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Do organic farming policies need to be more target-oriented to achieve sustainability?

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Title page

Do organic farming policies need to be more target-oriented to achieve sustainability?

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Abstract

Organic farming is a key element of the EU Green Deal's Farm-to-Fork strategy, which aims to achieve 25% of total utilized agricultural land being organic by 2030. The aim of this paper is to assess whether a more complex and targeted organic support mechanism delivers significant environmental benefits compared to a simpler but less targeted option within the context of the current organic conversion policy (CAP Strategic Plans for 2023-2027) and its performance in relation to reaching the 25% organic area target. Using the IFM-CAP model, three contrasting organic conversion policy strategies for the EU are assessed: an action-oriented approach, a result-oriented approach focused on environmental performance, and a combined approach emphasizing cost-effectiveness. Findings reveal significant trade-offs: the result-oriented strategy, while more costly and complex due to higher monitoring requirements, achieves greater emission reductions per euro spent, mainly by converting high-emitting livestock farms, but results in a larger gap to the 25% organic area target. Conversely, the action-oriented strategy is less costly, focuses on arable farm conversion, comes closer to the 25% organic area target, but achieves lower emission reductions. Therefore, achieving environmental benefits from organic farming may require focusing on farms with higher environmental improvement potential, not just on the amount of land converted.

Disclaimer

The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Dear Editor,

We are submitting our manuscript entitled " Do organic farming policies need to be more target-oriented to achieve sustainability?" for consideration for publication in the Journal of Environmental Management.

The paper compares different hypothetical organic conversion policies for the EU to assess the differences between action-based and a result-based approaches. The conversion of conventional farms to organic is simulated with a farm-level model (IFM-CAP). The outputs suggest that an approach based on cost-effectiveness might be the best performing one if we want to achieve not just more area under organic farming but also the biggest environmental benefits from conversion. The outcomes are relevant for the current European policy, specifically for the Farm-To-Fork Strategy.

Thank you for considering our work for publication in your esteemed journal.

Kind regards,

Dolores Rey Vicario

JRC – European Commission

Sevilla (Spain)

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Highlights

- EU aims for 25% of agricultural land to be organic by 2030.
- Action- vs. result-oriented policy strategies are assessed.
- Significant trade-offs found in organic conversion policies.
- Conversion policy based on cost-effectiveness yields better results
- Area targets should be combined with concrete environmental objectives.

Do organic farming policies need to be more target-oriented to achieve sustainability?

Abstract

Organic farming is a key element of the EU Green Deal's Farm-to-Fork strategy, which aims to achieve 25% of total utilized agricultural land being organic by 2030. The aim of this paper is to assess whether a more complex and targeted organic support mechanism delivers significant environmental benefits compared to a simpler but less targeted option within the context of the current organic conversion policy (CAP Strategic Plans for 2023-2027) and its performance in relation to reaching the 25% organic area target. Using the IFM-CAP model, three contrasting organic conversion policy strategies for the EU are assessed: an action-oriented approach, a result-oriented approach focused on environmental performance, and a combined approach emphasizing cost-effectiveness. Findings reveal significant trade-offs: the result-oriented strategy, while more costly and complex due to higher monitoring requirements, achieves greater emission reductions per euro spent, mainly by converting high-emitting livestock farms, but results in a larger gap to the 25% organic area target. Conversely, the action-oriented strategy is less costly, focuses on arable farm conversion, comes closer to the 25% organic area target, but achieves lower emission reductions. Therefore, achieving environmental benefits from organic farming may require focusing on farms with higher environmental improvement potential, not just on the amount of land converted.

Keywords: Common Agricultural Policy; European Union; Green Deal; farm model, IFM-CAP; organic agriculture, environmental performance.

1. Introduction

Organic farming has been promoted worldwide to reduce the environmental impacts of agriculture, although there is still a debate in the scientific community about whether organic agriculture actually mitigates environmental externalities (Debuschewitz and Sanders, 2022). Several studies have shown that organic agriculture reduces the impacts per hectare but not necessarily per unit of product (Tuomisto et al., 2012), due to lower yields in organic farming. According to Muller et al. (2017), organic agriculture can reduce environmental impacts but only when the implementation strategy is right.

In Europe, as part of the EU Green Deal and more specifically the Farm-to-Fork (F2F) strategy (European Commission, 2020), more sustainable ways of food production, including organic agriculture, are being endorsed. One of the F2F's targets is to have 25% of total Utilized Agricultural Area (UAA) in the EU as organic by 2030[1] (European Commission, 2021). While the objective is clear, the road to get there is still uncertain. Each Member State (MS) has set an annual budget for organic conversion, and designed different interventions related to organic farming in their Common Agricultural Policy (CAP) Strategic Plans (SP) for the 2023-2027 financial period. However, there is not a coordinated approach that would ensure the 25% target will be achieved at the EU level, and little effort has been made to assess the impacts on agricultural production or the environment for each individual MS and the EU as a whole. Lampkin and Padel (2022) looked at the environmental impacts of the F2F organic target, focusing on different organic growth rate scenarios. Their results clearly show the substantial environmental benefits of achieving the F2F organic target, but they also suggest that budget per MS would need to be increased considerably. This is consistent with the work by Kremmydas et al. (2023a) that estimated that the EU budget would need to be 4.5 times higher than the current one to achieve the 25% target. Kremmydas et al. (2023b) studied the effects of organic conversion under two different farm selection approaches – endogenous (based on profitability maximization) and exogenous (based on a combination of monetary and non-monetary drivers) –

[1] The organic area in the EU is currently around 9% according to Eurostat: https://ec.europa.eu/eurostat/databrowser/product/view/sdg_02_40

focusing on the impacts on cropped areas, income and production. Their results suggest that the reduction in yields due to organic conversion could decrease production quantity for most crops and animal products between -0.5% to -15% in the EU. On the other hand, production costs tend to decrease and income increases for some farm specializations depending on the scenario, showing the trade-offs of organic conversion.

