

EVALUATING THE IMPACT OF THE COMMON AGRICULTURAL POLICY ON THE DECLINE OF MINERAL FERTILIZER USE IN EUROPEAN FARMING SYSTEMS

DUMITRESCU CARMEN-SIMONA¹, IOSIM IASMINA², CONSTANTINESCU SIMONA CRISTINA², STANCIU SORIN MIHAI², SĂLĂȘAN COSMIN¹

¹ *University of Life Sciences "King Mihai I" from Timisoara, Faculty of Management and Rural Tourism, Department Management and Rural Development, Romania*

² *University of Life Sciences "King Mihai I" from Timisoara, Faculty of Management and Rural Tourism, Department Economy and Firm Financing, Romania*

*Corresponding author's e-mail: carmendumitrescu@usvt.ro

Abstract: *Mineral fertilizers, Agri-environmental indicators, Common Agricultural Policy (CAP), Sustainable agriculture, Environmental impact* In recent years, a clear trend has been observed in the reduction of mineral fertilizer consumption used in agriculture, amid growing concerns for environmental protection and the sustainable use of natural resources. This evolution is closely linked to the agri-environmental indicators established under the Common Agricultural Policy (CAP), which aim to reduce the negative impact of agriculture on soil, water, and biodiversity. The decrease in the use of mineral fertilizers is driven by several factors: the promotion of sustainable farming practices, the adoption of precision technologies, the increasing awareness among farmers of the effects of nitrate pollution, as well as the financial incentives provided through the CAP's agri-environment-climate measures. These measures reward farmers who reduce the use of chemical substances while promoting the use of organic fertilizers or crop rotation to maintain soil fertility. In this paper, the authors analyzed the consumption of mineral fertilizers within European agriculture. Agri-environmental indicators such as nitrogen and phosphorus consumption, groundwater quality, and the state of biodiversity reflect the progress achieved. The reduction in mineral fertilizers directly contributes to achieving the objectives of climate neutrality and the protection of rural ecosystems, supporting the transition toward a more green, balanced, and resilient European agriculture.

Key words: *mineral fertilizers, indicators, CAP, sustainable agriculture, impact*

INTRODUCTION

The intensification of agriculture throughout the 20th century has relied heavily on mineral fertilizers to boost crop productivity and meet the food demands of a growing population [3]. However, excessive fertilizer application has resulted in numerous environmental challenges, including soil degradation, eutrophication of water bodies, and greenhouse gas emissions [9].

In response, the European Union (EU) has incorporated sustainability principles into the Common Agricultural Policy (CAP), focusing on agri-environmental indicators (AEIs) to monitor and mitigate negative impacts of farming [1,7]. The integration of these indicators supports the European Green Deal and the Farm to Fork Strategy, both of which promote resource-efficient and environmentally friendly food systems [4].

This paper explores recent trends in the reduction of mineral fertilizer use within the EU, identifies the main drivers behind this transition, and examines the implications for sustainable agriculture and environmental protection.

MATERIALS AND METHODS

Data were obtained from the Eurostat Agri-Environmental Indicators (AEIs) database, the European Environment Agency (EEA), and national statistical agencies for the period 2005–2023 [6,7].

Key agri-environmental indicators include:

- Nutrient Balance (Nitrogen and Phosphorus Surplus) – assessing potential nutrient leaching [10].
- Gross Nutrient Use Efficiency – evaluating productivity per unit of nutrient applied [11].
- Groundwater Nitrate Concentration – reflecting fertilizer runoff impact [1].
- Farmland Biodiversity – measured by the Farmland Bird Index [12].

Linear regression and correlation analyses were applied to detect trends and relationships between fertilizer consumption and environmental indicators. Spatial patterns were visualized using thematic maps of EU Member States [8].

RESEARCH RESULTS

General Trends in Fertilizer Consumption

Table 1.

Average Mineral Fertilizer Consumption in the EU (kg/ha of UAA)

Year	Nitrogen (N)	Phosphorus (P ₂ O ₅)	Potassium (K ₂ O)
2005	85.6	34.8	44.2
2010	81.3	30.2	42.7
2015	77.5	28.1	40.9
2020	75.1	26.8	39.5
2023	74.3	25.6	38.8

Source : www.eurostat.eu

Between 2005 and 2023, nitrogen fertilizer use decreased by 13%, while phosphorus declined by 26% [7].

