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Fixing sustainability through technoscience and diversity: The case of EU agriculture policy

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ABSTRACT

Sustainability is a conveniently vague boundary term with which a variety of interest groups can identify. Over time, it has grown together with a technoscientific paradigm which demands a closer look at how actors envision science, technology, digitization, and innovation to foster said sustainability, and how the latter has shifted as a result. Sustainability also continues to hold strong value and political weight in the EU, where technoscientific optimism has had a binding effect, particularly in efforts of environmental protection in agriculture (in light of the Green Deal), in an increasingly decentralized political union. This paper discusses these processes in the recent reform of the Common Agriculture Policy (CAP; 2023–2027) by focusing on the one hand on how sustainability's three pillars – the environmental, the social, and the economic – are 'reconciled,' and on the other, on the new 'eco-schemes' as an instrument to achieve a more sustainable agriculture. Empirical data gleaned from participant observation, expert interviews and policy document analysis show how in EU agriculture policy science, digitization/technology and innovation are imagined as fixtures that cohere these pillars, thereby maintaining a growth paradigm imminent to dominant sustainability discourses. This *technoscientific sustainability* is also evident in agriculture measures on the ground, in the new eco-schemes, which offer a diversity of farming approaches for EU's member states, ranging from agroforestry to precision farming. In this technocratic instrument, holistic systems, like agroecology, are rendered technical 'tools' that member states can combine at will, fostering a *politics of toolkit diversity* that accommodates diverse farming approaches and philosophies while evading environmental compliance. Scientific epistemology, technical quantification, digital tools and innovation thus act as wider discursive fixture that not only hold together the holy trinity of sustainability, but also accommodates diverse landscapes and member states, and through that the political union of an increasingly decentralized EU.

1. Introduction

Competing interest groups have long aimed to capture the definition of sustainability (Buttel, 2006; Purvis et al., 2019; Scoones, 2007), and over time, sustainability discourses have gone hand in hand with a growing technoscientific innovation paradigm (Benessia and Funtowicz, 2015; Konefal, 2018; Levidow, 2018). Exemplary is the recent EU 'twin transition' through which policymakers envision a smooth integration of sustainable and digital policy as part of the European Green Deal and EU Digital Strategy, while effectively perpetuating an ecomodernist growth paradigm (Kovacic et al., 2024). This article addresses these shifting meanings in EU agricultural policy, further extending Kovacic et al.'s observation that the sustainability vision in the EU twinning discourse entails "merely 'adding' digitalization into the mix" (2024, p. 19). At the commencement of the project, digitization was not as distinct a field as in contemporary twin transition discourses, but bolstered up long-held visions of science, technology and innovation (STI) as seemingly neutral instances of European unification (Barry, 2006; Frahm et al., 2022; Laurent, 2022) that also *cohere* a European sustainable agriculture. This co-productionist lens (Jasanoff, 2004) highlights how desirable social orders – the technocratic political union of the EU in times of decentraliziation – are inextricably linked to norms of knowledge production – of diversified 'sustainable agriculture.' Resorting to the (seemingly) neutral virtues scientific epistemologies, digitization and technological innovation can help unite a European 'sustainable' agriculture that consists of diverse member states (MS), and multifarious landscapes. Empirical data for this paper stems from the research project "Innovating Food, Innovating Europe"?" (2019-2023) which focused,

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among others, on the role of science, technology and innovation in EU agriculture policy in the context of aligning the most recent CAP Reform with the Green Deal.

The article thus inquires what constitutes 'sustainability' in EU's *common* agriculture policy in the light of a 'digitally updated' technoscientific knowledge regime by addressing the following questions: how do EU policymakers envision science, technology, digitization, and innovation (SDTI) to foster European sustainable agriculture, and how does the meaning of sustainability shift as a result? How are these visions co-produced with the EU as unified yet increasingly renationalized political institution? Based on theories and concepts in science & technology studies (STS), critical sustainability studies and political science, the paper demonstrates how SDTI are envisioned not as mere 'twins,' fixes or something 'added into the mix' of sustainability. Rather, they take on the form of facilitating *fixtures* that cohere the economic, the social and the ecological, while effectively maintaining a growth paradigm imminent to dominant sustainability discourses. The paper then analyzes the envisioned role of SDTI to achieve *what kind* of sustainability (Konefal, 2018, Scoones, 2016), and how this is reflected in tensions of unified and increasingly decentralized EU.

Efforts to reach a more sustainable agriculture are evident in the promotion of a diversity of farming approaches that range from agroecology to precision farming, which are part of the CAP's new 'eco-schemes.' As an effort to move away from compliance (with environmental targets) towards results and performance (European CAP Network, 2023, p. 2), this policy instrument resounds a complementarity politics (Montenegro de Wit, 2022) of portraying technologies in an ahistorical and decontextualized way to fit such approaches as agroecology. This seemingly benign instrument exemplifies how the agenda for a greener economy (Green Deal, twin transition) serves a flexibilized and united agriculture – and EU – while sidelining environmental stewardship. To serve a diverse European agricultural landscape and decentralized EU, a *politics of toolkit diversity* is fostered, where holistic systems, like agroecology, are effectively rendered as 'tools' similar to, say, precision farming, that MS can combine or chose at will.

Findings for this research project were gathered through participant observation of agriculture policy events in Brussels, expert interviews in the EU agriculture policy domain, reviews of policy papers, and subsequently analyzed through discourse analysis. The paper proceeds with a section on collected data and methodology, followed by a state-of-the-art of critical scholarship on sustainability, technoscience, and the European Union (EU). The empirical section "Reforming the CAP, in times of the European Green Deal" is divided in three parts discussing (1) the boundary term of sustainability in EU agriculture policy, (2) the role of technoscience for sustainable agriculture, and (3) eco-schemes as example of a politics of toolkit diversity. The paper ends with a concluding discussion.

2. Data collection and methodology

Data for this article stems from the larger multi-sited research project "Innovating Food, Innovating Europe?" (2019–2023) that focused on the role of science, (digital) technology and innovation, both in EU sustainable agriculture policy, and in sustainable farming practices in Germany.[1] The project was based on a mixed-methods approach (Creswell and Clark, 2011) of ethnographic research (participant observation), semi-structured interviews, textual analysis, and a speculative design workshop with farmers. Events and field sites included agriculture policy events (e.g., conferences, workshops and roundtables/webinars) in Brussels, across Germany and online, ethnographic research at a regenerative farm in Southern Germany, interviews in the EU agriculture policy domain and among farmers, and the review of relevant policy papers and media reporting between 2018 and 2024.[2] The selection criterium determined that the event or field site was concerned with sustainable agriculture *and* made references to innovation, science and/or (digital) technology. For all events, detailed ethnographic fieldnotes were taken, such as of a workshop in Brussels on agriculture, innovation and technology (Gugganig, 2023).

For this article, only data pertaining to the EU policy level were considered, including 92 documents consisting of fieldnotes (38), policy documents (29), transcribed interviews (16, out of 23), and media reporting (9). All interviewees signed a consent form for the data to be used for publications, and are anonymized in this paper. These included 8 policy analysts working at European-wide environmental or food sustainability NGOs, 3 researchers, one policy advisor, and one industry representative.[3] The material was approached through a discourse analysis of how sustainable agriculture and technoscience are described and envisioned to justify and enact specific policies (Foucault, 1994; Tulloch, 2013). Data was analyzed through deductive and inductive coding via the software MAXQDA 2022.

3. Sustainability, technoscience, and the European Union: an interrelated analysis

3.1. Sustainability in technoscientific times

While it is commonly known that 'sustainability,' or 'sustainable agriculture' are vague and ambiguous terms (Buttel, 2006; Konefal, 2018), Purvis et al. (2019) point more specifically to its undertheorized and empirically vague tripartite definition of the environmental, economic, and the social (p. 690). One may say sustainability is conveniently flexible; a boundary term traded among various actors that is most effective when remaining "contested, ambiguous, and vague" (Scoones, 2007, p. 594). Exemplary is that despite its origin in an environmental ideology, the UN succeeded in norming sustainability as economic growth 'in disguise' – stemming from sustainable *development* (Tulloch, 2013) – by placing it as benign equal to the social and environmental pillar (Purvis et al., 2019).

To orient sustainability goals towards (more or less disguised) economic growth paradigms, scholars have pointed out how actors mobilize technoscientific innovation narratives to that end (Benessia et al., 2012; Lélé 1991; Pereira and Curvelo, 2015). Indeed, attending to how sustainability is "influencing and being influenced by the mutable boundaries of techno-science" (Benessia and Funtowicz, 2015, p. 331) shows how in productivist agriculture sustainability can be a technological *solution* (Iles et al., 2017, p. 956), while in a more recent digital turn it can turn into a *problem* of lacking data and quantitative precision (Goldstein and Nost, 2022). This malleability, perhaps counterintuitively, corroborates the ontology of sustainability: the belief that any environmental, economic, or social quandaries can be resolved through technological fixes or innovation (Scott, 2011; Pfotenhauer and Jasanoff, 2017) norms sustainability as quantifiable, scientific matter, with an inherent path towards technological advancement.