Each country has a limited budget to cover the costs of organic farming conversion and maintenance (IFOAM Organics Europe, 2021). Thus, maximizing the effectiveness of organic conversion policies must be a priority (Schader et al., 2013). So far, the approach has been mainly action-oriented (farmers that convert to organic receive financial support per ha) rather than result-oriented, without explicitly considering the associated environmental improvement and not encouraging farmers to adopt those practices that could deliver bigger benefits for the environment (Vainio et al., 2021). Focusing on the desirable outcome and incentivizing farmers to achieve a certain environmental target would contribute to the cost-effectiveness of the F2F's ambition. Result-oriented approaches for agri-environmental measures have been supported by many authors as a better alternative than action-based payments (e.g., Pe'er et al. 2022; Bergschmidt et al. 2021; Sidemo-Holm et al. 2019; Stolze et al. 2015; Burton and Schwarz 2013).

To better understand how the outcomes of a result-oriented conversion policy would compare with action-oriented ones, this paper assesses contrasting hypothetical organic conversion policy strategies (i.e., which farms to prioritize for conversion). The main objective is to assess how a more complex but better targeted organic support mechanism under the CAP (i.e. an results-based approach) delivers significant environmental benefits compares to a simpler but less targeted option (i.e. an action-based approach), which might be preferred if the additional benefits of the former approach are not substantial, because it is easier and less costly to implement. For this purpose, we consider three different strategies to implement organic conversion in the EU. The first strategy (referred to as “Budget”) minimizes the cost of conversion to organic production for a given budget (action-oriented approach). The second strategy (referred to as “Environment”) maximizes environmental benefits by selecting farms with the biggest emission reduction potential for organic conversion (result-oriented approach). The third strategy (referred to as "Combined") combines the first two strategies by maximizing the cost-effectiveness[2] of the policy. For this, we consider the budget allocated by Member States to support organic farms for the financial period 2023-2027, and analyse the impacts of these three strategies. In addition, we examine the gap in land conversion and the additional budgetary costs required to reach the 25% organic target compared to the CAP SPs. We focus on key performance indicators for each policy strategy, such as area converted, greenhouse gas (GHG) emissions reduction and impacts on production, to identify the trade-offs between different conversion policy options. Although many other environmental indicators could have been considered in this study, we focus on GHG emissions as it is one of the most widely used indicators to assess the sustainability of food systems and it is correlated with many other environmental externalities (Lambotte et al., 2023). The findings have direct implications for policymakers and contribute to the ongoing discourse on sustainable agriculture and environmental policy within the EU.

2. Methods

To assess the performance of different organic conversion policies we use the IFM-CAP model (Individual Farm Model for Common Agricultural Policy Analysis; Kremmydas et al., 2022). IFM-CAP is a farm-level optimisation model of agricultural supply designed for the economic and environmental analysis of European agricultural systems. It consists of a number of individual farm models – one for each of the 81,107 farms in the FADN[3] database covering all EU. The model provides EU-wide geographical and production coverage and it is representative of the effects of CAP policy on EU commercial farms. IFM-CAP simulates a farmer's decision to allocate resources to various crop and livestock activities as an optimisation problem. Each FADN farm selects the level of crop and livestock activities (in hectares and head of livestock, respectively) that maximises its expected utility of income for the given yields, variable costs, and prices, under a set of constraints related to the land

[2] Cost-effectiveness: Ratio of the costs and the outcome (effect) of an intervention.
[3] The Farm Accountancy Data Network (FADN) is a survey that collects and economic and financial data from representative agricultural holdings in the EU. The primary purpose of FADN is to provide a comprehensive and harmonized database that helps policymakers and researchers to assess the economic performance of the agricultural sector in the EU and the impacts of the Common Agricultural Policy (CAP). FADN contains information for around 80,000 commercial farms in the EU for each year from 1989.

endowment, animal feed requirements, and policy obligations. The model is calibrated for a baseyear (2017 in this case).

Figure 1 summarises the steps of the analysis. First, we take the conventional farms (i.e., non-organic farms) in FADN and simulate their conversion to organic farming (see next section for a methodological description). Secondly, we estimate the conversion incentive that each farm would need to make the decision to become organic, and the difference in GHG emissions between organic and the current state for each farm. Then, for each conversion policy strategy we select the farms that would convert to organic based on the criteria in each case (see section 2.3) until the budget for each MS is fully spent. Finally, the key outcomes of each strategy are estimated and compared.

2.1. Organic farming conversion

The approach to model organic conversion in IFM-CAP has already been described in Kremmydas et al. (2023a, 2023b). In summary, the organic conversion modelling in IFM-CAP includes two mains aspects. First, the model allows for the adjustment of performance-related parameters of converting farms to account for differences between conventional and organic farming in terms of prices, yields, costs, animal feeding, and unobserved conversion costs[4]. Second, technical constraints are considered for converting farms to reflect management practices specific to organic production system, namely crop rotation, nitrogen management, fertilizers and manure management, maximum stocking density, feed self-sufficiency and minimum share of fodder in the diet. In addition, organic payments can be applied to simulate farmers' responses to policy incentives. This includes two types of payments: conversion and maintenance payments. The conversion payment is a one-off payment paid per hectare designed to compensate farmers for the costs of converting to organic farming. The maintenance payment, on the other hand, is an annual per ha payment to support farmers' organic practices. The conversion payment is estimated by comparing the expected utility change for a farm if it were to

[4] The unobserved costs associated with a farm's decision to convert to organic include monetary and nonmonetary factors that are not captured in the underlying data, such as additional labor and investment in organic production required for conversion, costs of access to organic markets, or beliefs and attitudes about the environment. These costs are estimated econometrically (see Kremmydas et al. 2023b for details).

convert to organic, taking into account current payment levels (Kremmydas et al., 2023b). The decision to convert to organic farming in IFM-CAP depends on whether the monetary losses associated with organic production (e.g., lower yields, costs due to technical constraints) and unobserved conversion costs are outweighed by gains from higher organic prices (price premiums) and organic payments (if applied).

In the base year, the IFM-CAP model includes 71,748 conventional farms and 5,570 organic farms (the remaining 2,178 are either mixed farms or farms in the process of conversion). This distribution of farms reflects the pre-policy scenario, before the organic conversion policy strategies are simulated. In the policy scenarios, only conventional farms are considered for conversion, while organic farms present in the base year are assumed to remain organic. The baseyear serves as the reference scenario, and simulation results for the policy scenarios considered are evaluated relative to this baseyear.

