLS, using observations 1–28 (Dependent variable: AINCOME2021).

Indicators	Coefficient	Std. Error	t-Ratio	p-Value	High Significance
APRO2021	−4.42078	2.23101	−1.982	0.0596	Yes (*)
AQUANTITIES2021	6.44469	3.05941	2.107	0.0463	Yes (**)
UAA2021	1.99409	0.874612	2.280	0.0322	Yes (**)
APRI2021	−1.16797	0.688347	−1.697	0.1032	No
APRIO2021	−1.87320	1.76124	−1.064	0.2986	No
Mean dependent var		138.0568	S.D. dependent var		57.34250
Sum squared resid		59,254.48	S.E. of regression		50.75709
Uncentered R-squared		0.904805	Centered R-squared		0.332572
F(5, 23)		43.72168	p-value(F)		5.36×10^{-11}
Log-likelihood		−146.9338	Akaike criterion		303.8675
Schwarz criterion		310.5286	Hannan–Quinn		305.9039
Test for normality of residual—			White's test for heteroskedasticity—		
Null hypothesis: error is normally distributed			Null hypothesis: heteroskedasticity not present		
Test statistic: Chi-square(2) = 12.9269			Test statistic: LM = 17.5745		
with p-value = 0.00155941			with p-value = P(Chi-square(20) > 17.5745) = 0.615415		

(*)—medium statistical significant; (**)—statistical significant.

The year 2021 is the year with the lowest level of statistical significance of the model (90.5%), being from the agricultural point of view a year affected by climate change, pedoclimatic drought, vegetation fires and temporary unavailability of the labour factor affected by the pandemic. The mean of the dependent variable is maximum for the whole period studied (138.05), indicating an increase in farm income and tightening of production management procedures, which proves that, in crisis conditions, overstocking is reduced, releasing surplus through supply chains.

3.2. Weaknesses and Vulnerabilities

In addition to the indicator on output sold, other operationalised sectors are land use, where a 1% increase in revenue was able to induce more efficient land use in a 2:1 ratio, while the APRO, APRI and APRIO indicators show negative variations in relation to the dependent variable (inverse proportionality).

This year, against the background of the food crisis, there is an improvement in the *p*-value for all the regression variables, three of which, APRO, UAA and AQUANTITIES, fall within the 0.05 significance threshold. Residual normality and heteroskedasticity tests confirm the validity of the model, the rejection of the null hypothesis, the normality of the distribution of errors and the absence of heteroskedasticity, which also validates the proposed model for the year 2021. The dynamic analysis of the indicators allowed vulnerabilities to be identified (Figure 3).

Indicator/ Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Histograms
AINCOME	103.7993	112.1432	112.0721	114.1582	111.145	112.0093	126.3046	121.6543	131.0236	135.7129	138.0568	
>avgEU27	14	11	14	14	14	15	13	17	13	13	12	
AQUANTITIES	103.7654	97.3525	104.3904	107.6286	95.04214	93.07	95.74214	92.58321	109.5175	97.52643	97.46286	
>avgEU27	16	15	13	18	16	14	17	17	11	25	25	
UAA	108.0796	103.9479	106.5639	101.5964	98.10964	102.8904	100.2504	102.6679	100.2111	102.3446	99.9375	
>avgEU27	10	12	14	16	15	18	13	9	18	17	19	
APRI	99.31321	117.7761	90.24393	87.60179	97.45071	88.67786	107.8907	109.6454	99.02607	101.7593	119.2257	
>avgEU27	15	15	15	15	14	17	11	12	16	14	14	
APRIO	126.2964	107.6607	85.90714	84.27857	95.97857	88.35714	100.6893	81.72071	77.39714	73.07286	68.75107	
>avgEU27	18	16	17	18	23	19	21	22	19	18	18	
APRO	95.705	95.67714	96.40679	95.89893	96.20714	94.51929	91.42536	97.10679	98.73679	96.85357	95.30429	
>avgEU27	27	27	26	24	20	25	19	22	23	19	25	

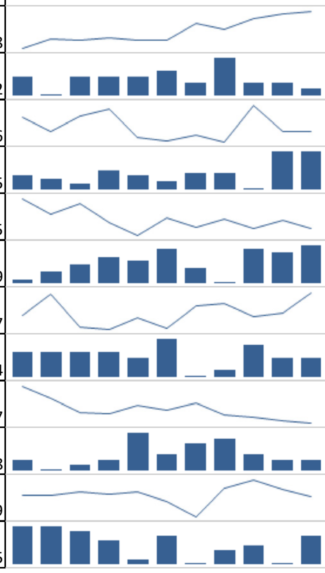


Figure 3. Table of vulnerabilities.