This is not surprising, as the political culture in which 'sustainability' has proliferated is a deeply technoscientific one, where scientific knowledge/institutions co-shape what technologies ought to be developed for society (Latour, 1987), e.g., in agriculture (Tanaka and Juska, 2010), with mechanization, genetic engineering, and most recently

[1] Germany was chosen based on its dominant role within the EU for setting policy and research agendas, for its reputation as highly industrialized nation, while having a strong environmentally conscious civil society in agriculture (see Polzin, 2024). Original fieldwork plans in three European countries had to be adapted due to the Covid-19 pandemic.

[2] Some references are made prior to 2018–2024 to offer a historical, comparative perspective.

[3] To remain within the scope of this analysis, perspectives of farmers who participated in this research study will be given adequate space in future publications.

digital tools. The EU is a prime example of such technoscientific political culture (Felt, rapporteur, 2007). This is discernible in such instances as to when knowledge, innovation, digitalization, and technology are consistently grouped together (see EC, 2023, p. 11–12), effectively rendering innovation and knowledge *technological* (EC 2010; cf. Sotte and Arcuri, 2025; p. 159; Levidow et al., 2013; Nemes and Augustyn, 2017).

Hence, attention should be paid to the "symbolic role – of aspiration, vision, and normative commitment" in dominant conceptions of sustainability (Scoones, 2007, p. 594): what kind of sustainability is aspired through what kinds of digitization, technologies, innovations, and scientific knowledge? That these are not given terms becomes evident in grassroots farming initiatives and policy paradigms of agroecology, which trouble technology-focused notions of innovation and the bias of agricultural (digital) technologies towards large-scale, monocultural farming based on farmer-owned, degrowth-oriented technologies and innovations (Bronson, 2019; Fairbairn et al., 2025; Grassroots Innovation Assembly Visual Report 2023; Levidow et al., 2013). Relatedly, 'reconciling' the social, environmental and economic dimensions of sustainability are often envisioned through simplistic scientific, technical or innovation fixes Lajoie-O' Malley et al., (2020), though how the 'trade-offs' between these dimensions ought to be 'balanced' often remains vague (Purvis et al., 2019, p. 690). Before attending to how this reconciliation is imagined in EU agriculture policy, we shall first look at efforts of making European agriculture more sustainable.

3.2. How to make European agriculture sustainable

It is worth recalling that the European Union was born out of an economic arrangement – the European Economic Community – with the agricultural sector following a path towards market policies (Milward 1999 [1992]; Sotte and Brunori, 2025). This is also reflected in the first objective of the 1962 established Common Agricultural Policy (CAP):

"to *increase agricultural productivity by promoting technical progress* and by ensuring the rational development of agricultural production and the optimum utilization of the factors of production, in particular labour" (Article 39 of the Treaty; emphasis added).

Two decades later, the Commission recognized that this technological push perpetuates environmentally harmful agriculture (Meeus et al., 1990, p. 292; see also EC, 2014, p. 21), leading among others to stronger environmental objectives through Pillar 2 (Matthews, 2013). Yet critics have noted that changes in CAP instruments have merely "reoriented the policy without any change in formal Treaty goals" (Grant, 2010, n.a.), keeping it 'locked-in' to a productivist path (Elton, 2010; Sotte and Brunori, 2025; Zwaan and Alons, 2015). At the millennial turn, the European Commission aimed to transition the CAP towards sustainable agriculture (Commission of the European Communities, 1999), though generally, (voluntary) environmental measures have been placed within the realm of MS (see Sotte and Moretti, 2025, p. 113–114) that barely challenged its growth paradigm. Today, the CAP is the only EU-wide policy with the largest budget, of which more than three quarters (76.8 %) are spent as direct payments (Pillar 1).[4]

Indeed, the EU still largely attains legitimacy based on economics, rather than, say, on a shared political culture and framework/constitution (Laurent, 2022). A common ground in the "multiply imagined community" of Europe (Jasanoff, 2005, p. 10) is a shared history of technoscientific optimism: scientific objectivity and technical quantification can foster policy harmonization, discursively discipline arguments, and reduce tensions between MS (Felt, rapporteur, 2007; Joerges and Neyer, 1997; Turnhout et al., 2014; Waterton and Wynne, 1996). How (economically oriented) sustainability is embedded in this technoscientific political culture is exemplified in the Commission's "Europe 2020 Strategy" envisioned in the early 2010s (EC 2010). It entails the three objectives 'smart growth,' 'sustainable growth' and 'inclusive growth,' where 'smart' includes "technological knowledge and innovation" for food production, 'sustainable' refers to environmental issues, and 'inclusive' to social aspects of rural development (see Sotte and Arcuri, 2025, 159). It is not hard to discern the tripartite dimension of sustainability reflected in these 'growths,' with technology and innovation being equated with the economic.

Part of the Europe 2020 Strategy was also the promissory rhetoric of innovation, in the form of an 'Innovation Union,' asserting the EU was "dependent on innovation for social and economic advancement" (Frahm et al., 2022, p. 21–22). In agriculture this manifested in "a push for fully using the latest technologies and innovations" for reaching "a more sustainable and competitive agricultural production" (DG AGRI, 2018b, p. 17), because

"[t]he insufficient or too slow uptake of new knowledge and innovative solutions in farming, particular by small and medium-sized farms, hampers a smooth transition towards a more sustainable agriculture […]" (EC, 2019b, p. 2).

This is a typical deficit model of farmers in need of technologies, innovations (and scientific reasoning) (Duncan et al., 2021; Wynne, 1996) that frames STI as something outside of small and medium-scale farms in need to be adopted to count as 'sustainable.' Idea(l)s of sustainable agriculture are thus inextricably linked to, or co-produced with, desirable social orders and political institutions: through a consistently cultivated identity – the EU as sustainable (economic) union –, executing institutions – the CAP, Green Deal – and a discourse, of science, technology and innovation as prerequisite for achieving sustainable agriculture (see Iles et al., 2017; Jasanoff, 2004, p. 38–39).

The need to 'catch up' via technology and innovation is also evident in the Green Deal – a large-scale "technocratic exercise" of ecological modernization through technology investment (Samper et al., 2021, p. 10). A "new delivery model" sets sustainable agricultural policy goals by shifting from compliance "towards results and performance, *hoping* it can show how their [MS] agriculture sectors and rural areas are on a sustainable path forward" (European CAP Network, 2023, p. 2; emphasis added; DG AGRI 2018b, p. 16; European Commission, 2019a; Hart, 2015). Said differently, the Green Deal reflects "a *desire* to achieve goals and declarations of intentions but no real commitment or consequence for not meeting concrete, assessable indicators" are made (Samper et al., 2021, p. 13; emphasis added), including environmental targets in agriculture (Pe'er et al., 2019; Simoncini et al., 2019). Part of this new model is a more flexible instrument – a National CAP Strategic Plan – for MS which includes eco-schemes for increasing sustainable agriculture (Runge et al., 2022, p. 19). The following sections presents empirical data discussing (1) the revival of 'sustainability,' (2) how its tripartite is imagined to be reconciled, and (3) the role of eco-schemes as a flexible toolkit of diversity.

4. Reforming the CAP, in times of the European Green Deal

"Sustainability works because you don't step on anyone's toes": reviving a boundary term

In December 2019, I attended the 5th Agricultural Outlook Conference in Brussels, a platform by the European Commission's Directorate-General for Agriculture and Rural Development (DG AGRI) to present its past work – and vision of European agriculture. The motto of the conference was 'Sustainability from Farm to Fork.' It seemed somewhat surprising to see this contended term so prominently on event posters decorating the EU's buildings. When I interviewed a policy analyst from an environmental NGO a few months later, she gave some clues:

IV: "I don't know if you're aware but last year, environmental NGOs boycotted the [2018 Agriculture Outlook] Conference. […] Because

[4] For 2023–2027, the CAP made up EUR 55.71 billion, or 31 % of the EU budget (EP, 2023). "Common Agriculture Policy Fund" https://agriculture.ec.europa.eu/common-agricultural-policy/financing-cap/cap-funds_en (accessed October 2, 2024). The CAP reform was initially set for 2021–2027, yet was delayed due to the Covid-19 pandemic and the introduction of the Green Deal.

there was nothing about sustainability on the agenda."

MG: "Oh, and now that year was all about sustainability."

IV: "Yeah, so that's interesting. But then it might be partly a consequence of that and then also partly because of the Green Deal, the Green Wave [which] has been big, the climate marches, the climate strikes" (IV_200220).