2.2. GHG emissions calculations

IFM-CAP has an agro-environmental indicators module that estimates the environmental impacts of FADN farms. In this paper, we focus on GHG emissions (N_2O, CH_4 and CO_2), calculated following the latest IPCC guidelines (IPCC 2019a, 2019b). Using IFM-CAP results for each farm (cropped areas, livestock units, input use, feed intake), the GHG emissions are calculated for the following categories: manure management, managed soils, enteric fermentation, rice cultivation, urea and liming, machinery and energy use. In all cases we use a Tier 1 approach, using emission factors from National Inventory Reports[5] or default IPCC ones. The only exception is enteric fermentation, as we use farm-level information on feed intake by animals to estimate a farm-specific emission factor (Tier 2 approach).

Using the data for the baseyear and IFM-CAP outputs, the model calculates the total GHG emissions for each modelled farm for the baseyear scenario and for converting farms in the policy scenarios. For the farms that are already organic in the baseyear, there is no change in GHG emissions between the baseyear scenario and policy scenarios because they are already implementing organic management

[5] https://unfccc.int/ghg-inventories-annex-i-parties/2023

practices. As outlined in section 2.1, for conventional farms that convert to organic farms, the model considers two fertilizers and manure related management practices: 1) the inorganic fertilizer application is set to zero, as organic farms can only use organic fertilizers; 2) the quantity of manure imported is increased by a percentage (estimated based on FADN data). We assume that farms that used synthetic fertilizers before conversion would rely more heavily on manure to provide crops with the needed nutrients.

We focus on the GHG emissions originated at the farm, based on the activities and inputs reported in FADN. Any emissions outside the farm gate (e.g., emissions from fertilizer production) are not considered here. Neither the carbon sequestration potential from organic farming. Thus, we acknowledge that the effects of organic conversion on GHG emissions could be bigger than reported here.

2.3. Conversion policies

To assess how a result-oriented organic conversion policy compares to an action-oriented alternative, we consider three hypothetical contrasting policy strategies that differ in the criteria used to select the converting farms, as follows:

- *Budget*: This strategy focuses on maximizing the number of farms converting to organic production by selecting farms for conversion that are least costly and therefore require the least monetary incentive (EUR per farm) to convert (i.e., action-based approach). This scenario is likely to be the most consistent with the current implementation of the organic policy in the CAP, as MS typically do not link the organic support to specific sustainability objectives in their CAP SPs.
- *Environment*: This strategy focuses on environmental benefits by selecting the farms that generate the greatest emission reductions (i.e., target-based approach) but are not necessarily the least costly.
- *Combined:* This scenario represents a combination of the two, based on the concept of cost-effectiveness. Under this policy strategy, the priority is given to farms that can significantly

reduce their emissions without needing a large monetary incentive to convert to organic. We calculate the cost-effectiveness of conversion for each farm as the ratio between the emission reduction and the conversion payment (i.e., how many tonnes of CO_2eq can be reduced per EUR spent in conversion).

Our primary focus is on the organic budget allocated to support organic farms in the CAP Strategic Plans for the 2023-2027 financial period. All three policy strategies assume the same EU budget as set out in the CAP SP for 2023-2027 (i.e., EUR 5.2 billion for the EU-27). As explained above, the organic budget considered in the scenarios in each MS covers both the cost of one-off conversion payments and annual maintenance payments. There are large differences in the budget allocated to organic farming across MS, depending on the size of the country and the importance of organic farming in the baseyear (see Table A1 in the Appendix). Italy is the country with the highest budget (more than 1 billion EUR per year) and Malta the lowest (0.01 mill EUR per year). The average maintenance payment is the highest in Cyprus (805 EUR/ha/year) and the lowest in Greece and Czechia (105 EUR/ha/year). The size of the organic budget in each country is somehow correlated with the proportion of farms already organic for which maintenance payments are allocated. Therefore, in countries with larger organic budgets, the budget left for converting new farms (i.e. conversion payments) may be lower.

For each conversion strategy, we select the farms in each MS to convert based on the strategy-specific assumptions outlined above, so that the entire organic budget allocated in the CAP Strategic Plans for the 2023-2027 financial period is exhausted. The selection process ensures that converting farms receive a one-off conversion payments, while both newly converted farms and baseyear organic farms receive annual maintenance payments. As a result, our scenarios represent a hypothetical situation in 2030 where the number of farms converting to organic production (and the organic area) is adjusted to fully utilize the organic payments foreseen in the CAP Strategic Plans.

For comparison, we also run a scenario where the 25% organic area target is met at the MS level for each of the three policy strategies defined above (Budget, Environment, and Combined). In this set of scenarios, the 25% organic target defined in the F2F strategy remains fixed, while the model adjusts the organic budget to cover both the conversion payments and the maintenance costs for organic farms. These 25% target scenarios provide insight into the additional emission reductions and the associated additional budgetary costs that may be required to meet the target compared to the implementation of the CAP strategic plans. In all scenarios, other policies (e.g. non-organic subsidies) are assumed to remain unchanged.

3. Results

3.1. Conversion incentive and emission reduction potential

The aim of this paper is to assess the trade-offs of different approaches to convert farms to organic farming in the EU. Specifically, we aim to assess whether, for the same level of expenditure, a greater reduction in environmental impacts (GHG emission in this case) can be achieved, making the results-based approach a superior option for supporting organic production in the EU—or whether the alternative outcome holds true.

Before presenting the simulation results for the policy strategies considered, we first analyse the variation in potential GHG emission reductions and the associated levels of conversion payments. To do this, we simulate a hypothetical scenario in which all conventional farms in the EU (i.e., those modelled in IFM-CAP) convert to organic production and obtain the potential GHG emission reductions and conversion payments that would need to be paid for farms to convert. Figure 2 plots, for each individual farm modelled in IFM-CAP by farm production specialization, the values obtained for conversion payments against the potential GHG emission reduction from the conversion. Ideally, policies should target farms on the right-bottom side of the graphs (low incentive, high emission reduction). The graph shows that for the same incentive level, the emission reduction can vary widely depending on which farms convert.