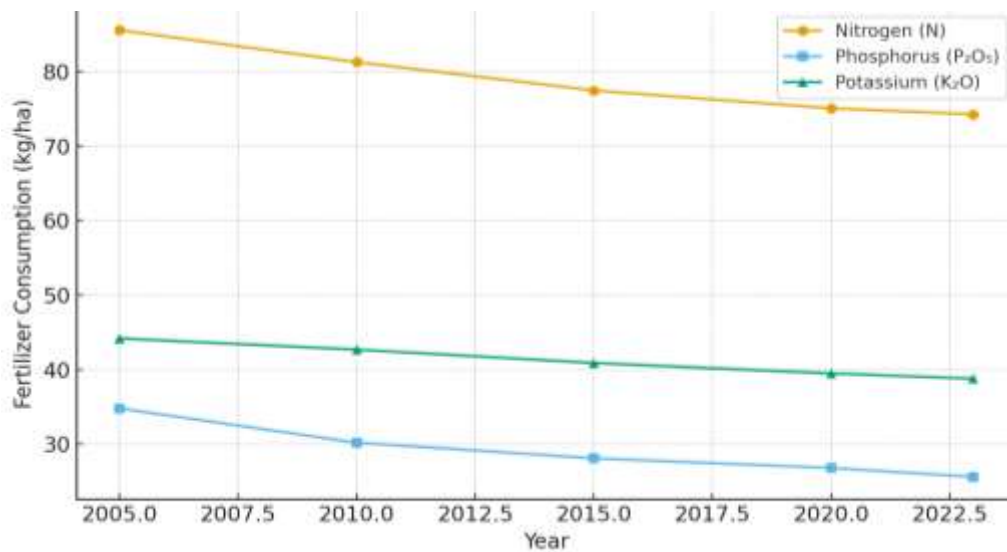


Figure 1. Trend of Mineral Fertilizer Consumption in the EU (2005–2023)
(Line graph showing steady declines in N, P₂O₅, and K₂O use.)

This trend indicates greater adoption of precision farming and organic soil management practices [16].

Regional Differences in Fertilizer Use

Table 2.

Fertilizer Use by Selected EU Member States (Average 2020–2023, kg/ha)

Country	Nitrogen	Phosphorus	CAP AECM Adoption (%)
Germany	74	23	68
France	77	27	59
Poland	92	34	32
Denmark	63	19	71
Spain	88	33	41
Netherlands	66	21	73

Source : www.eurostat.eu

Countries with higher participation in agri-environment-climate measures (AECMs) - such as Denmark and the Netherlands - show lower fertilizer use [4,8].

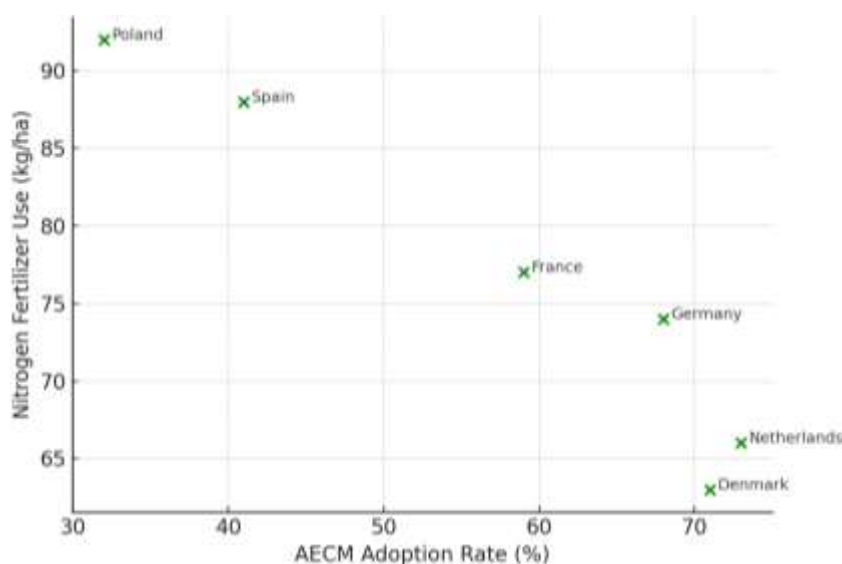


Figure 2. Correlation between Nitrogen Use and CAP AECM Participation
(Scatter plot showing negative correlation; higher participation correlates with lower N input)

Environmental Impact Indicators

Table 3.

Changes in Selected Agri-Environmental Indicators (EU-27, 2005–2023)

INDICATOR	2005	2023	CHANGE (%)	CORRELATION WITH N USE (R)
Nitrate in groundwater (mg/L)	29.4	23.2	-21.1%	-0.72
Farmland Bird Index (2000 = 100)	85	92	+8.2%	+0.41
Soil Organic Carbon (g/kg)	15.8	17.3	+9.5%	-0.36

Source : www.eurostat.eu

Improvements in groundwater nitrate concentration and farmland biodiversity demonstrate the environmental benefits of reduced fertilizer use [6,12].

