Impacts of Scaling up Agroecology on the Sustainability of European Agriculture in 2050

Les impacts du développement de l'agroécologie sur la durabilité de l'agriculture européenne en 2050

Die Auswirkungen einer großflächigen Verbreitung von agrarökologischen Maßnahmen auf die Nachhaltigkeit der europäischen Landwirtschaft im Jahr 2050

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Introduction

The goal of the Paris Agreement to limit the increase in global temperature to well below 2°C above preindustrial levels requires rapid decarbonisation of all economic sectors. The global food system alone is responsible for nearly one-third of total global greenhouse gas (GHG) emissions and could put the Paris Agreement's goals at risk (Crippa *et al.*, 2021). In the European Union (EU), agriculture is responsible for 12 per cent of the total GHG emissions and is the main cause of further negative environmental impacts such as biodiversity loss or eutrophication (Leip *et al.*, 2015). The EU has thus developed the European Green Deal (European Commission, 2019), a policy initiative that comprises, among others, the Farm-to-Fork and Biodiversity strategies. Key European targets include net-zero emissions of GHGs by 2050, 20 per cent reduced fertiliser inputs, 25 per cent of total farmland under organic management, and planting three billion trees by 2030, although the choice of policy measures is still unclear and left up to the individual Member States.

Reaching the objectives outlined above requires a fundamental change in how agricultural goods are produced and consumed. Agroecology (AE) is an integrated approach that simultaneously applies ecological and social principles to the design and management of food and agricultural systems (Barrios *et al.*, 2020). It is listed among the potential agricultural practices to reach the aforementioned goals in the common agricultural policy (CAP), and science views it as a capable concept to face the challenges ahead (Peeters *et al.*, 2021). Local examples have shown that AE benefits several ecosystem services (Boeraeve *et al.*, 2020). However, a robust evaluation of whether the findings and outcomes from local examples are scalable is so far missing in research. Further, it has not been evaluated whether an upscaling to the territorial, i.e. EU level leads to challenges that may arise from passing absolute thresholds, such as land requirements or nutrient supply from biological sources.

To fill this research gap, this study provides an assessment of the biophysical feasibility and ecological impacts of the large-scale adoption of agroecological measures in the EU, identifying important levers to steer the transformation towards low-impact agri-food systems. To do so, using the biophysical Biomass Balance Model BioBaM-GHG 2.0 (see Box 1 and Box 2), we systematically combine several parameters and variants of future developments in supply and demand in the EU agri-food system, e.g. agricultural technology, human diets, the livestock system and land use. This results in a large number of scenarios that can be evaluated according to their environmental and social performance. Rather than calculating indicators for a few internally consistent and stringent storylines (i.e. marker scenarios), we explicitly assess the environmental performance of a wide range of combinations of input parameters, adding a novel approach to scenario modeling. This allows us to strictly isolate and quantify the impact of individual measures (e.g. specific agroecological measures on croplands such as undersowing of cereals, or more hedgerows) on the overall outcomes. BioBaM-GHG 2.0 encompasses the large uncertainty about future developments in the agri-food system and can identify systemic trade-offs (Kalt *et al.*, 2021).

It is important to note that, other than 'marker scenarios' based on prognostic approaches like integrated assessment models (IAMs), the scenarios assessed in a diagnostic approach are systematic combinations of published or assumed future developments of individual components of the agri-food system, albeit some of these combinations might be neither plausible, nor desirable. This approach offers the possibility to determine the influence of each parameter and variant on the goal indicators, as well as the ability