Table 1 reports the averages of the conversion payments required for farms to convert, the GHG emission reductions and the cost-effectiveness of organic conversion (GHG emission reductions per EUR of conversion payment) by farm specialization in the EU. On average, livestock farms (especially granivores and dairy) require greater financial support per ha to convert than other farm types, while fieldcrop farms require the lowest (Table 1). However, livestock farms are the ones that tend to produce higher GHG emissions on average in the EU, mainly due to enteric fermentation. This would suggest that encouraging the conversion of certain sectors of agriculture could be more cost-effective, focusing on the ones that require less incentives to convert but create bigger environmental benefits. According to Table 1, on average for the EU, the conversion of grazing livestock farms, followed by farms specialized in dairy and granivores, would be more cost-effective than the organic conversion of other farm types. Other key aspects, such as production and income impacts would also need to be considered.

Table 1. Average utilized agricultural area (UAA), conversion payment, GHG emission and cost-effectiveness of organic conversion by farm specialization in the EU.

Type of farm	UAA (ha)	Conversion payment (EUR/ha)	GHG emissions reduction (t CO_2eq/yr)	Cost-effectiveness (kg CO_2eq/EUR)
Fieldcrops	148	636	1.37	1.3
Horticulture	16	4,976	0.66	2.8
Wine	24	914	0.39	0.6
Other permanent crops	21	999	0.62	1.1
Dairy	95	1,717	4.13	4.5
Other grazing livestock	83	2,819	3.59	6.0
Granivores	75	42,429	3.41	3.9
Mixed	160	784	1.62	1.8

3.2. Conversion policy strategies comparison for CAP SP

Table 2 shows the simulation results for the total area converted to organic production, emission reductions and production changes at the EU level for the three policy strategies considered with the budget allocated under the CAP SP. As expected, the Budget strategy leads to the largest converted area (18.3 million hectares) in the EU, as farms that require less financial incentive to convert are selected first. In contrast, in the Environment strategy, only 10.7 million hectares would be converted to organic farming, as it focuses on the GHG mitigation potential of conversion, prioritizing farms that reduce emissions the most. The Combined strategy results in 14.1 million hectares being converted, balancing both the conversion costs of farms and their potential to reduce emissions.

The amount of land converted to organic production in all three policy strategies is less than what is needed to meet the F2F target of 25%. As mentioned above, in the baseyear, about 9% of the agricultural area is already organic in the EU, which means that an additional 16% of the total agricultural area (about 24.1 million hectares) would have to be converted from conventional to organic farming to reach the F2F target.[6] This leaves an organic area gap of 5.8, 13.4 and 10.0 million hectares (or 4%, 8% and 6% of the total EU agricultural area) in the Budget, Environment, and Combined strategies, respectively. Compared to the other policy strategies, the Environment strategy results in the smallest production reductions in the EU for all production categories considered, except for meat, which decreases more than in the Budget strategy and less than in the Combined strategy (Table 2). These results are mainly explained by the fact that the Environment strategy has the lowest area converted to organic production, thus affecting crop activities less. Livestock farms tend to produce more GHG emissions than fieldcrop farms, and so in the Environment strategy and especially in the Combined strategy these farms are more frequently selected for organic conversion due to their greater potential for emission reductions. This is reflected in the larger reductions in meat and milk production in the Combined strategy compared to the other two policy strategies. In contrast, the Budget strategy has the largest impact on arable crop production in the EU, as fieldcrop farms require the lowest financial incentive to convert compared to other farms types.

Table 2. Simulation results by policy strategy in the EU (compared to baseyear).

			Production change (%)			
Policy strategy	Converted area (mill ha)	Emission reduction (%)	Arable crops	Permanent crops	Dairy	Meat
Budget	18.3	4.3%	-3.5%	-0.4%	-2.3%	-1.4%
Environment	10.7	6.6%	-0.7%	0.0%	-1.9%	-1.7%
Combined	14.1	7.3%	-0.8%	-0.6%	-2.6%	-1.9%

As discussed in section 3.1, which farms actually convert to organics matter in terms of policy performance. Table 3 shows the distribution of converted farms and converted area by farm

[6] Note the total agricultural area is 160.5 million hectares in the EU. https://ec.europa.eu/eurostat/databrowser/view/ef_m_farmleg/default/table?lang=en

specialization in the EU for the three policy strategies considered. The number of IFM-CAP farms converting to organic production system in the EU is 23,291 farms under the Budget strategy, 2,159 for the Environment strategy and 12,994 for the Combined strategy. The Budget strategy targets smaller farms (in terms of area), less intensive farms and specializing in field crop, as they have lower conversion costs and thus require lower conversion payments. The Environment strategy is aimed at very intensive livestock farms and larger field crop farms that would achieve high emission reductions by converting to organic farming. Intensive farms would need to receive a higher financial incentive to convert as they are further away from organic production system and therefore have high conversion costs. As a result, the main difference between the Environment and the Combined strategies is that the former focuses more on conversion of fieldcrop farms, while the latter promotes the conversion of permanent and livestock farms, as the GHG emission reduction per EUR spent is greater. The converted area is highly correlated with the number of farms converting to organic production across farm specializations in the three policy strategies considered.

Table 3. Comparison of the simulation results by policy strategy and farm specialization in the EU (compared to baseyear).

	Farms converting (%)			Converted area (mill ha)		
Farm specialization / Policy strategy	Budget	Environment	Combined	Budget	Environment	Combined
Fieldcrops	29	39	18	5.10	5.77	1.38
Horticulture	9	1	3	0.17	0.03	0.08
Wine	5	0	7	0.94	0.01	1.40
Other permanent crops	8	1	12	0.88	0.05	1.78
Dairy	18	26	21	3.00	1.44	2.52
Other grazing livestock	18	20	23	6.19	1.81	5.86
Granivores	5	5	8	0.50	0.50	0.41
Mixed	9	8	8	1.47	1.11	0.71
Total	100	100	100	18.3	10.7	14.1

The simulations show that with the organic budget allocated in the CAP Strategic Plans, emissions in the EU could be reduced by up to 7.3% in the Combined strategy (Table 2). As expected, the Budget strategy delivers the lowest emission reductions at 4.3%. Contrary to expectations, the Environment strategy leads to lower emission reductions than the Combined one. This is because the Combined strategy also takes into account the conversion costs and the associated conversion payments, allowing more farms to be selected for conversion with the same budget, ultimately resulting in greater overall emissions reductions. This means that selecting the top performing farms in terms of emission reduction potential does not produce the best outcome if conversion costs are not taken into account. However, selecting farms for conversion based on cost-effectiveness achieves greater overall emission reductions because it prioritizes more affordable farms in terms of the environmental improvement they generate per euro spent.