Indeed, 2019 was a different political climate, when the EU elections brought a boost to environmental topics, and Fridays for Future were still considered a worthwhile political movement of the next generation. Broadcasted into the conference rooms was the Commission's new president Ursula von der Leyen who then announced the Green Deal, which was to foster a "sustainable Europe that opens up opportunities, innovates, creates jobs and offers a competitive edge to its industries" to "reconcile the economy with our planet" (von der Leyen 2019, p. 6; FN_191211).

Sustainability, it seems, still worked because, in the words of the policy analyst, it is "a completely flexible term by which everyone can imagine what they want and that's why it's very popular with politicians. Because you don't step on anyone's toes." Whether it is her organization's promotion of agroecology or others promoting technologies, "sustainability enables both those world views to be encompassed in the term" (IV_200220), and to exist in parallel.

Both a sustainability manager representing pesticide agribusinesses and a professor of agronomy shared a different view: the focus on sustainable agriculture is often too much on environmental aspects and not enough on economics (IV_200219; IV_200302). Relatedly, an agroforestry policy analyst shared an experience with the agribusiness industry:

"The last event I went to before the [Corona] shutdown was on the forest strategy in Brussels. That was organized by DG Environment, and kudos for them. They had lots of great experts, proper scientists who know what they're talking about who say, 'we've got to stop killing ourselves.' But the people who were sitting in the row behind me were all representing industry and they were muttering between themselves 'stupid, ridiculous. they should've had people from industry up there! This is important, this is our livelihood, this is our work! blah blah blah.' So that is going on all the time. And what was the message that was sent to industry then is: 'guys, you've got to take sustainability seriously.' Which is interpreted by industry as: 'hmm we've got to start using the word sustainability a lot in all our communications'" (IV_200512).

The flexibility of sustainability is also conducive to another interest group: while several environmental policy analysts shared that in alternative movements this term is no longer used, a representative for the organic industry remarked that it is also a meeting point for organic farming advocates and others to deliberate over scientific indicators of sustainability (IV_200408).

Three decades ago, Sharachchandra Lélé (1991) noted about its precursor sustainable development that it is "a 'metafix' that will unite" anyone from the "risk-minimizing subsistence farmer to […] the goal-oriented bureaucrat, and therefore, the vote-counting politician" (p. 613). As boundary term among various actors – including the Commission's president – it stays most effective when remaining contested, ambiguous, and vague (Scoones, 2007): EU policy reports and websites incessantly refer to, but rarely define sustainability,[5] which has also been noted for the Green Deal (Samper et al., 2021, p. 14). Despite its seeming fading, sustainability continues to work in the EU context because its vagueness can either link diverse groups, or lets them exist in parallel. As sustainability rhetorics can obscure complex and contested interpretations (Leach et al., 2010; 42), a closer look at how the economic, social and environmental dimensions are 'balanced' is key (Purvis et al., 2019), which will be analyzed next along the case of the CAP reform and the Green Deal.

4.1. Technoscience as a fixture for sustainability

While the green and digital 'twinning' discourse was generally prevalent in the Green Deal, in agriculture references to science, technology and innovation were more interrelated with the 'digital.' The way SDTI were generally framed merits closer attention: At the Agriculture Outlook conference in 2019, Commissioner of DG Health and head of the F2F (Farm-to-Fork) Strategy Stella Kyriakides set the tone by affirming that "technology, innovation and research into new farming techniques will be crucial to approach food and production more sustainably" (FN_191210). At a workshop the following day, organized by the European Institute of Innovation and Technology for Food (EIT Food), a spokesperson for DG AGRI explained along a dizzying number of slides that "there is a right balance between productivity, climate and environmental goals" for achieving a sustainable agriculture and forestry, where research and innovation will "*speed up action* for sustainable soil and land management", "*increase the resilience* of plants and animals to biotic and abiotic stresses", and "*provide solutions* for rural communities and operators" (FN_191212; emphases added). An entrepreneur at the workshop framed it as follows: digital technologies, including artificial intelligence, robotics, or Internet of Things have the potential to increase farm efficiency while *improving* economic and environmental sustainability. In an EU report on the twin transition in agriculture, digital technologies appear as "*catalyst* [to cope with economic] shocks, acquire knowledge, build communities and relations, and adopt systems-related thinking" (Barabanova and Krzysztofowicz, 2023, p. 4; emphasis added). Consider also the Commission's description of the role of digital technologies for "smart sustainable farming":

Digital technologies *enable* optimisation in the agriculture sector. Digitalisation has been *a driver* for the modernisation of the agriculture sector for many years. There are different ways digitalisation contributes to precision agriculture. These include monitoring the health of plants or livestock, data analysis to propose actions to improve farm processes, and managing autonomous devices (e.g., robotic arms, switches, valves, or sprayers). Drones can also spray pesticides, or be used to control land and livestock. Digitalisation further contributes to communication and management of the agri-food supply chain and enables traceability and transparency of products (Muench et al., 2022, p. 29; emphasis added).

Except for tracking the health of plants or livestock, there is nothing indicating environmental factors, while economic optimization remains the defining feature.

In the spirit of the twin transition of 'reconciling the economy with the planet,' the (seemingly) benign digital technology and innovation paradigm perpetuates the (seemingly) benign economic paradigm in sustainability discourses. The various statements reveal a balancing-mantra of sustainability's three dimensions that point to *how* sustainability and digitization (and STI) are unequal twins (D4S, 2022; Kovacic et al., 2024): vivid verbs and nouns turn (digital) technology, innovation and research into facilitator; by reconciling/catalysing/accelerating/enabling sustainability.

Science also plays a key role. At the Outlook conference, Giovanni De Santi, Director of Sustainable Resources at the Joint Research Centre (JRC), explained that the JRC works together with DG AGRI, and other DGs to develop science in support of policies.[6] A mid-50s tall, slender man in suits, he sought to convey the value of the JRC within the Commission, as colleagues from the DGs tend to work in silos, and they "trust us because we are just science, we are just independent." For the F2F Strategy he explained that while there is no silver bullet solution and thus a need to diversify solutions for different areas, sustainable agricultural policies, food and health policies need to be consistent, and – by providing his colleagues with the same data and analysis – "science can be the glue" (FN_191210).

[5] For instance, one report mentions sustainability over 50 times, while remaining undefined, like 'sustainable work-life balance' (DG AGRI, 2018a)

[6] It is plausible that this was a Freudian slip, i.e., that De Santi meant developing policies in support of science.

While the JRC forms a scientific authority and collaborations with DGs are needed for policy development, Völker and Pereira (2023) point out that these intra-EC relations are not always clear, and tensions may prevail "between regimes of impact and ideas of independent research" (p. 445). Several interviewees shared that DG AGRI is known to be more conservative when it comes to reforming its policies. To an organic farmers' representative, the fact that the responsibility of the F2F Strategy was given to DG Health rather than to DG AGRI was indicative of a lack of trust in agricultural policymakers to align the CAP with environmental strategies (IV_200408). What Bruno Latour (1993) famously described as modernists' obsession with the purification of values and facts – of DGs' interests and JRC's scientific data – is here rationalized as 'gluing together' impact and research, values and facts. Just as (digital) technology and innovation are promised to reconcile economic competition, social stability and environmentally friendly agriculture, science is promised to reconcile, or cohere these domains, and so DGs' various interests. This is particularly illustrative in the (visual) evolution of the CAP Key Objectives:

In 2018, the Commission proposed that MS draw up National CAP Strategic Plans where (again) "potential trade-offs in the achievement of economic, environmental and social objectives of the CAP" would require "grasp[ing] the opportunities offered by innovation and technologies […]" (EC, 2018, p. 8). These sustainability objectives were subsequently elaborated as Nine Key Objectives for the recent CAP reform: three relate to economic objectives – fair income, competitiveness, food chain – three to environmental objectives – climate change, environmental care, landscapes and biodiversity – and three to societal objectives – generational renewal, rural areas, food and health quality (Fig. 1.).[7]

The graphic contains a curious vacant space to the left, and indeed, the Nine Key Objectives were incrementally expanded. Around the time, different graphics circulated in policy reports, presentations and on social media, including one posted on (then) Twitter, where "Knowledge & Innovation" filled this gap (Fig. 2).[8]

In 2021, the Commission proposed an additional "cross-cutting objective on digitisation, knowledge and innovation" with MS being provided "a portfolio of CAP tools that they can include in their National CAP Strategic Plans to boost digitalisation in agriculture and rural areas" (Fig. 3).[9]

Fig. 4 shows the final Ten Key Objectives where "Knowledge and Innovation" became their own objective. In a review article, Member of European Parliament De Castro and colleagues (2020) even proposed that for the (then) nine objectives, "knowledge and innovation represents [sic] a transversal objective" which they visualized at the center of their graphic (p. 6).