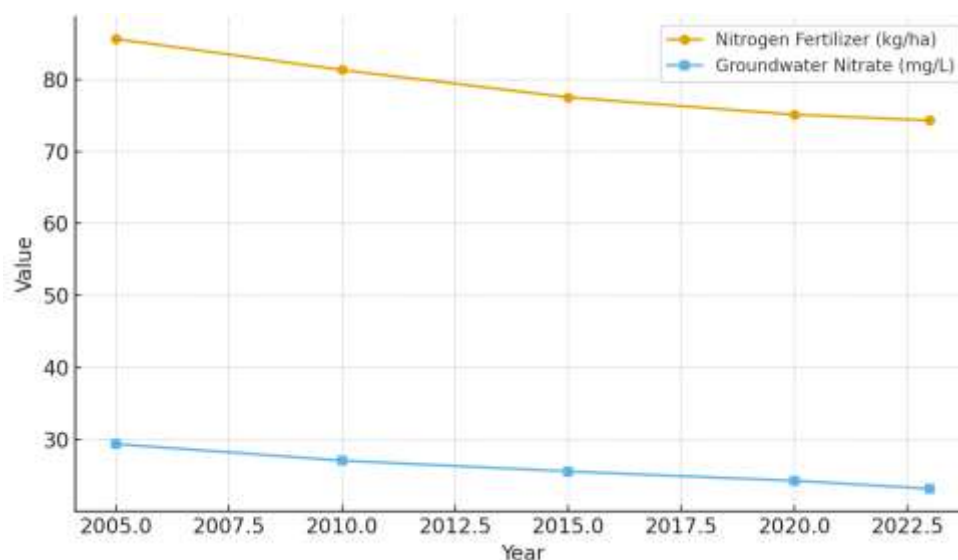


Figure 3. Relationship between Fertilizer Use and Groundwater Quality
(Line graph showing simultaneous reduction in N fertilizer and nitrate pollution)

The reduction in mineral fertilizer use is driven by policy incentives, technological advances, and environmental awareness [1,11]. Precision agriculture tools and soil nutrient mapping have improved fertilizer efficiency, lowering losses to the environment [13,16]. However, regional disparities persist - fertilizer intensity remains higher in parts of Eastern Europe due to limited technology access and weaker environmental scheme adoption [8]. To ensure equity, CAP should strengthen knowledge transfer and technical support for sustainable fertilizer management.

The transition contributes to climate neutrality goals by reducing nitrous oxide (N_2O) emissions from agricultural soils [9,15].

CONCLUSIONS

The steady reduction of mineral fertilizer use in European agriculture represents a cornerstone of the transition toward more sustainable farming systems. Excessive application of synthetic fertilizers has long been associated with soil degradation, nutrient runoff, water pollution, and greenhouse gas emissions, prompting the European Union to address this challenge through a combination of regulatory frameworks and incentive-based instruments [5,14]. Within the Common Agricultural Policy (CAP), agri-environment-climate measures, eco-schemes, and cross-compliance requirements have played a central role in encouraging farmers to optimize nutrient management practices [3]. These policy instruments are complemented by agri-environmental indicators that monitor nutrient balances, soil quality, and water status, providing an evidence-based foundation for evaluating progress and guiding future interventions [4,5,6,10].

Technological innovation has further accelerated improvements in fertilizer efficiency and environmental performance. Precision agriculture tools—such as variable-rate application technologies, soil nutrient sensors, decision-support systems, and satellite-based monitoring—enable farmers to apply fertilizers more accurately and only where needed, thereby reducing input use while maintaining or even increasing crop productivity [4]. Empirical evidence suggests that these innovations contribute to improved soil structure, reduced nitrate leaching, and enhanced on-farm biodiversity by lowering chemical pressures on agroecosystems [14]. However, sustaining and scaling these gains

requires continued investment in digital infrastructure, agricultural research, and targeted farmer training to ensure widespread adoption and effective use of new technologies [4].

Looking ahead, the long-term success of fertilizer reduction strategies depends on the coherent integration of environmental and agricultural policies at both EU and national levels. Aligning nutrient management objectives with climate mitigation, water protection, and biodiversity conservation goals is essential for building climate-resilient, resource-efficient, and environmentally sustainable European agriculture [2,5]. Strengthening policy coherence, knowledge transfer, and innovation systems will be critical to maintaining the current trajectory and meeting the ambitions of the European Green Deal and the Farm to Fork Strategy [3].

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