From Figure 3, it can be seen that overall the CAP, as part of sustainable development policies in the EU, has shown a dynamic evolution of efficiency and effectiveness indicators, with the most spectacular increase being recorded in the income of the sector, which has shown a constant upward trend, with 17 Member States (historical maximum in 2018) recording increases in the representation of the agricultural sector in GDP in the pre-pandemic period. However, under adverse economic, pandemic and geo-political impacts, the number of economies growing above the EU average at the end of the analysis horizon is 12, showing that from a sustainable point of view, the CAP is effectively implemented in 44% of Member States. Out of all European agricultural production, 18% of the value is grown below optimal sustainability parameters. For the remaining 37% of agricultural production, we can assess that there is no sustainable growth.

Based on these findings (validated and demonstrated hypotheses), by evaluating the Pearson correlation ratios in dynamics on each indicator (see Tables A1–A6 in Appendix A), the resulting opportunities for development and adjustment of agricultural policy elements (objective O2 of the research)—integrated into a dashboard of viable solutions for agricultural development in line with the needs expressed in the current unfavourable context (objective O3 of the research)—are listed in Table 12.

Regarding agricultural production, the polynomial trend of degree 2 is negative, recording a trend equation with negative values of the coefficient x^2, determined by the formula:

$$y = 0.1454x^2 - 2.1524x + 105.69 \tag{19}$$

where: y—polynomial trend equation of degree 2; x—change in average agricultural production in Member States relative to the EU average for the 11 years of analysis.

In terms of production capacity, there is an increase in the number of Member States that exceed the EU average in dynamics, which signals an increase in productive efficiency.

In the case of agricultural land use, against the background of pedoclimatic drought, vulnerability of productive conditions (climatic and environmental incidents), there is a marked decrease in performance by about 10% in the period 2011–2021, with 2021 marking the year when average land use falls below the EU average. From the dispersion of the number of countries point of view, the historical minimum was reached in 2018, when only nine Member States managed to make the use of agricultural land more efficient. The pandemic's decline and the increase in demand for food have stabilised the situation, so that in 2021, 19 countries manage to exceed the EU average, which is also the result of the decrease in the average value of agricultural land use.

Table 12. Scoreboard of viable agricultural development solutions.

CAP Targets 2023–2027	Vulnerabilities	Development Opportunities
Ensuring a fair income for farmers; Encouraging knowledge and innovation.	Economic crises and adverse environmental conditions affect the predictability of farm incomes.	Increasing investments with an impact on the sustainable development of agriculture (maximising organic farming less dependent on the chemical and petro-chemical industries).
Actions on climate change; Environmental protection; Conserving landscapes and biodiversity; Protecting food quality and health.	Vulnerability of sustainable agricultural production is lower than that of agricultural futures.	Implementing of sustainable agriculture and application of circular economy principles; Reducing the impact of environmental conditions (protected agriculture); Increasing the share of organic products in total agricultural production.
Improving the position of farmers in the food chain; Vibrant rural areas.	The use of agricultural land is influenced by agricultural policies and the short-term interest of organisations.	Intensification of the agricultural association phenomenon; Increasing share of large holding companies; Diversification of industrial agricultural production.
Increasing competitiveness; Supporting the renewal of generations.	At EU level, there is a trend towards reduced predictability of selling and output prices.	Implementing of new agricultural technologies; Smart management in agriculture; Attracting additional rural development funding; Facilitating farmers' access to commodity exchanges.