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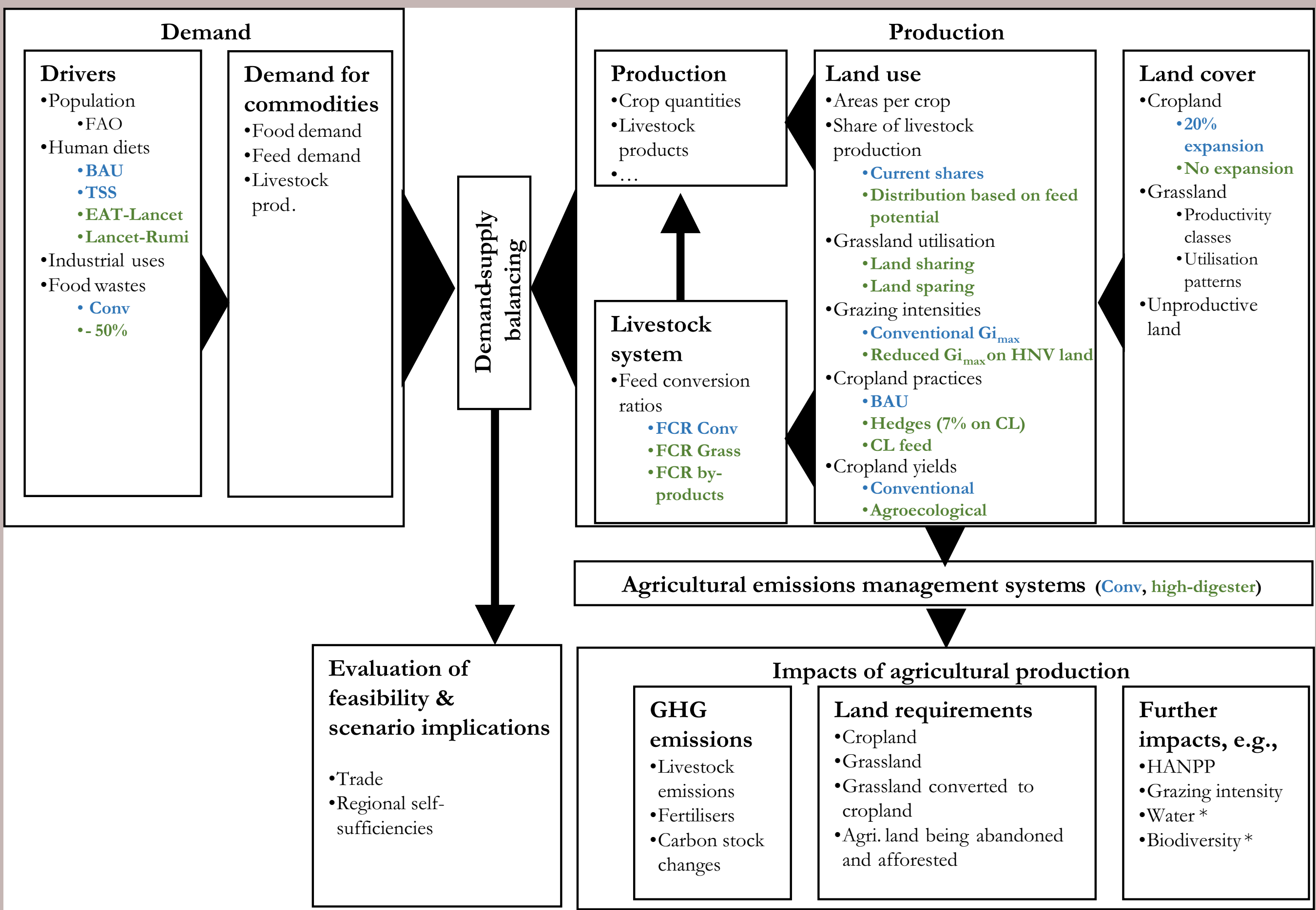
Box 1: Description of the territorial modelling approach

The BioBaM-GHG 2.0 model is based on exogenous trajectories for demand (i.e. fixed demand scenarios), and supply (e.g. crop yields, livestock systems, scenario-specific restrictions on land-use change, see Figure 1). The core of the model is a systemic integration of consistent, highly detailed databases that allow tracing biomass flows from their origin in ecosystems (Net Primary Production; NPP) through the various conversion steps (e.g. through livestock or economic processing) down to the final consumption of biomass products, following thermodynamic principles (mass conservation) at the subnational (i.e. NUTS-2) level in the EU, and the country-level for the rest of the world. All parameters in the agri-food system included in the model can be varied, i.e. at the supply side (e.g. area, yields) and at the demand side (e.g. diets, production efficiencies), by using a range of, not single, future trajectories (=variants; see Figure 1). For the analytical purpose followed here, conventional (marked blue) or agroecological (marked green; see Figure 1) variants are systematically combined. Scenarios where domestic demand could be met through domestic supply are labelled as 'land-feasible'. The sum of these land-feasible scenarios represents the future option space. For all land-feasible scenarios, we further calculated a potential land feasibility index (PLF_i) that represents the ratio between the available agricultural land (assuming no further deforestation), and the area of land needed to satisfy the regional demand under region-specific crop yields and livestock efficiencies. If this index is >1, it can be interpreted as a proxy for the land that can potentially be freed up in the future for natural climate solutions or the extensification of land use. For all land-feasible scenarios that define the option space, the associated CH_4, N_2O and CO_2 emissions were calculated and converted into CO_2eq, using activity-based factors from IPCC for all involved steps of production (emissions from soil management and livestock, carbon flows from land use change and land not used in agricultural production, including upstream flows, but excluding transport emissions). Additionally, a proxy indicator for biodiversity pressures was calculated, i.e. the ratio of the total amount of primary biomass harvest and the potential NPP in a region (Mayer *et al*., 2021a; Semenchuk *et al*., 2022). A detailed description of the BioBaM-GHG 2.0 is provided by (Kalt *et al*., 2021). Details on specific parameters and variants are described in (Mayer *et al*., 2021b).

Figure 1: Schematic illustration of the scope of agri-food and land-use modeling as applied in this study including specifications of parameters and variants (conventional variants marked in blue, agroecological variants marked in green). * denotes impacts that are not yet included in the model



to depict disruptive scenarios, which is important for policymakers. Our analysis helps understand under which circumstances the effects of individual or combined policy measures result in stronger or less strong impacts, or if results can even switch between positive and negative. Furthermore, it provides insights into which combinations of parameters may result in particular synergies or trade-offs between different goals.