These shifting visual renderings illustrate how science/research, innovation, digitization and technology turn into agile actors – as 'enabler,' 'catalysts' or a 'glue' – rather than 'equal twins' of sustainability/greening measures. Envisioned with such vivid agency, SDTI do not merely form generic fixes, but *fixtures* that hold together the holy trinity of sustainability; by operationalizing the economic (land management), the environmental (functionalizing plants, animals, and soil), and the social (rural livelihood). Rather than neutral vehicles that advance (an equally neutral) sustainability, approaching SDTI as fixtures highlights their active maintenance work of a growth-oriented sustainability (e.g., the Green Deal as *growth* strategy). Consequently, the *kind* of sustainability (Konefal, 2018, Scoones, 2016) that emerges when sustainability and techno-science discourses co-evolve (Benessia and Funtowicz, 2015) is a *technoscientific sustainability* where science, digitization/technology and/or innovation are envisioned as facilitating fixtures that cohere the economic, the social and the ecological, while effectively maintaining a growth paradigm imminent to sustainability discourses.

This brings up the question whether other not-so-technical/digital/scientific approaches for sustainability can count within a technocratic space like the EU. In 2023, the Agriculture Outlook Conference (then renamed "Agri-Food Days") for the first time held an "EU Agri-Digital Conference" day – indicative of where EU agriculture is to head towards. With speeches focusing on how and what digital tools are needed in agriculture, the lunch panel discussion slightly broke with this focus, with one speaker less concerned with the digital. On a panel with five business-like looking men, the European Coordinator of Via Campesina Geneviève Savigny explained that digitization is not an issue she sees among farmers, and that digitizing everything risks abandoning agroecology approaches (see more below). She shared that in the previous break-out group on 'Farming in 2040,', there were no small-scale farmers included, and in the envisioned future farmers were just looking at the smart phone, rather than engaging with farming (FN_231208). While she received much applause, and half the questions in the Q&A were directed at her, the visual graphic summarizing the panel did not include any reference to these discussions. A tweet (on X) from the DG AGRI channel "EU Agriculture" summed up her contribution as: "digitalisation is not a central topic for all small farms, including young farmers. Yet, we use networks to exchange and cooperate". This way, the tweet levelled her critique with the addition of a "yet"-sentence, as overall agreeing with the digitalization framing, rather than restating her critique of the general digitization trend in agriculture (FN_231208). It exemplifies the inability of EU agriculture policy actors to conceive of a European farming future that may not be pervasively digitized and techno-centric.

One question directed at Savigny was that if digitization were to improve agroecology, would she be more willing to include it? She responded that Via Campesina participated in the F2F Strategy, but that they did not really know what was meant by 'sustainability': "And it's a key question: will digitalisation lead to sustainability?" (FN_231208). It is this question that highlights another key dimension of EU technoscientific sustainability: the re-combination of diverse agricultural approaches.

4.2. Eco-schemes for greater sustainability, and the politics of toolkit diversity

While at the millennial turn sustainable agriculture measures included low-input farming techniques (organic farming) and agricultural practices for nature protection (Commission of the European Communities, 1999), nowadays it may be a combination of agroecology and GM crops (Royal Society, 2009; cf. Levidow et al., 2014, p. 1135), or biodynamic farming with precision or conservation agriculture (Buckwell et al., 2014). The new "eco-schemes" of the F2F Strategy, which are to "play an important role in the transformation of European agriculture towards greater sustainability" (Runge et al., 2022, p. 19), are exemplary for this widened definition. MS are to design a "catalogue" of eco-schemes as part of their National CAP Strategic Plans to incentivize farmers to adapt these voluntary measures (EURACTIV's Agrifood Team, 2023). When the eco-schemes were first introduced, they included precision agriculture, agro-ecology (including organic farming), carbon farming and agro-forestry (EC, 2020, p. 9) – and this did not chime with everyone. In response to Ursula von der Leyen's speech introducing the Green Deal, IPES-Food policy analyst Francesco Ajena criticized on (then) Twitter that DG AGRI puts the responsibility

[7] They were also showcased at the 2019 EU Green Week https://www.slideshare.net/slideshow/farm-sustainability-tool-for-nutrients-by-isidro-campos-ec/131624850 (accessed October 1, 2024).

[8] https://twitter.com/EUAgri/status/1140892900659781632 (accessed October 6th 2024).

[9] https://digital-strategy.ec.europa.eu/en/policies/future-farming; updated March 19, 2021 (retrieved on April 21, 2022; at the time of publication this information was not retrievable anymore, and the graphic was updated with Fig. 4). It is likely that these "CAP tools" referred to eco-schemes (see more below).

Fig. 1. The 9 CAP 2020 Key Objectives focus on social, environmental, and economic goals as basis upon which EU countries design their individual CAP Strategic Plans.

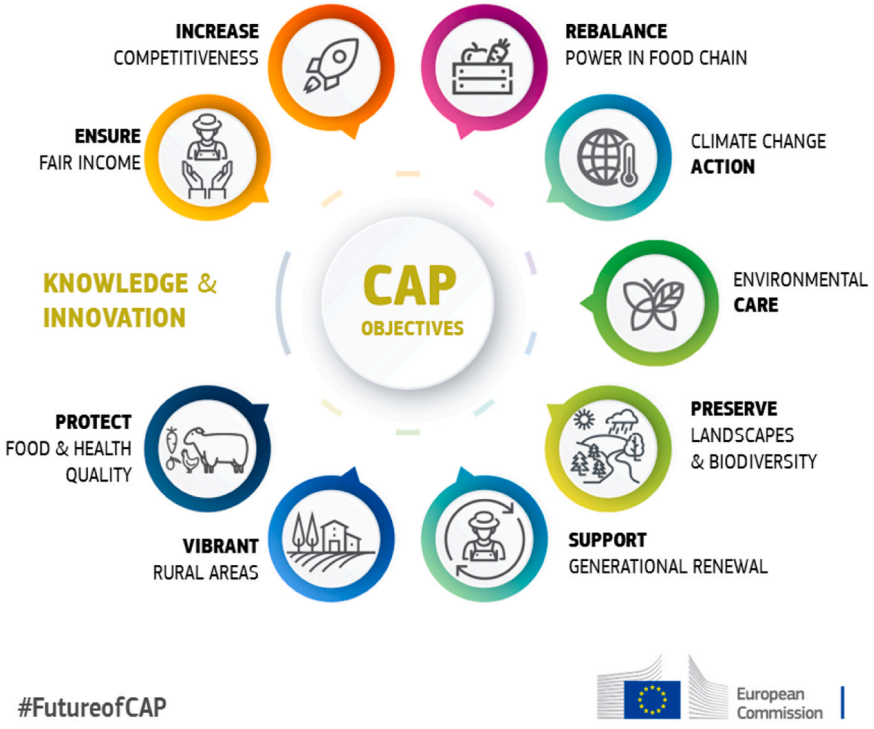

Fig. 2. The 9 Key Objectives of CAP for member states' CAP strategic plans (2021–27) in a tweet by DG AGRI from June 2019).

of implementing environmental measures onto MS, and, while not explicitly mentioning eco-schemes, added:

"Still promoting techno-fixes: 'sustainable practices, such as precision agriculture' 'new technologies and scientific discoveries'. The current #precisionagriculture agenda is not sustainable, and cannot be compared with #agroecology. We need a paradigm shift, not techno-fixes" (FN_191211).

This listing of a variety of agricultural approaches was also prominent in a talk by CEO of the French *Institut national de la recherche agronomique* (INRA) Philippe Mauguin, who explained that an agro-ecological project for Europe that looks at the economic and social implications of agriculture is only possible through a combined approach, of biotechnology, digital solutions, and agroecology (FN_191210).

After much criticism – and notably, to align a productivist CAP

Fig. 3. The 9 key objectives with a cross-cutting objective on digitisation, knowledge and innovation.

Fig. 4. The 10 key objectives of the CAP 2023–2027.

reform with an environmental policy-oriented Green Deal (Sotte and Vergamini, 2025, p. 228) – the list was expanded to twelve eco--schemes.[10] Consequently, 15 (of 27) MS alone submitted 161 eco-schemes in the first year of implementation, 2023 (Runge et al., 2022).

Several policy experts I interviewed were also critical of this combinatory approach. As a policy analyst for sustainable food systems explained:

"I was a bit concerned about the understanding that more and more people, organizations and institutions are having of the term agroecology, and also that sustainable agriculture is understood as digital agriculture and regenerative agriculture being assimilated as agroecology" (IV_200408).

The agroforestry representative cited earlier likewise noted this diversity:

"The word [agroforestry] appears in a sentence such as 'The Commission will support a higher uptake of sustainable practices such as precision agriculture, agroecology, agroforestry and organic farming.' The first thing they mention is precision agriculture" (IV_200512)

What they allude to is that agroecology and agroforestry are not approaches that can simply be extracted from holistic farming philosophies. Scientific credibility was another concern, as shared by a policy advisor for organic agriculture:

"genetic engineering methods, digitalization, precision farming, organic farming […] are placed side by side on an equal footing. However, only organic farming has so far been able to scientifically prove its advantages in relation to all environmental standards, while all other equivalent methods have not yet been able to do so" (IV_200211).