3.3. Reaching the 25% organic target

Table 4 and 5 show the simulation results for the case where the 25% organic target is assumed to be met in all EU MS for each of the three policy strategies considered. If all EU countries were to reach the 25% organic target, the total budgetary costs would amount to EUR 6.5 billion in the Budget strategy, EUR 8.3 billion in the Environment strategy, and EUR 7.8 billion in the Combined strategy. This implies that the total EU organic payments would need to increase by 26% in the Budget strategy, by 60% in the Environment strategy and by 50% in the Combined strategy compared to the organic budget set in the CAP strategic plans.

Table 4. Simulation results for the 25% organic target by policy strategy in the EU. Organic payments and GHG emissions reduction.

	Organic payments		Emission reductions	
Policy strategy	Total payments (billion EUR)	% change vs. CAP SP*	% reduction	% change vs. CAP SP*
Budget	6.5	25%	5.6%	30%
Environment	8.3	60%	10.7%	62%
Combined	7.8	50%	10.6%	45%

*Notes: CAP SP: CAP strategic plans; * Calculated by using simulation results from Table 2.*

Table 5. Simulation results for the 25% organic target by policy strategy in the EU. Production change (%)

	Production change							
	Arable crops		Permanent crops		Dairy		Meat	
Policy strategy	% change	% change vs. CAP SP*	% change	% change vs. CAP SP*	% change	% change vs. CAP SP*	% change	% change vs. CAP SP*
Budget	-4.3%	-23%	-0.5%	-20%	-3.1%	-35%	-1.8%	-29%
Environment	-2.0%	-186%	-0.1%	-186%	-3.6%	-89%	-2.7%	-59%
Combined	-1.3%	-63%	-0.8%	-33%	-4.4%	-69%	-3.0%	-58%

*Notes: CAP SP: CAP strategic plans; * Calculated by using simulation results from Table 2.*

The reduction in EU emissions in the Environment and Combined strategies is almost double that in the Budget strategy (around 11% versus 5.6%). The reduction in GHG emissions is very similar in the Environment and Combined strategies (10.7% versus 10.6%), but the budget expenditure in the latter is 520 million EUR lower (Table 4).

When comparing the relative changes in emissions and the organic budget between the 25% target and the CAP Strategic Plans scenarios, the emission reductions exceed the budget increases. In the Environment strategy, emission reductions are 62% greater with the target compared to the CAP SP, while the organic budget increases by 60% (Table 4). Similarly, in the Budget strategy, the emission reductions are 30% compared to a 25% increase in the budgetary costs. In contrast, in the Combined strategy, the relative increase in budget costs is less than the improvement in environmental outcomes (45% versus 50%). These results indicate a decreasing cost-effectiveness of additional euros spent on organic payments. As the area converted to organic production increases, the remaining conventional farms that can potentially convert tend to be less cost-effective, requiring higher additional conversion payments while delivering fewer emission reductions per euro spent.

Similar to the simulation results of the CAP SP scenarios, the Combined strategy leads to larger reductions in meat and milk production, as it prioritizes livestock farms with higher GHG emissions for organic conversion. In contrast, the Budget strategy mainly affects field crop production, as fieldcrop farms have lower financial costs to convert. The Environment strategy lies between these two policy strategies, except for permanent crops, where the production effect is the lowest (Table 4). The production impacts are much higher in these scenarios simulating the achievement of the 25% target than those estimated for the CAP SP scenarios, especially for permanent crops. This result shows the trade-offs between reducing the environmental impacts of EU food production while maintaining food security.

4. Discussion

4.1. Comparison of different organic conversion policy strategies

The new CAP (2023-2027) focuses more than ever on making EU agriculture sustainable, with a strong emphasis on results and performance. National CAP Strategic Plans are meant to contribute to the EU Green Deal ambitions, using mainly eco-schemes to encourage more environmental-friendly practices, including organic farming. Despite the importance of the organic farming target set at the EU level, there is not a clear plan on how exactly this will be achieved. This paper aims to provide some insights on the implications of different conversion policies, to better understand what options might be more desirable for the EU. Based on the results of this study, depending on the conversion policy strategy adopted, the implications in terms of expenditure, food production and environmental benefits are very different. Thus, designing the right policy for each country is key for organic conversion to succeed, maximizing the benefits for the environment and reducing the adverse impacts on food production.

Based on the current budget allocated for organic farming in CAP SP, our results suggest that, unless more financial resources are devoted to organic farming, achieving 25% of agricultural area as organic by 2030 is unlikely. The three policy strategies considered reduce the gap in the organic area between the base year (before the implementation of the CAP SP) and the F2F target from 16% of the total EU agricultural area to between 4% and 8%, depending on the strategy. To reach the F2F target, total EU organic budget would need to increase by 26% to 60%.

From the conversion policy options considered, the Combined strategy, as it focuses on cost-effectiveness, delivers the highest emission reductions per Euro spent. However, it converts less land than the Budget strategy, resulting in a larger gap to the F2F organic area target. This implies a trade-off between cost-effectiveness and land conversion in action- versus result-based strategies. The Combined strategy achieves higher emission reductions per Euro but converts less land, widening the gap to the F2F target compared to the Budget strategy. In contrast, the Budget strategy converts more land and thus comes closer to the F2F target, but achieves lower emission reductions per Euro spent. When comparing the performance of different policy options, monitoring costs must also be taken into account. The results-based approach is expected to have higher monitoring costs as it requires an assessment of the environmental performance of farms to ensure that only the most cost-effective farm conversions are selected. Monitoring costs are expected to be lower for the action-based approach as it does not require an assessment of the environmental performance of farms.