Box 2: Scenario assumptions

Demand-side measures include two conventional variants, i.e. a continuation of current (BAU) and a more sustainable variant of the BAU dietary patterns (towards sustainability scenario, TSS) from FAO (2018), and two agroecological variants, i.e. an EU-wide transformation of diets towards less animal products (EAT-Lancet), and an EAT-lancet diet variant with a specific emphasis on less monogastric animal products (Lancet-Rumi) (Willett *et al.*, 2019). Food waste amounts either to current levels (Conv) or is reduced (–50%). Dietary change directly translates into altered demand for primary agricultural products. Reduced demand is assumed to directly translate into lower levels of production.

Supply-side measures include agronomic and food system measures specifically targeted on cropland or grassland production, livestock systems and manure management. Ruminant livestock feed conversion ratios (FCR) include current (Conv) and two AE variants, i.e. a purely grass-based variant (FCR Grass) and a feed supply consisting mainly of by-products and grass (FCR by-products). Livestock distribution patterns within the EU either correspond to current patterns (Conv) or are better aligned with domestic feed production potentials (Potential). Agroecological grassland utilisation patterns comprise a land-sharing variant (changes in grass demand are covered by varying grazing intensities but not area changes), and a land-sparing variant (grazing is intensified to maximum ecological levels and unused areas are set free for afforestation). Concurrently, two distinct assumptions on maximum grazing intensities ($GI_{max,}$ i.e. the maximum fraction of NPP that can be grazed by livestock without causing degradation (Fetzel e*t al.*, 2017a, 2017b)) were made. The variant for conventional farming refers to maximum sustainable thresholds derived from the literature (Kalt *et al.*, 2021); Conv GI_{max}), the agroecological variant assumes reduced GI_{max} in high natural value (HNV) grasslands by 20 per cent (Reduced GI_{max}). Cropland measures comprise current practices (Conv), and two AE variants with 7 per cent of hedges on total cropland (Hedges), or undersowing of cereals and replacing fodder maize through fodder legumes (CL feed). In all agroecological cropland variants, yields are reduced by 50 per cent of the yield gap between conventional and organic production (Ponisio *et al.*, 2015), and the use of synthetic fertilisers is allowed. Expansion of cropland is allowed in conventional, and prohibited in all AE cropland variants. Agricultural emissions management comprises a variant with current manure management systems (Conv), and an AE variant with increased biogas digesters (high-digester). The base year for this study is 2012, and scenarios are assessed for the year 2050.

Potential land feasibility of agri-food scenarios for the EU in 2050

The systematic combinations of all conventional and agroecological measures on the demand-side and the supply-side result in 432 scenarios. Of those scenarios, 288 are land-feasible and define the future option space of agri-food systems in the EU. Figure 2 shows the change in land-feasible scenarios, i.e. scenarios in which regional (NUTS-2) demand theoretically can be supplied from the land in the region in 2050, depending on the conventional and agroecological demand and supply side measures implemented. Future scenarios in which livestock distribution patterns follow current production shares without better alignment with feed production capacities would surpass land feasibilities within the EU and thus are labeled as 'non-feasible' (Figure 2). When livestock is distributed according to the feed production capacity, all scenarios become land-feasible and define the option space. The majority of these scenarios show moderate to strong increases in the potential land feasibility index. This holds true under all levels of supply-side agroecological measures at all levels of demand. Livestock production had a central role for all combinations evaluated in Figure 2 since livestock consumes a significant share of agricultural biomass resources in the EU. Therefore, a reallocation of livestock production within countries (monogastric livestock) and within the EU (ruminant livestock) was a decisive factor to enable agroecological measures across the EU. A second decisive factor was the reduced size of the agri-food system, here implemented through a shift towards human diets with fewer animal products, fewer food wastes and reduced export production (i.e. Purely AE demand-side measures).

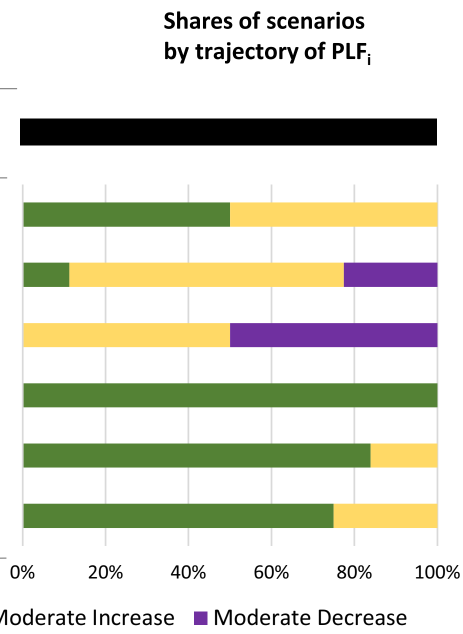
The combination of agroecological supply-side measures (Purely AE, or Hybrid (conv/AE)) with conventional demand (Purely conv) showed that a higher degree of agroecology decreases potential land feasibility. From all 16 scenarios that contain conventional demand- and AE supply-side measures, half (8 scenarios) showed moderate increases and moderate decreases in potential land feasibility, respectively. However, this trade-off was mitigated with agroecological diets. Then, potential land feasibility increased strongly (i.e. >50 per cent increase) in 75 per cent of all scenarios (12 scenarios), moderately in 25 per cent or 4 of these scenarios, and it decreased in no scenario. All 4 scenarios where AE demand-side measures were combined with purely conventional supply-side measures showed strong increases of around 125 per cent in potential land feasibility in comparison to the base year.