Numerous scientists have likewise criticized the inclusion of precision farming, for they lack benefits to biodiversity and favour monocultural landscape simplification for increased productivity (Cuadros Casanova et al., 2023; Heyl et al., 2023; Pe'er et al., 2022). Others noted that lacking ambitions and confusing regulations on eco-schemes (IEEP, 2022) can lead to "perverse subsidies" incentivizing the livestock sector and discouraging organic farming (Alabrese and Saba, 2023, p. 45; IFOAM EU, 2023). Indeed, highly technocratic sustainability measures may backfire when technocracy becomes both means and inhibitor to a sustainable agrifood system (Konefal, 2018). As Runge et al. (2022) note

[10] (1) Organic farming, (2) Integrated Pest Management, (3) Agro-ecology, (4) Husbandry and animal welfare, (5) Agro-forestry, (6) High nature value (HNV) farming, (7) Carbon farming, (8) Precision Farming, (9) Improve nutrient farming, (10) Protecting water sources, and (11) beneficial practices for soil and (12) GHG emissions (EC, 2021). Eco-schemes are amendable annually.

for eco-schemes: "By adding yet another policy instrument to the CAP's toolbox, the complexity of the policy" may risk that farmers "turn their back on the CAP and voluntarily forgo the cash benefits – not a good prospect for the environment either" (p. 25–26). This resounds two moments I witnessed during research: at a Foresight workshop on "Transformative Futures for Farmers and Rural Communities" organized by JRC and DG AGRI, working groups were given various future scenarios, among others the likeliness of "a complex world where everything is carefully measured to deliver sustainability in the most effective way", and an "opaqueness of the heavy compliance regimes, full of incessant rules and strict standards."[11]; Slightly related, at the earlier referenced EIT Food workshop, a participant suggested making agriculture subsidies "technology subsidies," since through technologies more sustainable goals can be reached (FN_191212).

As a number of scholars have pointed out, this combination rhetoric of "we need all solutions" reduces debates to technological innovation (Holt-Giménez and Shattuck, 2011, p. 133). Agroecology turns into "a narrow set of technologies, to offer some tools that appear to ease the sustainability crisis of industrial food production" without addressing that very production system (IFA, 2015, p. 164; Giraldo and Rosset, 2018, 2023; Levidow et al., 2014). It perpetuates a discourse of sustainable intensification where farmers are provided "a rich toolkit of relevant, adoptable and adaptable ecosystem-based practices" that require "every possible solution, including agroecology and biotechnologies" to reconcile higher productivity with environmental sustainability (FAO, 2009; cf. Levidow, 2018, p. 23; 2015). This promotion of "diverse and inclusive toolkit of innovations", e.g., of gene editing with agroecology, cultivates a complementarity politics fostering a neutral portrayal of technology that is stripped away from its history and politics to become transplantable into agroecological systems (Montenegro de Wit, 2022, p. 733) – reminiscent of what Walthall et al. (2024) call a portrayal of unrelated approaches as "false equivalence."

In EU agriculture policy, tools to fit a 'toolkit' or 'toolbox' have likewise become prominent buzzwords. At the EU Green Week in Brussels in May 2019, concerns over aligning the CAP with environmental policies were addressed by providing MS an "enhanced toolbox" with "the right mix of voluntary and mandatory measures" (Pierre Bascou, Director of the Sustainable Directorate/DG AGRI; FN_190516).[12] Here, a kind of *politics of toolkit diversity* promotes flexible agricultural toolkits for farmers, and flexible policy toolkits for MS. This politics is also evident in a missing, overarching vision of European agriculture:

"There are certain measures and certain funding schemes that farmers can use to help them either go towards agroecology or invest in precision farming but there's not really strong incentives or disincentives either way. We need this overarching framework that says here is where we're heading, but there's no… destination" (IV_200220).

An approach of 'anything goes' can also mean 'nothing at all,' and resonates with Via Campesina's statement that "[t]here is no coherent vision on EU policies, and there is no commitment to put in place stronger measures to comply with the Green Deal and the F2F strategy, and there is no real commitment to the paradigm shift that is so clearly needed to transition to sustainable agriculture" (European Coordination Via Campesina, 2021). What these actors describe exemplifies a "desperate modernity" where policymakers may conceive the issue's complexity, but no radical steps are made (Strand, 2002), thereby recreating an EU "culture of no culture" (Waterton and Wynne, 1996). The following passages of the Webinar "Food Security & Climate Change post-COVID: Improving the sustainability of EU Agriculture" that took place in June 2020[13] is indicative.

Tassos Haniotis, then Director for Strategy, Simplification and Policy Analysis at DG AGRI, shared that there is a need to account for diverse soil conditions across Europe, adding that at EU Agriculture Outlook conferences they presented agroecological, conventional, and organic farming practices as equally important approaches to improve soil health. Later, CEO of Syngenta Erik Fyrwald shared:

"Farmers need the right input, the right seeds, the right fertilizer, the right crop protection. And that could be synthetic chemistry combined with biologicals. They need precision agriculture technology with imaging to help them focus where the problems are, cover crops, crop rotations. I mean, there are so many *tools* that we can bring to farmers to help them achieve the objectives that all of us [Syngenta, the government, NGOs] have. And I think we've been too polarized, but if we can come together and say: what is the real aim here? Feed people with healthy food, with safe food, and address climate change, and *what are all the tools*, and how can we make those tools available to farmers" (FN_200630).

Haniotis' account exemplifies a common slippery framing in EU agriculture policy where a diversity of (farming) conditions are addressed with a diversity of farming philosophies – i.e., a lack of fertility requires a conventional approach compared to, say, an organic approach. Fyrwald then renders the diverse farming approaches – again – as 'tools,' calling for industry, government and NGOs to work together, while disguising the (agricultural and power) differences of those 'tools' and institutions. In the spirit of the boundary term sustainability, both speakers pleased everyone in their own agricultural pathways, reflecting a fractured vision of European agriculture.

Here is another indicator of a politics of toolkit diversity: it is not only the combination of diverse farming practices, as scholars above describe, but a kind of right of existence in parallel, where policymakers can please every MS with their preferred agricultural approaches without stepping on anyone's toes; the vagueness of sustainability mirrors the vagueness of the EU as political union. EU agriculture policy exhibits a politics of toolkit diversity by rendering holistic systems, like agroecology, as technical approach, to corroborate a false equivalence of 'tool-equals' that fit into (agriculture and policy) 'toolkits.' Such politics serve an increasingly diversified EU, where MS can define and execute their own 'sustainable' paths (through eco-schemes). While their environmental effects are questionable, the EU succeeds – at least for now – to cohere an agricultural political union of 27 MS through technocratic means.

5. Concluding discussion

As the article set out to ask how EU policymakers envision (digital) technology, innovation and science to foster what kind of sustainable agriculture, and how these visions are co-produced with Europe as political union, this concluding discussion syncretizes how agriculture is *made* sustainable in two correlating, seemingly contradictory processes, and what this means for alternative visions of sustainable agriculture.

Rather than attempting to define sustainability (Stirling, 1999), it is insightful to approach it as a context-dependent process (Buttel, 2006) and "useful metaphor of the contemporary world" (Benessia and Funtowicz, 2015, p. 332). This article turns to the world of EU agriculture policy at a time of well-meant environmental measures – the Green Deal, Twin transition – and efforts to deal with an increasingly decentralized, political union. Considering sustainability as a boundary term reveals

[11] Together with around 40 experts, I was invited to participate in two workshops in September 2022 and March 2023 (results were published in Barabanova and Krzysztofowicz, 2023). The cited document is in my possession.

[12] It is likely that these measures were precursors of the eco-schemes introduced towards the end of 2019.

[13] The webinar was organized by the European news portal EURACTIV and the agritech corporation Syngenta: https://www.youtube.com/watch?v=CvuoCH2aXzY. It also sparked critique as "[a]nother corporate media event" https://x.com/nina_holland/status/1277945227270119424; (both accessed October 1, 2024).

that it is inherently "contested, ambiguous, and vague" (Scoones, 2007, p. 594), allowing a focus on how powerful actors attempt to make it *less* ambiguous and contested. A prominent strategy is to 'balance trade-offs' of the three pillars which is highly value-driven (Purvis et al., 2019; Pretty, 1994): a strategy that is embedded in EU's technoscientific optimism, which can cohere arguments (Joerges and Neyer, 1997; Turnhout et al., 2014), and the economic base of sustainability itself despite, and exactly because it is framed as one of three pillars (Purvis et al., 2019).