The GHG emission reductions estimated in this paper for CAP SP are consistent with Lampkin and Padel (2022). The Combined strategy would lead to a bigger reduction in GHG emissions from converting farms (around 7.3%), in comparison with the Budget strategy that would reduce emissions by only 4.3%. This highlights the importance of which farms actually convert, and the need to understand what sectors within agriculture would provide the highest environmental benefits from organic conversion. Organic animal production accounts for 1-7% of total EU animal production, depending on the sector (European Commission, 2023). As livestock farms, especially dairy, are responsible for a big proportion of the GHG emissions from agriculture in the EU, finding ways to encourage livestock farms to convert would bring greater environmental benefits.

Finding the right balance between environmental sustainability and production effects is critical for the CAP to contribute to the European Green Deal objectives (OECD, 2023). Our simulations for CAP SP show that the impacts on production are bigger for arable crops under the Budget strategy (3.5%) and for milk and meat production under the Combined strategy (2.6% and 1.9% reduction respectively). This highlights a trade-off between production impacts and budgetary costs in action- versus result-based strategies: minimizing budgetary costs, which leads to larger reductions in crop production, versus prioritizing environmental benefits at higher budgetary costs per converted area, which leads to larger reductions in livestock production. Part of the reduction in production could be offset by other factors not considered here. As stated by Tuomisto et al. (2012), both research and policy should focus on developing high yielding farming systems with low negative environmental impacts, combining techniques from both organic and conventional systems. Such strategies require further investigation to better understand their cost-effectiveness.

4.2. Implications for policymaking

The goal set by the EU in the Farm-to-Fork Strategy (25% of UAA organic by 2030) is very clear, easy to understand and monitor, and clearly shows the ambition of the EU to become more sustainable in the way food is produced. However, rather than focusing only on the area converted as a measure of success, the potential environmental gains and the impacts on production would need to be acknowledged too. This is important not only to assess the consequences of the policy itself but also for the incentivisation of farms that will receive the organic conversion support. As currently designed, there is the risk that farms that engage in organic conversion are already applying more sustainable practices and hence the impact on the environment will be marginal (Calabro and Vieri, 2024). In fact, many studies have shown that agri-environmental schemes failed in many cases to deliver substantive positive effect on the environment (Baráth et al., 2024). The European Court of Auditors' recent report

(ECA, 2024) on organic farming highlighted that the EU strategy lacks quantifiable objectives and a way to measure progress. Moreover, the support allocated in the CAP SP to incentivise an increase in the area under organic farming does not take into account the environmental objectives.

Although setting a result-based approach policy for organic conversion is challenging due to the need to find suitable indicators and ways to easily measure them (Stolze et al., 2015), a more targeted approach to payments would reward the best performers accordingly, following the public money for public goods maxim (Lampkin, 2023). Based on our results, a conversion policy based on cost-effectiveness would ensure that the organic farming budget goes to those farms that would provide more environmental gains for the money spent.

As stated by Pacini et al., (2015), there is a large variability in farm types within regions. Thus, tailoring policies to different farm typologies could improve their outcomes (Huber et al., 2024). The new CAP, thanks to the flexibility given to Member States to adapt the implementation of the agricultural policy to the local or national level, provides an adequate framework to establish an organic conversion system that is appropriate for each MS. Measures could target specific farm typologies or propose a tiered system that rewards farms differently depending on the expected environmental outcomes.

4.3. Research approach and limitations

This paper presents the modelling of the organic conversion of individual farms using the IFM-CAP model. When drawing conclusions, one must be aware that our results obviously reflect the assumptions made in the model. One limitation is that the model assumes a fixed farm structure, meaning that farms' production specialization and size remain unchanged following conversion to organic production. In reality, converted farms may make more significant adjustments in production structure and scale than our modeling framework accounts for. Additionally, our simulations for the conversion payment assume that the organic price premium will remain the same even after a significant number of farms convert to organic. However, as the organic production supply increases, depending on the demand for organic products, the price premium may decrease, and thus larger conversion payments may be needed to induce farmers to convert than those simulated in the current paper. Furthermore, we implicitly assume that organic payments will continue in the medium to long term. We do not account for policy uncertainties related to the future implementation of the CAP, in particular with respect to organic payments. If farmers anticipate policy uncertainties (e.g. a possible reduction in future organic payments), our simulations would overestimate the conversion effects.

The main source of data in our model is the FADN, a dataset that was designed for economic analysis and hence the relevant information for environmental assessments is limited. However, data on farm characteristics (size, crops areas and livestock numbers, input use, etc.) can be used as proxy to calculate agro-environmental indicators. This dataset has been used for similar purposes in the past (Baldoni et al., 2023; Sinesterra-Solis et al., 2023; Dabkiene et al., 2021; Coderoni and Esposti, 2018; Syp and Osuch, 2017). FADN, together with IFM-CAP outputs, allow us to estimate GHG emissions following the guidelines from IPCC using a Tier 1 approach in most cases (except for enteric fermentation in which we apply a Tier 2 approach). Several assumptions were needed when the level of detail in FADN was not enough, and this may have an impact on our simulation results. In addition, the emission factors used for the estimations were average national values coming from each country National Inventory Reports, or default values from IPCC (IPCC 2019a, 2019b).

It is important to note that we are focusing on the emissions within the farm, and therefore not considering the potential emission reduction upstream or downstream the supply chain (e.g., for fertilizers, we are accounting for the emissions related to their application on the field, but not the emissions related to their manufacturing or transport). For this reason, the emissions of farms that are buying their input from elsewhere could be underestimated. In addition, organic agriculture also contributes to mitigating the greenhouse gas effect and global warming through its ability to sequester carbon in the soil (Ireland Department of Agriculture, Food and the Marine, 2014). For these reasons, the mitigation potential of organic conversion could be bigger than estimated here. GHG emissions is used here as an example of an environmental performance indicator for organic farming in comparison with conventional practices. In agriculture, GHG emissions are mostly related to enteric fermentation and therefore livestock activities. Combining the emissions with another indicators such as nitrogen balance, could be more relevant. Other indicators may be used as well to assess other potential environmental benefits derived from organic farming (e.g., soil erosion, biodiversity).