Greenhouse gas emissions from the EU agri-food system in 2050

Does the large-scale adoption of agroecological measures also decrease the environmental impact of

Figure 2: Agroecology and potential land feasibility index (PLF_i)

Livestock distribution	Demand-side measures	Supply-side measures	No. of scenarios
Current (Conv)	All	All	144
Aligned with feed production capacity (Potential)	Purely conv	Purely conv	4
	Purely conv	Hybrid (conv/AE)	124
	Purely conv	Purely AE	16
	Purely AE	Purely conv	4
	Purely AE	Hybrid (conv/AE)	124
	Purely AE	Purely AE	16



Note: 432 scenarios are shown according to the assumed distribution patterns of livestock within the EU, and by the implementation of conventional and/or agroecological measures on the demand-side and the supply-side. Percentages refer to the share of scenarios where the PLF index moderately (0–50% change of PLF index) or strongly (>50% change of PLF index) increases or decreases, respectively, in comparison to the base year. Purely conv = only conventional practices; purely AE = only agroecological practices; hybrid (conv/AE) denotes scenarios that include conventional and agroecological parameter variants (e.g., conventional cropland and agroecological grassland management). All = purely AE, purely conv, hybrid (conv/AE).

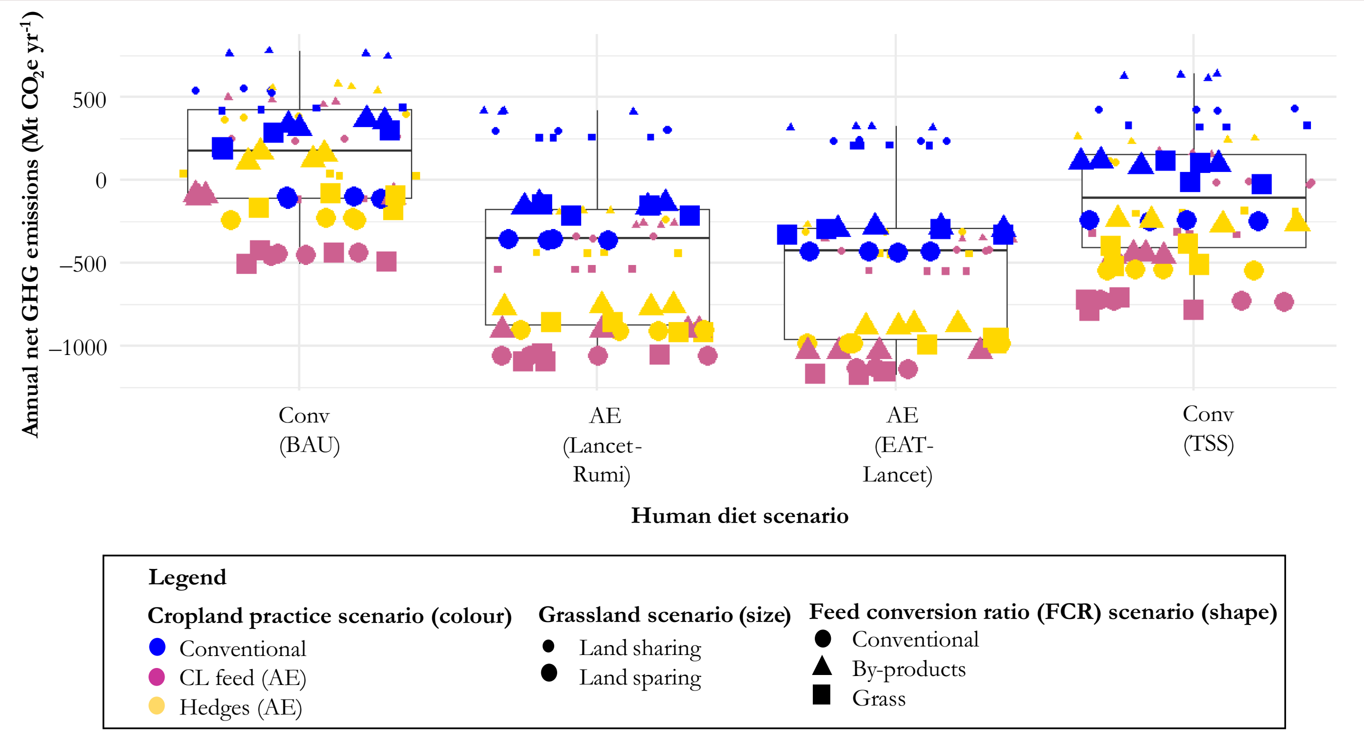
domestic agri-food systems? Figure 3 presents boxplots for total net GHG emissions for all 288 land feasible scenarios in the EU in 2050.

> “Associée à un système agroalimentaire de plus petite taille et des systèmes d'élevage en phase avec les capacités régionales de production d'aliments pour animaux, l'agroécologie peut atténuer les impacts négatifs.”