While in the EU twinning discourse digitization has become a panacea for reaching 'sustainability,' in agricultural policy, it more so dovetails with similar promissory rhetorics of science, technology and innovation. Yet rather than acting as technological fixes or silver bullets for sustainability (Giraldo and Rosset, 2023, Lajoie-O'Malley et al., 2020), the discursive framing of science, digitization/technology and innovation (SDTI) is more lively; as agile facilitators, they 'catalyse'/'accelerate'/'enable' sustainability by 'reconciling' its three pillars. As such, they form *fixtures* that hold together the 'holy trinity of sustainability,' and with it long-held EU values that (presumably) stand in tension with each other (Elton, 2010; Kleinman and Kinchy, 2003): of pristine landscapes and rural life (the social), welfarism and global competitiveness (economic), and ecologically sound practices (environment). This is for instance evident in the visualization of the Key Objectives of the recent CAP reform gradually held together through research/technology/innovation/digitization (see Figs. 1- 4). And rather than a 'sustainable transition', a discursive transition is underway: towards a *technoscientific sustainability* where the rendering of farming knowledge into quantifiable information via digital gadgets, technological innovation and scientization is both the precondition and logical result of EU agriculture policy: a technocratic EU needs technoscientific data. Here, SDTI is understood as something outside small- and medium-scale farmers' realms which they ought to 'take up' (see EC, 2019b). But what could sustainable agriculture grounded in farmers' and grassroots' epistemologies, innovations and (digital) technology development (Chiffoleau and Loconto, 2018; Grassroots Innovation Assembly, 2023; Fairbairn, 2025) look like?

Combining such approaches with more conventional (high-tech) farm systems are commendable, but such 'diversity' is not apolitical. The paper next analyzes such attempts in the case of eco-schemes which were introduced as part of the Green Deal's Farm-to-Form Strategy to enhance sustainable agriculture. Spanning from agroforestry to precision farming, MS are to create a 'catalogue' of eco-schemes, resembling a complementarity politics of neutral, apolitical portrayals of technology to become transplantable into agroecological systems (Montenegro de Wit, 2022, p. 733). In EU agriculture policy, a *politics of toolkit diversity* emerges where holistic farming approaches and philosophies, like agroforestry, are rendered as neat, decontextualized 'tools' of choice, ready to dovetail with other approaches, or, to exist in parallel. While such politics evade an overarching destination of where European sustainable agriculture is heading, eco-schemes (Pe'er et al., 2022) and an increasing emphasis on digitization (Fairbairn, 2025) effectively perpetuate monocultural landscapes, and with that monocultural visions of agriculture.

How does a more standardizing technoscientific sustainability and a politics of diversity correlate? Scientific epistemology, technical quantification and innovation can act as a discursive *fixture* that holds together both the holy trinity of sustainability, and the political union, by disciplining arguments in policy debates and facilitating social and economic advancements (see Frahm et al., 2022; Waterton and Wynne, 1996). In an increasingly decentralized EU, 'diversity' has political weight, for it allows avoiding stepping on anyone's toes, while essentially moving away from compliance (with environmental targets) towards results and performance, as is the case with eco-schemes (European CAP Network, 2023, p. 2). Counter to what policymakers often claim, the 'diversity' of agricultural approaches does not always reflect Europe's diverse landscapes; a common slippage is one where a diversity of (farming) conditions is addressed with a diversity of farming philosophies – i.e., a lack of fertility requires a conventional approach, while a lack of biodiversity requires, say, an agroforestry approach. Eco-schemes, just as much as sustainability, remain 'sufficiently vague' (Daly, 2014), and MS can pick and choose their more-or-less large-scale industry-inducing, high-tech-promoting measures with more-or-less environmentally conducive effects (Alabrese and Saba, 2023; Runge et al., 2022). These 'tools,' then, become cohering forces of a technoscientific sustainability that is co-produced with a vision of a unified, while increasingly decentralized European Union.

A trend is observable where for any EU farmer to count as 'sustainable' means submitting to a technoscientific knowledge regime and its instruments, such as "data schemes" that reward farmers for using specific technologies and sharing data (Barabanova and Krzysztofowicz, 2023, p. 41). The same EU report acknowledges that farmers and rural communities should "have a voice, agency, and control over their own digital transition", including "the right to not go digital and still thrive" (p. 31; see also D4S, 2022). This is because other forms of sustainable farming that are not measured or measurable – e.g., by farmers who do not depend on EU subsidies[14] – simply remain illegible. That farmers have expertise on how to 'enhance' biodiversity or 'mitigate' climate change acquired over several decades falls out of any policy measures, simply because policymakers had not cared about this previously. This "technology trap" in EU policy (van der Velden 2025) reflects a 'high--tech-tunnel vision' that is evident in the vast majority of EU agriculture policy papers, reports and presentations that prioritize digital, heavy-tech solutions (e.g., breeding technologies), while only slowly acknowledging the need for alternative, smaller-scale farming technologies (SCAR, 2023; p. 23; see also Grassroots Innovation Assembly, 2023; Scoones, 2016, p. 302).

Yet merely adding more stakeholders 'into the mix,' similar to decontextualized farming approaches in eco-schemes, does not work, such as the case of the "EU Agri-Digital Conference" illustrates, where critiques of the increasing digitization as exclusive path are simply levelled. As Scoones (2016) notes, the implication of novel technologies "will depend on wider politics—whether embedded in market-, state-, or citizen-led processes" (p. 304), and thus determine if and what alternative technologies emerge from within grassroots innovation (p. 302) – instead of SDTI being framed as outside adoptions. For organic farmers' or agroecology representatives bringing into the European political arena their own visions of 'sustainability'[15]; requires constituting their own co-production pathways of identity and discourse making (Iles et al., 2017, p. 957–961). This requires a broad, participatory and collaborative agenda that includes researchers, citizens and farmers (Gugganig et al. 2023; Levidow et al., 2014; Pe'er et al., 2019; SCAR, 2023; Walthall et al., 2024). Initiatives like the Strategic Dialogue (EC, 2024) are promising, as they promote long-term engagement of diverse actors and cultivate more nuanced images to policymakers: of what sustainable agricultural futures are aspired, and how these processes constitute a political union based on, and in, wider deliberation than technocratic measures. Just as 'tools' in policy or agriculture toolkits, not all involved actors are equal, and power relations need to be accounted for.

[14] At the presentation of the "Strategic Dialogue" to the European Parliament on October 14, 2024, the president of "Agroecology Europe" Lili Balogh shared that 30 % of European farmers do not receive any CAP subsidies, a severely understudied topic. https://multimedia.europarl.europa.eu/en/webstreaming/committee-on-agriculture-and-rural-development_20241014-1500-COMMITTEE-AGRI (accessed October 14, 2024).

[15] See for instance IFOAM's "Best Practice Guideline for Agriculture and Value Chains" (SOAAN, 2013) where sustainable agriculture considers ecology, society and economy in a wider sense, and includes "culture" and "accountability" as fourth and fifth pillar.

Author statement

I declare that I have not submitted or published the article, or parts of the article elsewhere, and there is no conflict of interest.

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Mascha Gugganig: Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Data availability

The data that has been used is confidential.

References

Alabrese, M., and A. Saba (eds.). 2023. "EU Law on Sustainable and Climate Resilient Agriculture after the European Green Deal." Rurinnova.

Barabanova, Y., Krzysztofowicz, M., 2023. "Digital Transition: Long-term Implications for EU Farmers and Rural Communities. Publications Office of the European Union, Luxembourg, 10.2760/093463, JRC134571.

Barry, A., 2006. Technological zones. Eur. J. Soc. Theory 9 (2), 239-235.

Benessia, A., Funtowicz, S., 2015. Sustainability and techno-science: what do we want to sustain and for whom? Int. J. Sustain. Dev. 18 (4), 329. https://doi.org/10.1504/IJSD.2015.072666.

Benessia, A., Funtowicz, S., Bradshaw, G., Ferri, F., Ráez-Luna, E.F., Medina, C.P., 2012. Hybridizing sustainability: towards a new praxis for the present human predicament. Sustain. Sci. 7, 75–89.

Bronson, K., 2019. Looking through a responsible innovation lens at uneven engagements with digital farming. NJASWagening. J. Life Sci. 90, 100294.

Buckwell, A., A. Nordang Uhre, A. Williams, J. Polakova, W. Blum, J. Schiefer, G. Lair, A. Heissenhuber, P. Schießl, and Ch Krämer. 2014. "Sustainable Intensification of European Agriculture."

Buttel, F.H., 2006. Sustaining the unsustainable: agro-food systems and environment in the modern world. Handb. Rural Stud. 213–229.

Chiffoleau, Y., Loconto, A.M., 2018. Social innovation in agriculture and food. Int. J. Sociol. Agric. Food 24 (3), 306–317.

Commission of the European Communities, 1999. "Directions towards sustainable agriculture. Brussels. January 27.

Creswell, J., Plano Clark, V., 2011. Designing and Conducting Mixed Methods Research. Thousand Oaks, Second ed. Sage, CA.

Cuadros-Casanova, I., Cristiano, A., Biancolini, D., Cimatti, M., Sessa, A.A., Mendez Angarita, V.Y., Dragonetti, C., Pacifici, M., Rondinini, C., Di Marco, M., 2023. Opportunities and challenges for common agricultural policy reform to support the european Green deal. Conserv. Biol. 37 (3), e14052. https://doi.org/10.1111/cobi.14052.