5. Conclusions

By 2030, the EU aims at going from 9% to 25% of its UAA under organic farming. Each Member State has allocated a budget in their CAP Strategic Plans to support organic farm conversion and maintenance for farmers that want to make the change. This paper presents an assessment and comparison of the potential impacts of different policy strategies aimed at reaching the EU's 25% organic target. The paper uses the EU-wide individual farm-level model (IFM-CAP) to simulate three different policy strategies—Budget, Environment, and Combined—each designed as either action-oriented strategies, prioritizing land conversion, or results-oriented strategies, emphasizing environmental benefits and cost-effectiveness. The simulations for the three policy strategies are conducted for both the CAP Strategic Plans, assuming the organic budget as set out in those plans, and the 25% organic target, assuming full achievement of the target. This dual approach makes it possible to assess the gap in the converted area and the additional budgetary costs required to meet the 25% target compared to the CAP SP. Through this approach, the paper seeks to provide insights into the trade-offs associated with each policy strategy, assessing their respective budgetary costs, environmental benefits (in particular greenhouse gas emission reductions) and impacts on agricultural production.

Our simulation results show that given the current implementation of the CAP, the EU target of 25% organic area by 2030 is unlikely to be achieved with the organic budget allocated under the CAP Strategic Plans without additional financial resources. The three policy strategies analysed reduce the gap between the pre-CAP SP organic area and the F2F target from 15% to between 4% and 8%. To reach the 25% target, the EU organic budget would have to increase by 26% to 60%, depending on the policy strategy applied.

Among the conversion policy strategies analysed, the results-oriented strategy (Combined strategy) is the most cost-effective, delivering the highest emission reductions per euro spent. However, there is an important trade-off between cost-effectiveness and land conversion to reach the 25% target between the action-oriented and the results-oriented strategies. While the results-oriented strategy delivers the highest emission reductions (7.3%), it converts less land than the action-oriented strategy (Budget strategy), resulting in a larger gap to the 25% organic area target (i.e. 6% of the EU UAA). In contrast, the action-oriented strategy (Budget strategy) comes closer to the 25% organic area target (i.e. it reduces the gap to the target to 4% of the EU UAA), but delivers lower emission reductions (4.3%).

The key factor driving the performance of the organic conversion policy is the selection of farms for conversion. The results-oriented strategy prioritizes livestock farms for organic conversion, as these farms have higher potential for emissions reductions. In contrast, the action-oriented strategy prioritizes arable farms for conversion, as they require less financial support to incentivize their transition to organic productions. This highlights a trade-off between production impacts and budgetary costs in action- versus outcome-oriented strategies: minimizing budgetary costs results in larger reductions in crop production in the action-oriented strategy, while prioritizing environmental benefits at higher budgetary costs per hectare leads to more significant reductions in livestock production in the result-oriented strategy.

Overall, our results suggest that, although the results-based approach is more costly and more complex to implement (e.g., it has higher monitoring costs), these costs may be offset by the significantly greater environmental benefits it delivers at lower unit costs than the action-based approach. Furthermore, our results indicate that achieving environmental improvements through promoting organic farming should not focus solely on the amount of land converted to organic production; rather, it is more important to select relevant farms for conversion that have a greater potential for environmental improvement or that currently generate substantial environmental damage. Without such targeted selection, environmental improvements may not be proportional to the resources invested. To enhance policy performance, it may be beneficial for the area target to be accompanied by concrete environmental objectives (e.g., % of GHG emission reduction, % of N input reduction) to ensure the desired environmental impacts are achieved.

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Figure captions

Figure 1. Modelling farm conversion to organic farming: overview

Figure 2. Conversion incentive and GHG emission reduction potential for each FADN farm in by production specialization

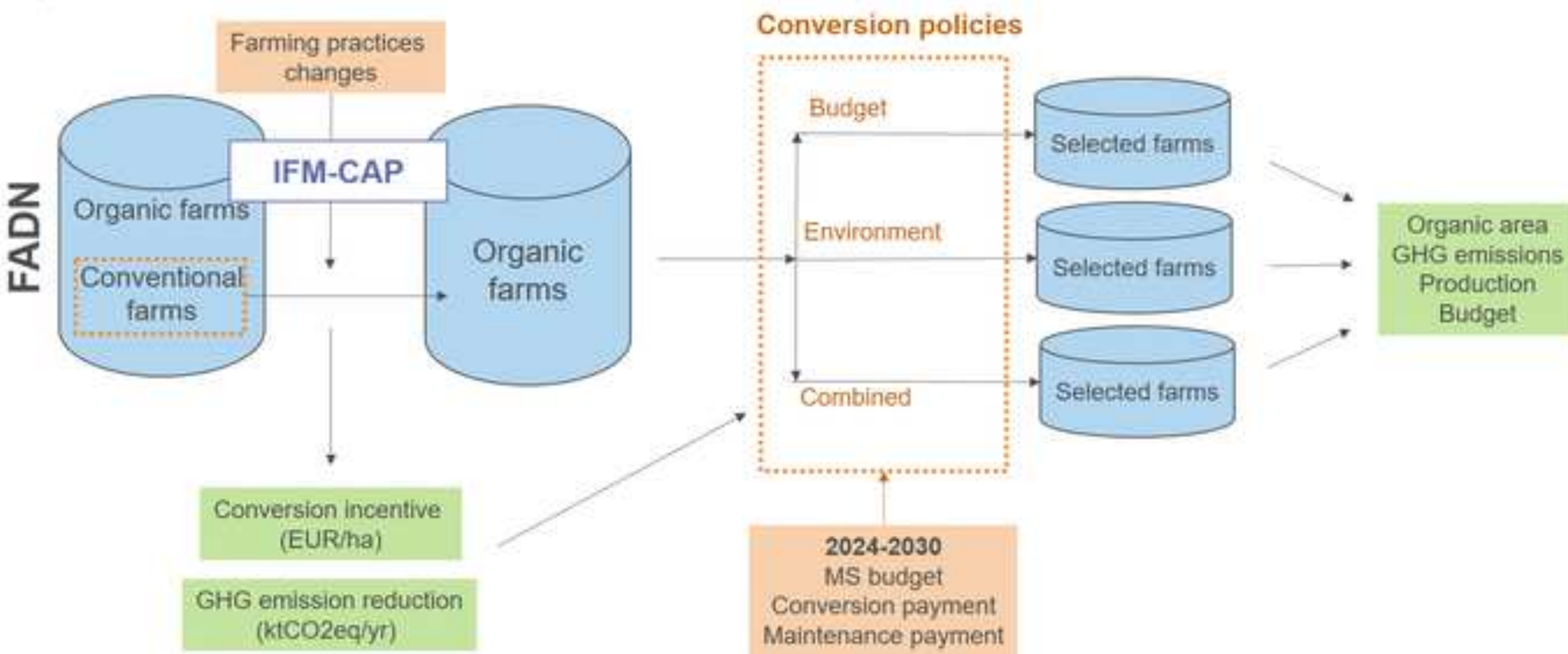
FADN
Farming practices changes
IFM-CAP
Organic farms
Conventional farms
Organic farms
Conversion incentive (EUR/ha)
GHG emission reduction (ktCO2eq/yr)
Conversion policies
Budget
Environment
Combined
2024-2030
MS budget
Conversion payment
Maintenance payment
Selected farms
Selected farms
Selected farms
Organic area
GHG emissions
Production
Budget