The 288 land-feasible scenarios showed a wide range of total net GHG emissions in 2050. In our defined option space, changes in diets had the highest impact on net GHG emissions, followed in decreasing order by cropland practices, grassland management and feed conversion ratios. The effect of grazing intensity and manure management on net GHG emissions was not statistically significant. The combination of conventional diets and conventional practices on cropland (blue scenarios in the most left and right boxplots of Figure 3) yielded total net GHG emissions reaching up to 750 Mt CO_2e yr^{-1}; a strong increase compared to the 565 Mt CO_2e yr^{-1} of GHG emissions in the base year 2012. In contrast, scenarios with strongly reduced demand for animal products in the EU, i.e. the diet variants Lancet-Rumi and EAT–Lancet (plots in the middle of Figure 3), reduced annual GHG emissions by 550 and 630 Mt CO_2e yr^{-1} on average, respectively.

Across all scenarios, agroecological cropland measures showed beneficial effects for total net GHG emissions. Both agroecological variants on cropland (pink and yellow markers in Figure 3), namely increasing hedges (Hedges) and undersowing cereals plus replacing fodder maize with fodder legumes (CL Feed), further contributed to a considerable reduction of net GHG emissions under the assumption of reduced production levels (both EAT-Lancet dietary assumptions). Scenarios which included the cropland variant hedges performed better than the conventional cropland variant, but worse than the CL feed variant. In contrast, agroecological feeding measures (shape of marker in Figure 3) had heterogeneous effects on net GHG emissions. Both, a feed mix of grass, fodder crops and by-products (FCR By-products) as well as grassland biomass as the single feed source for ruminants (FCR Grass) decreased feed efficiency and, hence, increased feed demand. Consequently, GHG emissions from enteric fermentation increased in comparison to a conventional FCR variant, but the extent was less pronounced in combination with other agroecological measures (CL feed). Grassland scenarios comprised two agroecological variants (size of marker in Figure 3), a land-sharing, and a land-sparing variant. Only the land-sparing variant, however, allowed for negative emissions in most scenarios, as large land areas could be afforested. The land-sharing variant did not enable such large carbon sinks (since no grassland is allowed to be abandoned and utilised for vegetation regrowth), but the considerable reduction of the realised grazing intensity slightly reduced total GHG

Figure 3: Total net GHG emissions including emissions from land-use change in the European Union in the year 2050 in Mt CO_2 equivalents (Mt $CO_2e\ yr^{-1}$)



Note: Each marker represents one land-feasible scenario (n = 288), with a specific combination of conventional and agroecological parameter variants. The figure displays only those parameters included in the BioBaM-GHG 2.0 model that had a statistically significant impact on GHG emissions (calculated as the average effect on the modeled GHG emissions of a change in one parameter variant, independently from other parameters).

emissions through better maintenance of carbon sinks in grassland soils (effect not statistically significant).

Environmental impacts of a purely agroecological agri-food system in 2050

All 288 land-feasible scenarios that define the option space were evaluated in terms of their environmental impacts. Figure 4 presents six maps that compare the regional patterns of animal products per hectare of agricultural land, grazing intensities and the heterogeneity of agricultural land between the base year 2012 and one representative, purely agroecological scenario in the year 2050. This scenario comprises agroecological measures on both the demand (reduced meat consumption and waste) and the supply side (on cropland, grassland and livestock systems), and can be seen as a representation of a comprehensive transformation towards agroecological agri-food systems in the EU. In this scenario, the presented environmental indicators improved across the majority of NUTS regions (Figure 4), and on average, EU-wide pressures on ecosystems decreased for all indicators. In general, regions with the highest pressures in 2012 performed better in this specific scenario in 2050.