As for the selling prices of crop products, they are on an upward trend with a positive subunit value of the index of the variable x^2, according to the formula:

$$y = 0.5684x^2 - 5.763x + 110.12 \quad (20)$$

where: y—polynomial trend equation of degree 2; x—change in average selling prices of crop products in Member States relative to the EU average for the 11 years of analysis.

There is a regularisation of the indicator at Member State level through the agricultural supply–demand mechanism.

In the case of APRIO—Price indices of agricultural products, there is a steady decrease in the average price index in the EU, falling relative to the EU average from 126.3% in 2011 to 68.75% in 2021. This development represents a major vulnerability of the CAP and signals price erosion based on climate measures and a decline in efficiency in the industry. At the dispersion level, we observe the same regularity based on the demand–supply mechanism as in the previous indicator analysed.

The APRO indicator—Crop production in EU standard humidity is on a relatively constant trend line, with the exception of the inflection point in 2017, when the indicator recorded a historical minimum of average values in relation to the European average:

$$y = 0.0388x^2 - 0.3986x + 96.412 \quad (21)$$

where: y—polynomial trend equation of degree 2; x—variation of average crop production in EU standard humidity in Member States relative to the EU average for the 11 years of analysis.

The value close to 0 of the x^2 coefficient indicates the relative linearity of the trend curve with a slight increase towards the end of the period, and the level of dispersion at Member State level is small, with about 23 countries on average managing to obtain values over the analysis period above the EU average.

4. Conclusions

In this study, we started from the premise that European agriculture, marked by transformations in the last 10 years as a result of the sustainable development objectives assumed by European bodies, represents a branch whose predictability in development is currently affected by exogenous events (economic crisis, geo-political crisis, soil and climate crisis, health crisis).

The dynamic analysis of the efficiency and effectiveness indicators calculated on the basis of gross reporting and collected through the Eurostat spreadsheet has shown that the transformation of the agricultural sector in Europe has led to vulnerabilities in the positioning of the various efficiency and effectiveness targets in relation to their projected size.

Through the regression analysis carried out, the Vulnerability Table was constructed as part of research objective O1: Identify the vulnerability components of the context in which European farmers operate. The authors conducted a statistical analysis to determine the perfectible level of vulnerabilities showing through modelling (using a valid, homogeneous and statistically representative econometric model) that:

- The predictability of incomes in agriculture is affected by economic crises and unfavourable environmental conditions, and efforts are needed to improve inputs in agriculture by increasing investment with an impact on the sustainable development of agriculture (maximizing organic agriculture less dependent on the chemical and petrochemical industries) (the subject of hypothesis H1 of the research).
- The sustainability and predictability of agricultural production is less vulnerable than that of income in terms of economic predictability and multi-year dynamics, but it is still influenced by adverse environmental and pedo-climatic conditions (the subject of hypothesis H2 of the research).
- Agricultural land use is a sensitive component of the development of the agricultural sector, the dynamics of which are influenced by agricultural policies and by the conjunctural interest of organisations (the subject of hypothesis H3 of the research).
- At EU level, there is a trend towards a reduction in the predictability of sales and output prices, which is strongly influenced by economic conditions and elements of uncertainty (the subject of hypothesis H4 of the research).

The limitations of this study lie in the relatively small number of indicators analysed. As a result, we propose new research in this area covering the current geo-political, climatic and economic impact on European agriculture.

Author Contributions: Conceptualization, R.V.I., M.L.Z. and V.M.A.; data curation, R.V.I., M.L.Z. and V.M.A.; formal analysis, R.V.I., M.L.Z. and V.M.A.; investigation, R.V.I., M.L.Z. and V.M.A.; methodology, R.V.I., M.L.Z. and V.M.A.; project administration, R.V.I., M.L.Z. and V.M.A.; resources, R.V.I., M.L.Z. and V.M.A.; visualization, R.V.I., M.L.Z. and V.M.A.; supervision, R.V.I., M.L.Z. and V.M.A.; writing—original draft, R.V.I., M.L.Z. and V.M.A., writing—review and editing, R.V.I., M.L.Z. and V.M.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Pearson correlation rates in dynamics for the agricultural income indicator.