Figure 2

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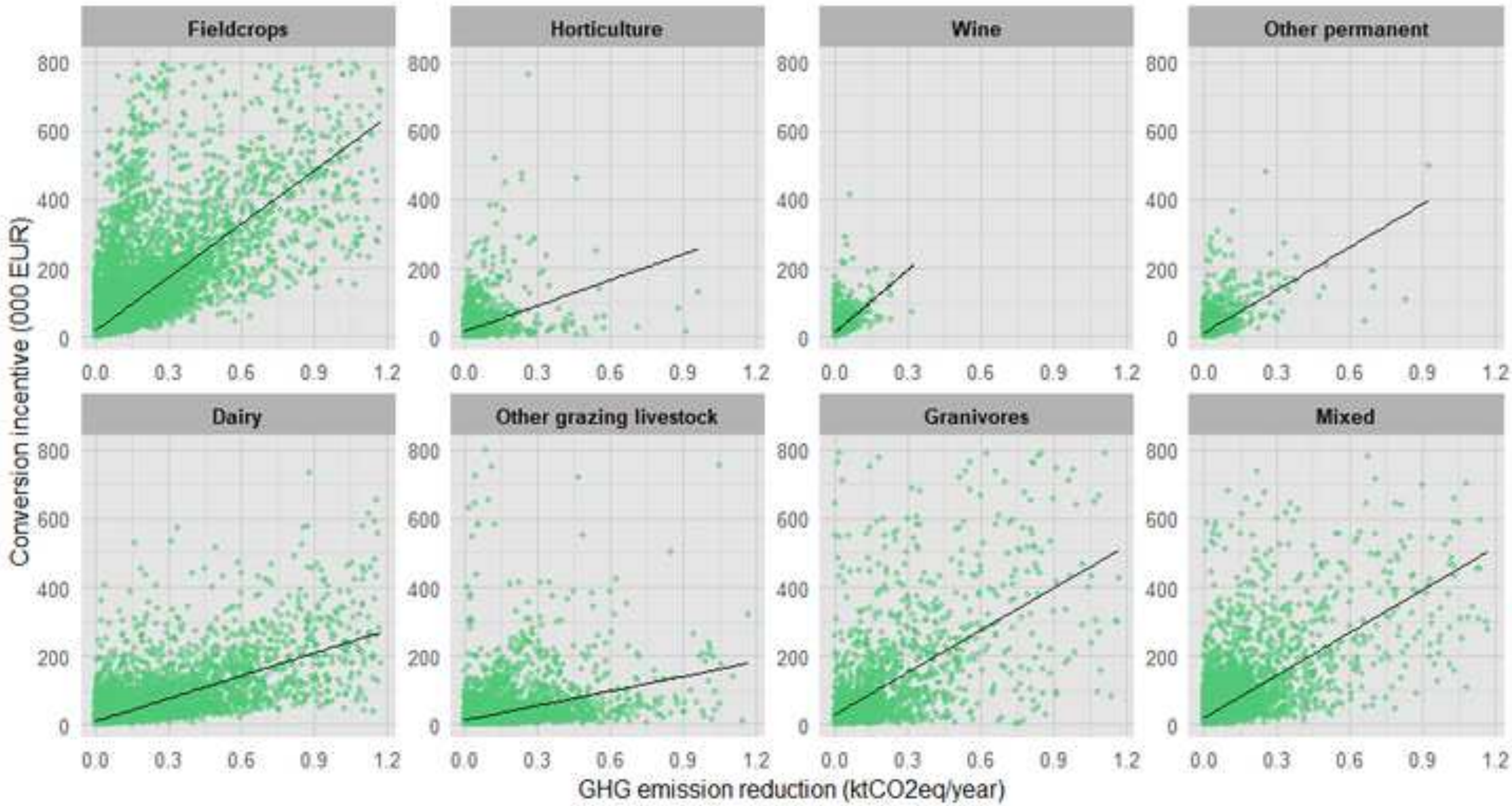

APPENDIX – Organic farming budget per country.

Table A1. Organic budget per country. Source: IFOAM Organics Europe (2021).

Country	Organic budget (mill EUR/year)	Average maintenance payment[1] (EUR/ha/year)	% of certified area supported
AT	238	234.36	81%
BE	69	243	89%
BG	100	354	53%
CY	8.1	805	76%
CZ	104	105	97%
DE	831	261	81%
DK	123	184	87%
EE	31	105	85%
EL	212	390	50%
ES	484	152	47%
FI	122	205	92%
FR	726	173	52%
HR	89	350	92%
HU	85	186	55%
IR	75	111	97%
IT	1027	352	56%
LT	78	197	77%
LU	8.5	258	85%
LV	56.7	107	94%
MT	0.01	374	13%
NL	90.4	213	80%
PL	166	138	71%
PT	77	124	97%
RO	192	232	56%
SE	154	211	58%
SI	17	210	96%
SK	36	108	84%

1: The area payment shown in the table is for 2018. For the calculations in this paper, the value is increased by 25% as suggested in the IFOAM report.

Declaration of interests

☐The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

This research is related to the European Commission strategy for organic farming within the context of the Farm-To-Fork Strategy (part of the EU Green Deal). The authors work at the Joint Research Centre of the European Commission.

If the paper is accepted for publication, we will ask the Journal to add a disclaimer to the article that says: The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.