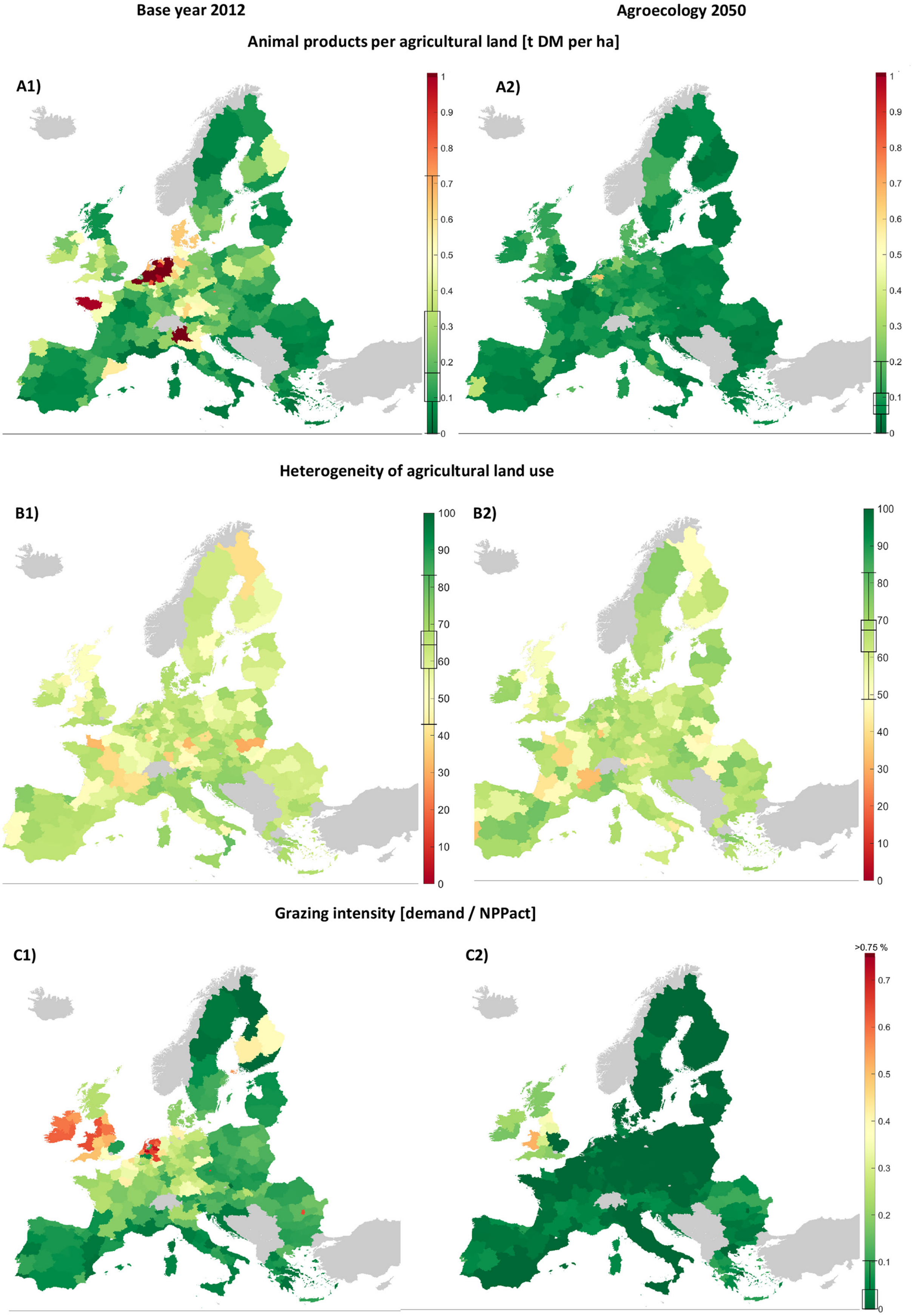
> “Agrarökologie kann negative Umweltauswirkungen nur in Kombination mit verringerter Produktion und integrierter Ackerbau-Tierproduktion erreichen.”

Animal products per hectare of agricultural land (Figures 4A1 and 4A2) decreased across all NUTS-2 regions in the EU. Particularly, stocking densities in regions such as the Benelux countries, Northern Italy and Western France decreased considerably, reducing pressures from livestock systems. These altered production patterns also decreased grazing intensities (Figures 4B1 and 4B2), based on the specific scenario assumption that reduced grassland feed demand for ruminant livestock (driven through reduced production levels of beef and dairy) translates into lower grazing intensities. Furthermore, breaking up the specialisation in agricultural systems through a predominant orientation on meeting domestic demand (see Figures 4C1 and 4C2), mostly increased the heterogeneity of agricultural land use in the year 2050 in regions with the lowest values in 2012 (i.e. having a strong specialisation in agricultural production, such as in Eastern Slovakia, regions in Southern Germany, or parts of France), while regions with a medium heterogeneity in the base year only showed marginal positive changes.

Strong conditionalities for agroecology to be sustainable

In this article we have presented a large number of land-feasible scenarios for the agri-food system in the European Union in 2050 (i.e. referred to as the future option

Figure 4: Impacts of the agroecological scenario with purely agroecological demand and supply-side measures for selected environmental indicators, comparison of the base year 2012 with 2050 in the EU



Note: Figures B1 and B2 display the Shannon Index for the heterogeneity of agricultural land use, with higher values representing a more even occurrence of all crop types (0–100%); Figures C1 and C2 are calculated as grazed biomass / current vegetation (t DM harvest/NPP_{act}). Scenario comprises the following, purely AE, parameter variants: cropland variant: CL feed; human diet variant: EAT-Lancet diet in the EU; FCR variant: CL by-products; GI_{max} variant: Reduced GI_{max} on HNV land; Emission management variant: high-digester; grassland variant: land sharing.

space), focusing on the sustainability of a large-scale adoption of agroecological measures on the demand- and the supply-side. We found that many pathways exist which allow cover of the domestic demand for agricultural products while at the same time reducing GHG emissions. A large share of the land-feasible scenarios also reached key targets, such as net-zero GHG emissions (83 per cent), the extent of non-conventional farming practices (100 per cent), and afforestation. In total, 96 per cent reached the goal of planting 3 billion trees (assuming 1,250 trees per hectare from European Commission, 2021, as outlined in the European Green Deal (European Commission, 2019).