Pearson Correlation	AINCOME 2011	AINCOME 2012	AINCOME 2013	AINCOME 2014	AINCOME 2015	AINCOME 2016	AINCOME 2017	AINCOME 2018	AINCOME 2019	AINCOME 2020	AINCOME 2021
AINCOME 2011		0.831	0.790	0.746	0.403	0.337	0.453	0.260	0.350	0.298	0.233
AINCOME 2012	0.831		0.734	0.678	0.399	0.299	0.526	0.277	0.478	0.487	0.401
AINCOME 2013	0.790	0.734		0.884	0.700	0.686	0.773	0.615	0.748	0.724	0.693
AINCOME 2014	0.746	0.678	0.884		0.783	0.767	0.825	0.739	0.814	0.735	0.757
AINCOME 2015	0.403	0.399	0.700	0.783		0.884	0.821	0.841	0.827	0.870	0.869
AINCOME 2016	0.337	0.299	0.686	0.767	0.884		0.907	0.935	0.891	0.864	0.879
AINCOME 2017	0.453	0.526	0.773	0.825	0.821	0.907		0.887	0.924	0.903	0.897
AINCOME 2018	0.260	0.277	0.615	0.739	0.841	0.935	0.887		0.912	0.856	0.868
AINCOME 2019	0.350	0.478	0.748	0.814	0.827	0.891	0.924	0.912		0.934	0.938
AINCOME 2020	0.298	0.487	0.724	0.735	0.870	0.864	0.903	0.856	0.934		0.943
AINCOME 2021	0.233	0.401	0.693	0.757	0.869	0.879	0.897	0.868	0.938	0.943	

Table A2. Pearson correlation rates in dynamics for selling prices of crop products indicator.

Pearson Correlation	APRI 2011	APRI 2012	APRI 2013	APRI 2014	APRI 2015	APRI 2016	APRI 2017	APRI 2018	APRI 2019	APRI 2020	APRI 2021
APRI 2011		0.493	−0.293	0.200	0.219	0.337	0.006	0.027	0.058	0.221	0.324
APRI 2012	0.493		−0.832	0.353	0.186	−0.060	0.405	0.311	−0.418	0.502	0.088
APRI 2013	−0.293	−0.832		−0.741	−0.252	0.242	−0.396	−0.052	0.236	−0.265	0.086
APRI 2014	0.200	0.353	−0.741		0.004	−0.362	0.319	−0.330	0.163	−0.075	−0.008
APRI 2015	0.219	0.186	−0.252	0.004		0.070	−0.034	−0.194	0.031	−0.081	−0.118
APRI 2016	0.337	−0.060	0.242	−0.362	0.070		−0.657	0.057	−0.139	0.424	−0.004
APRI 2017	0.006	0.405	−0.396	0.319	−0.034	−0.657		−0.145	0.090	−0.256	−0.012
APRI 2018	0.027	0.311	−0.052	−0.330	−0.194	0.057	−0.145		−0.791	0.214	0.225
APRI 2019	0.058	−0.418	0.236	0.163	0.031	−0.139	0.090	−0.791		−0.444	−0.374
APRI 2020	0.221	0.502	−0.265	−0.075	−0.081	0.424	−0.256	0.214	−0.444		−0.030
APRI 2021	0.324	0.088	0.086	−0.008	−0.118	−0.004	−0.012	0.225	−0.374	−0.030	

Table A3. Pearson correlation rates in dynamics for price indices of agricultural products indicator.