Daly, H.E., 2014. Beyond Growth: The Economics of Sustainable Development. Beacon Press.

De Castro, P., Miglietta, P.P., Vecchio, Y., 2020. The common agricultural policy 2021-2027: a new history for european agriculture. Riv. Di Econ. Agrar. 75, 5–12.

Digitalization for Sustainability (D4S), 2022. dIgital Reset. Redirecting Technologies for the Deep Sustainability Transformation. Policy report. TU Berlin, Berlin. https://doi.org/10.14279/depositonce-16187.

Directorate-General for Agriculture and Rural Development (DG AGRI), 2018a. Strategic plan 2016-2020. European Commission, Brussels.

Directorate-General for Agriculture and Rural Development (DG AGRI), 2018b. 2018 Annual Activity Report. European Commission, Brussels.

Duncan, E., Glaros, A., Ross, D.Z., Nost, E., 2021. New but for whom? Discourses of innovation in precision agriculture. Agric. Hum. Values 38 (4), 1181–1199. https://doi.org/10.1007/s10460-021-10244-8.

Elton, C., 2010. Paradigm change within the CAP 1985-92: the european Commission's construction of an alternative policy narrative in the late 1980s. J. Eur. Integr. Hist. 16 (2), 103–123. https://doi.org/10.5771/0947-9511-2010-2-103.

EURACTIV's Agrifood Team. 2023. "CAP Tracker: Lessons from the Ground. ⟨https://en.euractiv.eu/section/agriculture-food/linksdossier/cap-tracker-lessons-from-the-ground/#policy-title-4⟩ (accessed September 29, 2024).

European CAP Networks. 2023. Putting the Evaluation Pieces in Place to Assess the Next CAP's Performance. ⟨https://eu-cap-network.ec.europa.eu/news/putting-evaluation-pieces-place-assess-next-caps-performance_en⟩. Blogpost. July, 28 (accessed October 1, 2024).

European Commission. 2014. "Farming for Natura 2000: Guidance on how to support Natura 2000 farming systems to achieve conservation objectives, based on Member States good practice experiences." Brussels.

European Commission. 2018. "Proposal for a Regulation of the European Parliament and of the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) […]" Brussels, June, 1.

European Commission, 2019a. "Towards a sustainable Europe by 2030." Reflection Paper. EU Publications Office Luxembourg.

European Commission, 2019b. "Bulding Stronger Agricultural Knowledge and Innovation Systems (AKIS) to foster advice, knowledge and innovation in agriculture and rural areas." Brussels.

European Commission, 2021. "List of potential AGRICULTURAL PRACTICES that ECO-SCHEMES could support." Brussels.

European Commission. 2020. "Farm to Fork Strategy: For a Fair, Healthy and Environmentally-friendly Food System." Brussels.

European Commission. 2023. "Report from the Commission to the European Parliament and the Council: Summary of Cap Strategic Plans For 2023-2027: Joint Effort and Collective Ambition." November 23.

European Commission. 2024. "Strategic Dialogue on the Future of EU Agriculture." ⟨https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/main-initiatives⟩- strategic-dialogue-future-eu-agriculture_en.

European Coordination Via Campesina. 2021. "The Trade Policy Review and the CAP Reform: Incongruences and Incoherencies." Blogpost. ⟨https://viacampesina.org/en/the-trade-policy-review-and-the-cap-reform-incongruences-and-incoherencies/⟩ (accessed September 25, 2024).

European Parliament. 2023. "Financing of the CAP: Facts and Figures". ⟨https://www.europarl.europa.eu/factsheets/en/sheet/106/financing-of-the-cap⟩.

Fairbairn, M., Faxon, H.O., Montenegro de Wit, M., et al., 2025. Digital agriculture will perpetuate injustice unless led from the grassroots. Nat. Food. https://doi.org/10.1038/s43016-025-01137-8.

Felt, U., 2007. Science and governance: taking european knowledge society seriously. rapporteur. European Commission, Brussels. EUR 22700.

Foucault, M., 1994. "Truth and Power". In: Faubion, J. (Ed.), Power: essential works of Foucault, 1954-1984. Penguin, London.

Frahm, N., Doezema, T., Pfotenhauer, S., 2022. Fixing technology with society: the coproduction of democratic deficits and responsible innovation at the OECD and the european commission. Sci. Technol. Hum. Values 47 (1), 174–216. https://doi.org/10.1177/0162243921999100.

Giraldo, O.F., Rosset, P.M., 2018. Agroecology as a territory in dispute: between institutionality and social movements. J. Peasant Stud. 45 (3), 545–564.

Giraldo, O.F., Rosset, P.M., 2023. Emancipatory agroecologies: social and political principles. J. Peasant Stud. 50 (3), 820–850. https://doi.org/10.1080/03066150.2017.1353496.

Goldstein, J., Nost, E., 2022. The Nature of Data: Infrastructures, Environments, Politics. U of Nebraska Press.

Grant, W., 2010. Policy instruments in the common agricultural policy. West Eur. Polit. 33 (1), 22–38. https://doi.org/10.1080/01402380903354049.

Grassroots Innovations Assembly 2023. Visual Report ⟨https://www.scholacampesina.org/grassroot_innovation_assembly_report/⟩ (accessed September 1, 2024).

Gugganig, M., 2023. Brussels, Food Innovation Workshop, 2019. In: Elliott, D., Wolf-Meyer, M.J. (Eds.), Naked Fieldnotes: A Rough Guide to Ethnographic Writing. Minneapolis, University of Minnesota Press.

Gugganig, M., Burch, K.A., Guthman, J., Bronson, K., 2023. Contested agri-food futures: Introduction to the Special Issue. Agr Hum Values. 40, 787–798.

Hart, K., 2015. Green Direct Payments: Implementation Choices of Nine Member States and Their Environmental Implications. IEEP London.

Heyl, K., Ekardt, F., Roos, P., Garske, B., 2023. Achieving the nutrient reduction objective of the farm to fork strategy. An assessment of CAP subsidies for precision fertilization