We find that agroecology has the potential to mitigate negative environmental impacts of the agri-food system. Yet, the scenario analysis revealed that, for example, unambiguous reductions in GHG emissions independent from all other scenario assumptions can only be realised under the following two conditions. Firstly, in combination with a smaller overall food system (i.e. fewer animal products in human diets, reduced food wastes and reduced net exports) and secondly, with a better alignment of livestock systems with domestic land endowment, if sustainable ecological thresholds for grassland intensity are not exceeded. Therefore, the two main conditions that allow agroecological farming practices to curtail environmental pressures are a) the overall size of the food system, and b) the reallocation of livestock production to where feed production can draw from the largest feed production potential. To avoid the risk of overstretching the ecological capacity of domestic grasslands, to prevent shifting negative environmental impacts to regions beyond the European Union (Fuchs, Brown and Rounsevell 2020), as well as simply maintaining current production levels to increase net-exports, reducing livestock production is a key prerequisite before aligning livestock distribution with feed production potentials. Currently, the livestock system in Europe is found to be exceedingly large. In some regions livestock consumes even more than the entire ecosystem capacity of the region – enabled by feed imports from other regions (Mayer *et al.*, 2021a). In combination with innovative livestock diets, agroecological food systems can re-balance nutrient supply and demand at the sub-national scale.

Heterogenous agricultural landscape, cover crops for soil protection and regenerating soils, hedgerows, and forests in South-Eastern Austria. © Rainer Weisshaidinger

Extensive grazing in Maramures, Romania. © WWF Romania

Our analysis further illustrates synergies, but also trade-offs between agronomic practices and systemic measures targeting the whole agri-food system. One central trade-off is that agroecological cropland management requires more land due to potentially lower yields and additional land demand through ecological features, and lower yield stability in comparison to conventional cropland management. Reduced utilisation of synthetic fertilisers and benefits for soils due to less intensive management, however, might reduce GHG emissions and benefit soil health. Nonetheless, the higher land demand in such scenarios can be avoided through reduced production levels of animal products, sufficient to provide enough food for meat and dairy-reduced human diets in the EU, and reduced food wastes. Such examples underline that no single solution alone can bear the transformation of the systemic and interrelated agri-food system, often causing a range of synergies and trade-offs when individual parameters change.

The option space approach, therefore, is highly suitable to deliver and support policy advice by identifying and quantifying the impact of changing individual or several parameters to transform the EU's agri-food system. In this, the biophysical viability assessments provide a prerequisite for any socio-economic or policy analysis. If a policy option is biophysically not viable (i.e. non-land-feasible), it is not worth investigating it further. Or, if specific biophysical trade-offs or synergies are identified, it is worth focusing on how to remedy or build on those when going further towards socio-economic and political discussions.

Researchers and stakeholders discussing agroecological practices to be implemented in the BioBaM-GHG 2.0 model. © Katalin Balazs

"Agroecology can mitigate negative impacts, but only if combined with a smaller-sized agri-food system, and if livestock systems are better aligned with regional feed production capacities."

Using a purely agroecological scenario from the 288 scenarios that define the option space, we found that agroecological measures on croplands, such as undersowing cereals and replacing fodder maize with leys and clover, allow for a considerable reduction of grazing intensities of approximately 67 per cent in comparison to the base year, and additionally provide roughage for ruminant livestock. Such measures can release synergies between cropland and grassland systems, reduce food-feed competition, and increase land-use efficiency. A positive outcome in this scenario was that a reduction of maximum grazing intensities on high natural value (HNV) farmland is possible without risking shortages in grass supply for domestic ruminant livestock. However, undersowing legumes in cereal production systems might lead to competition for water and nutrients from the primary and undersown crops, thus reducing cereal yields (Dierauer and Gelencser, 2019). Competition for nutrients, water, and sunlight might also occur in proximity to hedgerows, again negatively impacting crop yields. While this specific scenario assumed that no grasslands are spared for vegetation regrowth, such a strategy would create a substantial net-sink for GHG emissions since all unused grasslands are abandoned and left for vegetation re-growth and afforestation. However, such scenarios imply drastic changes in grazing intensities in regions with currently extensive grassland systems, coupled with large-scale afforestation, thus resulting in considerable trade-offs (Doelman *et al.*, 2020). These scenarios require further scrutiny and refinement to comply with agroecological principles.

Concluding remarks and a call to be attentive to the dilution of the concept of agroecology

The concept of agroecology has so far fallen short of a precise and clear definition, and lacks measurable and unambiguous sustainability criteria, which we consider a central weakness. The vagueness of the concept of agroecology might, however, also explain its recent popularity: it is indeed easy to interpret one's own agenda into agroecology. This might be one reason why agroecology has received increasing attention in science, industry, and policymaking in the European Union, and nourished hopes that it is a powerful lever to transform domestic agri-food systems towards sustainability – but could also be used for greenwashing business-as-usual practices. In this article, we aimed to operationalise the concept of agroecology through a stringent quantitative approach. We defined a set of agroecological practices in the agri-food system and assessed the socio-environmental implications if those were implemented on a large scale within the EU. We found a range of positive outcomes, but the benefits of AE do only materialise unambiguously across all other scenario assumptions when implemented in combination with two decisive developments: a) a smaller-sized food system based on the reduction of livestock, wastes and export production, and b) a more stringent orientation of livestock production to domestic crop and grass production potentials. Only then can improvements in terms of ecological performance be realised. If agroecological measures are implemented only on the supply-side without fundamental changes in production levels, agroecology runs the risk of becoming yet another excuse for the continuation of current practices and policies with a risk of producing and hiding negative emission leakage, e.g. outside the European Union.