Pearson Correlation	APRIO 2011	APRIO 2012	APRIO 2013	APRIO 2014	APRIO 2015	APRIO 2016	APRIO 2017	APRIO 2018	APRIO 2019	APRIO 2020	APRIO 2021
APRIO 2011		0.678	0.902	0.765	0.843	0.836	0.873	0.842	0.814	0.779	0.736
APRIO 2012	0.678		0.740	0.856	0.899	0.918	0.742	0.889	0.879	0.862	0.839
APRIO 2013	0.902	0.740		0.791	0.835	0.900	0.820	0.899	0.888	0.870	0.844
APRIO 2014	0.765	0.856	0.791		0.945	0.909	0.861	0.947	0.938	0.921	0.897
APRIO 2015	0.843	0.899	0.835	0.945		0.937	0.939	0.960	0.939	0.910	0.873
APRIO 2016	0.836	0.918	0.900	0.909	0.937		0.836	0.969	0.960	0.943	0.919
APRIO 2017	0.873	0.742	0.820	0.861	0.939	0.836		0.891	0.859	0.820	0.773
APRIO 2018	0.842	0.889	0.899	0.947	0.960	0.969	0.891		0.997	0.987	0.968
APRIO 2019	0.814	0.879	0.888	0.938	0.939	0.960	0.859	0.997		0.996	0.985
APRIO 2020	0.779	0.862	0.870	0.921	0.910	0.943	0.820	0.987	0.996		0.996
APRIO 2021	0.736	0.839	0.844	0.897	0.873	0.919	0.773	0.968	0.985	0.996	

Table A4. Pearson correlation rates in dynamics for crop production in EU standard humidity indicator.

Pearson Correlation	APRO 2011	APRO 2012	APRO 2013	APRO 2014	APRO 2015	APRO 2016	APRO 2017	APRO 2018	APRO 2019	APRO 2020	APRO 2021
APRO2011		1.000	0.978	0.963	0.942	0.957	0.966	0.971	0.987	0.917	0.971
APRO2012	1.000		0.979	0.962	0.942	0.957	0.967	0.971	0.987	0.917	0.971
APRO2013	0.978	0.979		0.890	0.944	0.915	0.934	0.973	0.971	0.946	0.930
APRO2014	0.963	0.962	0.890		0.855	0.959	0.944	0.905	0.949	0.811	0.968
APRO2015	0.942	0.942	0.944	0.855		0.821	0.884	0.965	0.917	0.964	0.854
APRO2016	0.957	0.957	0.915	0.959	0.821		0.935	0.881	0.951	0.797	0.974
APRO2017	0.966	0.967	0.934	0.944	0.884	0.935		0.902	0.950	0.834	0.970
APRO2018	0.971	0.971	0.973	0.905	0.965	0.881	0.902		0.953	0.958	0.900
APRO2019	0.987	0.987	0.971	0.949	0.917	0.951	0.950	0.953		0.881	0.974
APRO2020	0.917	0.917	0.946	0.811	0.964	0.797	0.834	0.958	0.881		0.805
APRO2021	0.971	0.971	0.930	0.968	0.854	0.974	0.970	0.900	0.974	0.805	

Table A5. Pearson correlation rates in dynamics for the unit value statistics for agricultural products indicator.

Pearson Correlation	AQUANTITIES 2011	AQUANTITIES 2012	AQUANTITIES 2013	AQUANTITIES 2014	AQUANTITIES 2015	AQUANTITIES 2016	AQUANTITIES 2017	AQUANTITIES 2018	AQUANTITIES 2019	AQUANTITIES 2020	AQUANTITIES 2021
AQUANTITIES 2011		0.546	0.708	0.840	0.680	0.764	0.553	0.612	0.738	0.896	0.896
AQUANTITIES 2012	0.546		0.332	0.591	0.919	0.212	0.769	0.199	0.775	0.719	0.717
AQUANTITIES 2013	0.708	0.332		0.483	0.515	0.749	0.433	0.778	0.477	0.793	0.794
AQUANTITIES 2014	0.840	0.591	0.483		0.695	0.654	0.612	0.504	0.706	0.855	0.856
AQUANTITIES 2015	0.680	0.919	0.515	0.695		0.369	0.789	0.367	0.853	0.847	0.846
AQUANTITIES 2016	0.764	0.212	0.749	0.654	0.369		0.126	0.809	0.395	0.737	0.737
AQUANTITIES 2017	0.553	0.769	0.433	0.612	0.789	0.126		0.188	0.715	0.728	0.727
AQUANTITIES 2018	0.612	0.199	0.778	0.504	0.367	0.809	0.188		0.131	0.679	0.680
AQUANTITIES 2019	0.738	0.775	0.477	0.706	0.853	0.395	0.715	0.131		0.789	0.788
AQUANTITIES 2020	0.896	0.719	0.793	0.855	0.847	0.737	0.728	0.679	0.789		1.000
AQUANTITIES 2021	0.896	0.717	0.794	0.856	0.846	0.737	0.727	0.680	0.788	1.000	

Table A6. Pearson correlation rates in dynamics for the indicator utilised agricultural area (UAA) managed by low-, medium- and high-input farms.