and sustainable agricultural practices in Germany. Front. Sustain. Food Syst. 7. https://doi.org/10.3389/fsufs.2023.1088640.
Holt-Giménez, E., Shattuck, A., 2011. Food crises, food regimes and food movements: rumblings of reform or tides of transformation? J. Peasant Stud. 38 (1), 109–144. https://doi.org/10.1080/03066150.2010.538578.
Iles, A., Graddy-Lovelace, G., Montenegro, M., Galt, R., 2017. Agricultural systems: Co-producing knowledge and food." in. In: Felt, U., Fouché, R., Miller, C., Smith-Doerr, L. (Eds.), Handbook of Science and Technology Studies, 4th ed. MIT Press, Cambridge, pp. 943–972.
Institute for European Environmental Policy (IEEP). 2022. The Eco-Schemes in the New CAP Strategic Plans. Presentation. ⟨https://ec.europa.eu/enrd/sites/default/files/1_midler.pdf⟩.
International Federation of Organic Agriculture Movements Europe (IFOAM EU). 2023. Evaluation of Support for Organic Farming in Draft CAP Strategic Plans (2023-2027). Report.
International Forum for Agroecology (IFA). 2015. "Declaration of the International Forum for Agroecology, Nyéléni, Mali: 27 February 2015." Development 58, no. 2 (June 1, 2015): 163–168. https://doi.org/10.1057/s41301-016-0014-4.
Jasanoff, S., 2004. States of knowledge. Taylor & Francis, Abingdon, UK.
Jasanoff, S., 2005. Designs on Nature: Science and Democracy in Europe and the United States. Oxford and cambridge. Princeton University Press.
Joerges, C., Neyer, J., 1997. Transforming strategic interaction into deliberative Problem-Solving: european comitology in the foodstuffs sector. J. Eur. Public Policy 4 (4), 609–625. https://doi.org/10.1080/135017697344091.
Kleinman, D.L., Kinchy, A.J., 2003. Boundaries in science policy making: bovine growth hormone in the european union. Sociol. Q. 44 (4), 577–595.
Konefal, J., 2018. Fault lines in agricultural sustainability: contestation, cooptation, reform, and transformation. In: Konefal, T.Jason, Douglas, H., Maki, Hatanaka (Eds.), Contested Sustainability Discourses in the Agrifood System. Routledge.
Kovacic, Z., C.G. Casañas, L. Argüelles, P. Yáñez Serrano, R. Ribera-Fumaz, L. Prause, and H. March. 2024. "The Twin Green and Digital Transition: High-Level Policy or Science Fiction?" Environment and Planning E: Nature and Space, June, 25148486241258046. https://doi.org/10.1177/25148486241258046.
Lajoie-O'Malley, A., Bronson, K., van der Burg, S., Klerkx, L., 2020. The future(s) of digital agriculture and sustainable food systems: an analysis of high-level policy documents. Ecosyst. Serv. 45, 101183.
Latour, B., 1987. Science in Action: How to Follow Scientists and Engineers through Society. Harvard University Press, Cambridge.
Latour, B., 1993. We Have Never Been Modern. Harvard University Press, Cambridge, MA.
Laurent, B., 2022. European objects. The Troubled Dreams of Harmonization. MIT Press.
Leach, M., Stirling, A.C., Scoones, I., 2010. Dynamic sustainabilities: technology. Environment, Social Justice. Taylor & Francis.
Lélé, S.M., 1991. Sustainable development: a critical review. World Dev. 19 (6), 607–621.
Levidow, L., 2018. Sustainable intensification: agroecological appropriation or contestation? In: Douglas, H., Konefal, Jason, T. (Eds.), Contested Sustainability Discourses in the Agrifood System. Earthscan Food and Agriculture. Routledge/Earthscan, London, pp. 19–41.
Levidow, L., Birch, K., Papaioannou, T., 2013. Divergent paradigms of european agro-food innovation: the knowledge-based bio-economy (KBBE) as an R&D agenda. Sci. Technol. Hum. Values 38 (1), 94–125.
Levidow, L., Pimbert, M., Vanloqueren, G., 2014. Agroecological research: Conforming—or transforming the dominant Agro-Food regime? Agroecol. Sustain. Food Syst. 38 (10), 1127–1155. https://doi.org/10.1080/21683565.2014.951459.
Matthews, A., 2013. Greening agricultural payments in the EU's common agricultural Policy. Bio Based App. Eco. 2 (1), 1–27.
Meeus, J.H.A., Wijermans, M.P., Vroom, M.J., 1990. Agricultural landscapes in Europe and their transformation. Landsc. Urban Plan. 18 (3–4), 289–352.
Milward, A., 1999 [1992]. Edition). London. In: The European Rescue of the Nation State. Routledge.
Montenegro De Wit, M., 2022. Can agroecology and CRISPR mix? The politics of complementarity and moving toward technology sovereignty. Agric. Hum. Values 39 (2), 733–755. https://doi.org/10.1007/s10460-021-10284-0.
Muench, S., Stoermer, E., Jensen, K., Asikainen, T., Salvi, M., Scapolo, F., 2022. Towards a Green and digital future. Publications Office of the European Union, Luxembourg doi:10.2760/977331, JRC129319.
Nemes, G., Augustyn, A.M., 2017. Towards inclusive innovation in the european context–the innovation capacity of alternative networks for sustainable agriculture. Innov. Dev. 7 (1), 133–152.
Pe'er, G., Zinngrebe, Y., Moreira, F., Sirami, C., Schindler, S., Müller, R., Bontzorlos, V., et al., 2019. A greener path for the EU common agricultural policy. Science 365 (6452), 449–451. https://doi.org/10.1126/science.aax3146.
Pe'er, G., Finn, J.A., Díaz, M., Birkenstock, M., Lakner, S., Röder, N., Kazakova, Y., et al., 2022. How can the european common agricultural policy help halt biodiversity loss? Recommendations by over 300 experts. Conserv. Lett. 15 (6), e12901. https://doi.org/10.1111/conl.12901.
Pereira, Â.G., Curvelo, P., 2015. Editorial: in the name of sustainability. Int. J. Sustain. Dev. 18 (4), 247. https://doi.org/10.1504/IJSD.2015.073695.
Pfotenhauer, S., Jasanoff, S., 2017. Panacea or diagnosis? Imaginaries of innovation and the 'MIT Model' in three political cultures. Soc. Stud. Sci. 47 (6), 783–810. https://doi.org/10.1177/0306312717706110.
Polzin, C., 2024. The role of visions in sustainability transformations: exploring tensions between the agrarwende vanguard vision and an established sociotechnical imaginary of agriculture in Germany. Glob. Environ. Change 84, 102800.
Pretty, J., 1994. Alternative Systems of Inquiry for a Sustainable Agriculture. Ids bulletin 25 (2), 37–48.
Purvis, B., Mao, Y., Robinson, D., 2019. Three pillars of sustainability: in search of conceptual origins. Sustain. Sci. 14 (3), 681–695. https://doi.org/10.1007/s11625-018-0627-5.
Runge, T., Latacz-Lohmann, U., Schaller, L., Todorova, K., Daugbjerg, Carsten, Termansen, Mette, Liira, Jaan, et al., 2022. Implementation of Eco-schemes in fifteen european union member states. EuroChoices 21 (2), 19–27. https://doi.org/10.1111/1746-692X.12352.
Samper, J.A., Schockling, A., Islar, M., 2021. Climate politics in Green deals: exposing the political frontiers of the european Green deal. Polit. Gov. 9 (2), 8–16.
Scoones, I., 2007. Sustainability. Dev. Pract. 17 (4–5), 589–596. https://doi.org/10.1080/09614520701469609.
Scoones, I., 2016. The politics of sustainability and development. Annu. Rev. Environ. Resour. 41 (1), 293–319. https://doi.org/10.1146/annurev-environ-110615-090039.
Scott, D., 2011. The technological fix criticisms and the agricultural biotechnology debate. J. Agric. Environ. Ethics 24, 207–226.
Simoncini, R., Ring, I., Sandström, C., Albert, C., Kasymov, U., Arlettaz, R., 2019. "Constraints and opportunities for mainstreaming biodiversity and ecosystem services in the EU's common agricultural policy: insights from the IPBES assessment for Europe and Central Asia.". Land Use Policy 88, 104099.
Towards the CAP 2014-2020. In: Sotte, F., Arcuri, S., Sotte, F., Arcuri, S. (Eds.), 2025. European Agricultural Policy: History and Analysis. Springer, pp. 149–168.
Sotte, F., Brunori, G., 2025. European agricultural policy: history and analysis. Springer.
Sotte, F., Moretti, M., 2025. Fischler's first attempt to reform the CAP. In: Sotte, In.F., Brunori, G. (Eds.), European Agricultural Policy: History and Analysis. Springer, pp. 93–118.
Sotte, F., Vergamini, 2025. The Green deal and the CAP 2023-2027. In: Sotte, In.F., Brunori, G. (Eds.), European Agricultural Policy: History and Analysis. Springer, pp. 219–236.
Standing Committee on Agricultural Research (SCAR). 2023. The Agroecology Partnership's SRIA. ⟨https://scar-europe.org/images/Agroecology/SRIA_rev23-02-2023.pdf⟩.
Stirling, A., 1999. The appraisal of sustainability: some problems and possible responses. *local*. Environment 4 (2), 111–135.
Strand, R., 2002. Complexity, ideology, and governance. Emergence 4 (1–2), 164–183. https://doi.org/10.1080/15213250.2002.9687743.
Sustainable Organic Agriculture Action Network (SOAAN) 2013. Best Practice Guideline For Agriculture And Value Chains. Bonn.
Tanaka, K., Juska, A., 2010. Technoscience in agriculture: reflections on the contributions of the MSU school of sociology of food and agriculture. J. Rural Soc. Sci. 25 (3), 3.
Tulloch, L., 2013. On science, ecology and environmentalism. Policy Futures Educ. 11 (1), 100–114. https://doi.org/10.2304/pfie.2013.11.1.100.
Turnhout, E., Neves, K., De Lijster, E., 2014. Measurementality' in biodiversity governance: knowledge, transparency, and the intergovernmental Science-Policy platform on biodiversity and ecosystem services (Ipbes). Environ. Plan. A Econ. Space 46 (3), 581–597. https://doi.org/10.1068/a4629.
Völker, T., Pereira, Â.G., 2023. What was that word? It's Part of ensuring its future Existence' exploring engagement collectives at the european Commission's joint research centre. Sci. Technol. Hum. Values 48 (2), 428–453. https://doi.org/10.1177/01622439211046049.
Von der Leyen, U., 2019. A union that strives for more: my agenda for Europe. Political Guidel. Eur. Comm. 2019–2024.
Walthall, B., Vicente-Vicente, J.L., Friedrich, J., Piorr, A., López-García, D., 2024. "Complementing or Co-Opting? applying an integrative framework to assess the transformative capacity of approaches that make use of the term Agroecology.". Environ. Sci. Policy 156, 103748.
Waterton, C., Wynne, B., 1996. Building the european union: science and the cultural dimensions of environmental policy. J. Eur. Public Policy 3 (3), 421–440. https://doi.org/10.1080/13501769608407042.
Wynne, B., 1996. "Misunderstood misunderstandings: social identities and public uptake of science.". In: Irwin, A., Wynne, B. (Eds.), Misunderstanding Science? The Public Reconstruction of Science and Technology. Cambridge University Press, Cambridge.
Zwaan, P., Alons, G., 2015. Legitimating the CAP: the european Commission's discursive strategies for regaining support for direct payments. J. Contemp. Eur. Res. 11 (2).