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Summary

Impacts of Scaling up Agroecology on the Sustainability of European Agriculture in 2050

Les impacts du développement de l'agroécologie sur la durabilité de l'agriculture européenne en 2050

Die Auswirkungen einer großflächigen Verbreitung von agrarökologischen Maßnahmen auf die Nachhaltigkeit der europäischen Landwirtschaft im Jahr 2050

The European Commission recently embraced the concept of agroecology as a pathway to reduce negative impacts from agri-food systems on the environment. So far, it remains unclear whether agroecology can deliver on these high hopes if implemented on a large scale. We here assess socio-economic and environmental implications of multiple agroecological futures in the European Union in 2050, based on a novel diagnostic scenario approach, i.e. the biomass balancing model BioBaM-GHG 2.0. We find that agroecological measures from the plot to the food systems level can indeed reduce environmental pressures while maintaining domestic food availability within the EU. Such measures are, for example, more hedgerows on croplands or reduced biomass harvest on high natural value – HNV grasslands. However, a key prerequisite is an overall reduction of the food system's size (based on the reduction of animal production, food wastes, and export production) and an optimised crop-livestock integration. Only then does the transformation towards an agroecological agri-food system in the EU not risk overstretching domestic land availability or produce insufficient agricultural commodities. Mitigating the accompanied trade-off of reduced farm income is a central mandate for policy development aimed at re-designing agriculture in Europe to align with the Green Deal goals.

La Commission européenne a récemment adopté le concept d'agroécologie comme moyen de réduire les impacts négatifs des systèmes agroalimentaires sur l'environnement. Jusqu'à présent, il n'est pas clair que l'agroécologie puisse répondre à ces grands espoirs si elle est mise en œuvre à grande échelle. Nous évaluons ici les implications socio-économiques et environnementales de multiples futurs agroécologiques dans l'Union européenne en 2050, sur la base d'une nouvelle approche par scénario de diagnostic, à savoir le modèle d'équilibrage de la biomasse BioBaM-GHG 2.0. Nous constatons que les mesures agroécologiques appliquées de l'échelle de la parcelle jusqu'au niveau des systèmes alimentaires peuvent en effet réduire les pressions environnementales tout en conservant la disponibilité alimentaire intérieure au sein de l'Union européenne. Ces mesures consistent, par exemple, à planter davantage de haies sur les terres cultivées ou à réduire la récolte de biomasse sur les prairies à haute valeur naturelle – HVN. Cependant, une condition préalable essentielle est de diminuer globalement la taille du système alimentaire (basée sur la réduction des cheptels, des déchets et de la production exportée) et d'optimiser l'intégration agriculture-élevage. Ce n'est qu'alors que la transformation vers un système agroalimentaire agroécologique dans l'Union européenne ne risque pas d'aboutir à une surexploitation des terres nationales ou une production insuffisante de produits agricoles. L'atténuation du compromis résultant en termes de réduction des revenus agricoles est un mandat central pour l'élaboration de politiques visant à repenser l'agriculture en Europe pour l'aligner sur les objectifs du Pacte vert.

Die Europäische Kommission hat kürzlich das Konzept der Agrarökologie als einen Weg zur Verringerung der negativen Auswirkungen von Agrar- und Ernährungssystemen auf die Umwelt begrüßt. Bislang ist jedoch unklar, ob Agrarökologie diese Hoffnungen erfüllen kann, wenn sie in großem Maßstab umgesetzt wird. Wir bewerten im vorliegenden Beitrag die sozioökonomischen und ökologischen Auswirkungen einer großen Anzahl von agrarökologischer Zukunftsszenarien in der Europäischen Union für das Jahr 2050. Grundlage hierfür ist ein neuartiger diagnostischer Modellierungsansatz, d. h. das Biomasse-Bilanzierungsmodell BioBaM-GHG 2.0. Wir kommen zu dem Ergebnis, dass agrarökologische Maßnahmen von der Schlag- bis zur Ebene des gesamten Ernährungssystems tatsächlich Umweltbelastungen verringern und gleichzeitig die Verfügbarkeit von Lebensmitteln in der EU aufrechterhalten können. Solche Maßnahmen sind zum Beispiel mehr Hecken am Rand von Ackerflächen oder eine extensivere Nutzung von Grünland mit hohem Naturwert ('high nature value grasslands'). Eine wichtige Voraussetzung ist jedoch eine grundsätzliche 'Verkleinerung' des Ernährungssystems (Verringerung der Viehbestände, der Lebensmittelabfälle und der Nettoexporte) und eine optimierte Integration von Ackerbau und Viehzucht. Nur so kann erreicht werden, dass die Umstellung auf ein agrarökologisches Agrar- und Ernährungssystem mit den lokalen Produktionskapazitäten in der EU vereinbar ist, und keine negativen Verlagerungseffekte stattfinden. Die Abfederung der damit einhergehenden Einkommenseinbußen für die Landwirtschaft ist ein zentrales Mandat für Politikgestaltung die darauf abzielt, die Landwirtschaft in Europa so umzugestalten, dass sie mit den Zielen des Green Deal übereinstimmt.