Pearson Correlation	UAA 2011	UAA 2012	UAA 2013	UAA 2014	UAA 2015	UAA 2016	UAA 2017	UAA 2018	UAA 2019	UAA 2020	UAA 2021
UAA 2011		0.189	0.210	0.017	−0.134	0.121	−0.009	−0.228	0.127	0.338	0.296
UAA 2012	0.189		−0.021	0.191	0.059	−0.002	−0.011	−0.311	0.241	0.407	0.316
UAA 2013	0.210	−0.021		0.239	0.028	0.426	−0.035	0.260	−0.121	0.495	0.611
UAA 2014	0.017	0.191	0.239		0.039	−0.109	−0.008	0.202	−0.290	0.436	0.336
UAA 2015	−0.134	0.059	0.028	0.039		−0.224	0.266	0.065	−0.447	0.390	0.353
UAA 2016	0.121	−0.002	0.426	−0.109	−0.224		−0.748	−0.320	0.014	0.427	0.498
UAA 2017	−0.009	−0.011	−0.035	−0.008	0.266	−0.748		0.427	−0.002	−0.269	−0.194
UAA 2018	−0.228	−0.311	0.260	0.202	0.065	−0.320	0.427		−0.344	−0.279	0
UAA 2019	0.127	0.241	−0.121	−0.290	−0.447	0.014	−0.002	−0.344		−0.413	−0.254
UAA 2020	0.338	0.407	0.495	0.436	0.390	0.427	−0.269	−0.279	−0.413		0.924
UAA 2021	0.296	0.316	0.611	0.336	0.353	0.498	−0.194	−0.159	−0.254	0.924	

