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HOW DO WE EVALUATE AND GIVE ECONOMICAL VALUES TO ORGANIC FARMING AND FOOD EXTERNALITIES?

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Abstract: In addition to producing food, farming also generates negative externalities (costs) or positive externalities (benefits or amenities) that financial markets do not take into account. These externalities have taken more and more importance in social expectations. Several public tools tend to take them into account, and market initiatives tend also to reveal them and give them value.

The question of quantifying externalities of organic farming (OF) is an old one. There has been numerous papers in different countries producing multi-criteria assessment. Nevertheless very few of them have tried to give economical values to these externalities in the context of promoting new tools in the future CAP, namely payment for environmental services.

Our methodology consisted in identifying, qualifying, quantifying and assigning economic values, when possible, for environmental and social externalities differentials between OF and conventional farming (CF).

Our results show that OF generates positive externalities differentials on very large items, with a few points to improve, and a concerning point about productivity that impacts some indicators like land use. This analysis gives not only a summary of established knowledge but also identifies points where knowledge gaps need to be filled or which are controversial, and points methodological difficulties, in particular i) the use of a conventional repository, which evolves, and which can be very territorial dependent, but also ii) the difficulty of establishing causalities between practices and ecosystems services' bouquets, and iii) the problem of payment levels for farmer's practices when the services improvement can be a result of practices' management at different scales.

Introduction: Externalities occur when a production activity of one actor has a non-commercial influence (whether positive or negative) on the well-being of another, while this actor does not receive or give any money for this effect.

- For negative externalities (Fig1), we have analyzed differences between OF and CF impacts on environmental aspects (pollution, biodiversity loss, soil erosion, run-off and flooding, greenhouse gas emissions, consumption of non-renewable resources, etc), as well as on human health.

- For positive externalities (Fig 1), we have also analyzed both environmental and social aspects, including animal welfare. Determining the differential in environmental positive externalities between OF and CF required examining the level of ecosystem services provided by agroecosystems managed in OF or CF, such as those affecting the climate (soil carbon sequestration), biological regulation, or pollination.

Of course, practices are diverse among these two groups, and we had to take into account mean effects.

Material and methods: This study compiles scientific articles from agronomists, ecologists, zoological technicians, epidemiologists, toxicologists, economists, sociologists, etc. It is important to highlight the very interdisciplinary nature of our work, given the vast array of themes covered, as well as the different scales.
Around 300 references were taken into account until February 2020.

Results:
The literature agrees that there are fewer negative externalities in OF compared with CF: the most significant ones are tied to the ban on synthetic pesticides and, to a lesser extent, the ban on synthetic nitrogen fertilizers but also to the reduction of antibiotics used, and additives authorized.
Beyond specifications, certain practices are more widely deployed in OF such as more diversified cultivated or reared species on farms that lead to the production of certain types of externalities.

Environmental services
The effects that have been best quantified are those related to the pollution of water resources used to produce drinking water. The cost for society is real and high, and it has been demonstrated that preventative measures to reduce pollution at the source are less expensive than measures taken to treat water. After a first initiative in 2010, which was rejected, the EU Commission just approved in February 2020 the initiative of Eau de Paris which launched payment for economic services for producers that convert to OF (CPES Interreg). The payment will be effective when the water quality in terms of nitrate will improve. We see that this experimentation makes the payment move from a mean measure to a result obligation. However, this raises the question of collective practices, because only a significant conversion to OF in water catchment areas will allow a global benefit in terms of water treatment cost.

For biodiversity, the use of synthetic pesticides is well known to generate negative impacts (Francisco Sanchez-Bayo, Kris A.G. Wyckhuys, 2019). In the case of birds, even if the reduction of common farmland birds is not solely tied to the use of synthetic pesticides (habitat loss is a high factor), a part of this decline can still be attributed to these pesticides. Same for bees, whose population decline comes from a combination of stresses: chemical (pesticides), diseases and lack of feed. Some economical values have been proposed for instance for the pollination service at a macro level. But yet, we are not able to affect a percentage for the specific impact of the synthetic pesticides on the pollinators, as these phenomenon are synergetic.
In terms of biological regulation OF has certain advantages (Muneret et al., 2018). But converting this advantage into an individual payment for this service is difficult as this regulation is also very much linked to the landscape mosaic.