References

1. European Commission Commission Acts for Global Food Security and for Supporting EU Farmers and Consumers. Available online: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1963 (accessed on 31 August 2022).
2. European Commission Ensuring Global Food Supply and Food Security. Available online: https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/contingency-plan_en#efscm (accessed on 31 August 2022).
3. European Commission Impact of Russia's Invasion of Ukraine on Selected Agricultural Sectors. Available online: https://agridata.ec.europa.eu/extensions/Ukraine/Ukraine.html#EU_stocks_header (accessed on 31 August 2022).
4. Kissinger, G.; Gupta, A.; Mulder, I.; Unterstell, N. Climate Financing Needs in the Land Sector under the Paris Agreement: An Assessment of Developing Country Perspectives. *Land Use Policy* **2019**, *83*, 256–269. [CrossRef]
5. Noack, F.; Larsen, A. The Contrasting Effects of Farm Size on Farm Incomes and Food Production. *Environ. Res. Lett.* **2019**, *14*, 84024. [CrossRef]
6. Martin, W. Economic Growth, Convergence, and Agricultural Economics. *Agric. Econ.* **2019**, *50*, 7–27. [CrossRef]
7. Kiryluk-Dryjska, E.; Baer-Nawrocka, A. Reforms of the Common Agricultural Policy of the EU: Expected Results and Their Social Acceptance. *J. Policy Model.* **2019**, *41*, 607–622. [CrossRef]
8. Biagini, L.; Antonioli, F.; Severini, S. The Role of the Common Agricultural Policy in Enhancing Farm Income: A Dynamic Panel Analysis Accounting for Farm Size in Italy. *J. Agric. Econ.* **2020**, *71*, 652–675. [CrossRef]
9. Sándor, Z.; Zoltan, Z. Output Value and Productivity of Agricultural Industry in Central-East Europe. *Agric. Econ. (Zemědělská Ekon.)* **2019**, *65*, 185–193. [CrossRef]
10. Sroka, W.; Dudek, M.; Wojewodzic, T.; Król, K. Generational Changes in Agriculture: The Influence of Farm Characteristics and Socio-Economic Factors. *Agriculture* **2019**, *9*, 264. [CrossRef]
11. Severini, S.; Di Tommaso, G.; Finger, R. Effects of the Income Stabilization Tool on Farm Income Level, Variability and Concentration in Italian Agriculture. *Agric. Food Econ.* **2019**, *7*, 23. [CrossRef]
12. Loizou, E.; Karelakis, C.; Galanopoulos, K.; Mattas, K. The Role of Agriculture as a Development Tool for a Regional Economy. *Agric. Syst.* **2019**, *173*, 482–490. [CrossRef]
13. Kiryluk-Dryjska, E.; Beba, P.; Poczta, W. Local Determinants of the Common Agricultural Policy Rural Development Funds' Distribution in Poland and Their Spatial Implications. *J. Rural Stud.* **2020**, *74*, 201–209. [CrossRef]
14. Streimikis, J.; Baležentis, T. Agricultural Sustainability Assessment Framework Integrating Sustainable Development Goals and Interlinked Priorities of Environmental, Climate and Agriculture Policies. *Sustain. Dev.* **2020**, *28*, 1702–1712. [CrossRef]
15. Burja, V.; Tamas-Szora, A.; Dobra, I.B. Land Concentration, Land Grabbing and Sustainable Development of Agriculture in Romania. *Sustainability* **2020**, *12*, 2137. [CrossRef]
16. Streimikis, J.; Miao, Z.; Balezentis, T. Creation of Climate-Smart and Energy-Efficient Agriculture in the European Union: Pathways Based on the Frontier Analysis. *Bus. Strateg. Environ.* **2021**, *30*, 576–589. [CrossRef]
17. Guth, M.; Smedzik-Ambrozy, K.; Czyzewski, B.; Stepien, S. The Economic Sustainability of Farms under Common Agricultural Policy in the European Union Countries. *Agriculture* **2020**, *10*, 34. [CrossRef]
18. Negra, C.; Remans, R.; Attwood, S.; Jones, S.; Werneck, F.; Smith, A. Sustainable Agri-Food Investments Require Multi-Sector Co-Development of Decision Tools. *Ecol. Indic.* **2020**, *110*, 105851. [CrossRef]
19. Maier, D.; Remete, A.-N.; Corda, A.-M.; Nastasoiu, I.-A.; Lazăr, P.-S.; Pop, I.-A.; Luca, T.-I. Territorial Distribution of EU Funds Allocation for Developments of Rural Romania during 2014–2020. *Sustainability* **2022**, *14*, 506. [CrossRef]
20. Feher, A.; Stanciu, S.; Iancu, T.; Adamov, T.C.; Ciolac, R.M.; Pascalau, R.; Banes, A.; Raicov, M.; Gosa, V. Design of the Macroeconomic Evolution of Romania's Agriculture 2020–2040. *Land Use Policy* **2022**, *112*, 105815. [CrossRef]
21. Eurostat Economic Accounts for Agriculture -Agricultural Income. Available online: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aact_eaa06&lang=en (accessed on 30 August 2022).
22. Eurostat Crop Production in EU Standard Humidity. Available online: https://ec.europa.eu/eurostat/databrowser/view/apro_cpsh1/default/table?lang=en (accessed on 30 August 2022).
23. Eurostat Unit Value Statistics for Agricultural Products. Available online: https://ec.europa.eu/eurostat/databrowser/view/EF_LUS_MAIN/default/table?lang=e&category=agr.ef.ef_landuse (accessed on 30 August 2022).
24. Eurostat Utilised Agricultural Area (UAA) Managed by Low-, Medium- and High-Input Farms. Available online: https://ec.europa.eu/eurostat/databrowser/view/aei_ps_inp/default/table?lang=en (accessed on 30 August 2022).
25. Eurostat Selling Prices of Crop Products (Absolute Prices)—Annual Price. Available online: https://ec.europa.eu/eurostat/databrowser/view/apri_ap_crpouta/default/table?lang=en (accessed on 30 August 2022).
26. Eurostat Price Indices of Agricultural Products, Output (2010 = 100)—Annual Data. Available online: https://ec.europa.eu/eurostat/databrowser/view/apri_pi10_outa/default/table?lang=en (accessed on 30 August 2022).