The level of carbon storage seems to be higher in OF especially thanks to the presence of more meadows in the rotations (Gattinger et al., 2012), but it is difficult to identify the potential for additional carbon storage that converting to OF would allow. Two levers exist: i) increasing the storage through mulch, cover crops ... and ii) plowing limitation.
In terms of payments, one difficulty is to be able to take into account some antagonist kinetics that can occur.

The thorny issue of productivity

Considering OF’s less productivity is challenging. Because of lower yields, converting from CF to OF assumes an increase in surfaces in order to produce the same quantity of food. An OF extension would be at the expense of ecosystems that are potentially rich in biodiversity and/or stored carbon. Advantages of OF due to its lower use of inputs are generally cancelled out by the lower crop yields, long breeding periods and lower individual animal productivity in OF. This results in sometimes poorer performance when calculations are made per unit of good produced (but not by hectare). However, a holistic approach must be adopted when analyzing the impact of lower productivity. Other major factors impacting land use have to be taken into account, in particular changes in our food diet (importance of animal products), non-food uses, food waste, etc (Müller et al, 2017; Poux and Aubert 2018).

Human Health

Because OF does not use synthetic pesticides and has a lower use of antibiotics for livestock, it reduces the human health risks by pesticide residue exposure through food and the development of antibiotic resistant bacteria. The effects of chronic synthetic pesticide exposure are better known and recognized, but they have still not been quantified. Concerning antibiotic resistance, while the benefit of OF is evident because of the antibiotic limitation use that it imposes, it remains difficult to quantify.

Regarding the nutritional composition of products, differences in the concentration of certain beneficial components (e.g. antioxidants, omega-3) between organic and conventional food products have been identified, but it is not currently possible to deduce a specific effect of these differences on human health. Long-term studies which analyze healths’ effects of organic food preferences are rare. The recent outcomes from BioNutrinet cohort shows that high organic food consumers exhibited better diet quality and have fewer problems with obesity and related diseases (Baudry et al., 2017).

Finally, the summary table (fig 2) highlights the numerous favorable effects of OF. However, the level of these benefits is not always easy to establish, and the economic values are often missing.

Discussion: Of course, these results have been revealed in contexts where OF is still not highly developed. Levels of ecosystem services are susceptible to evolve at the same time as OF will increase from 6% currently to 20% of agricultural area or more. An evolution of this kind could redefine OF’s performances. The meaning of certain evolutions is also to debate: for instance, the effects on pest populations could increase because of decreased insecticide use, or on the other hand could be reduced because of more global and efficient biological regulation.
This study has demonstrated the numerous benefits of OF that could justify financial support based on its proven advantages. However, the economic values are difficult to produce, and some authors believe that the usefulness of these monetary evaluations lies more in the societal awareness they can incite than in their calculation of precise economic figures. Trying to give economical values to environmental services is even controversial concerning the risk of monetarizing nature. But we can advocate a pragmatic approach based on the double observation that ecosystems are

degrading and that debates and decisions seem to be dominated by economics. Full cost accounting that incorporates i) external costs of farming and ii) value of ecosystem services into economic decision-making represents one way to provide guidance in a policy reform such as the following CAP.
The link with individual payments is complex because taking into account and managing ecological processes (water, biodiversity) cannot be done at the plot or farm scale, and requires coordination on a larger scale.

Another important point is that outside OF many initiatives are developing ("Zero pesticide residues", "Low carbon", "High Environmental Value", "Welfare Quality" ...). All these make OF/OC differentials evolve, and push OF to wonder about its own evolution: i) should OF evolve by adding additional labels (private specific labelling), or by an increased standard (evolution of the EU regulation)?, ii) how also to aim to limit productivity gap while conserving environmental assets ?

However, thinking about OF's contribution to the provision of ecosystem services also invites us to think about new mechanisms allowing their management (individual or collective) and their economic development, even to deeply rethink farming systems and agri-food systems.

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Image:

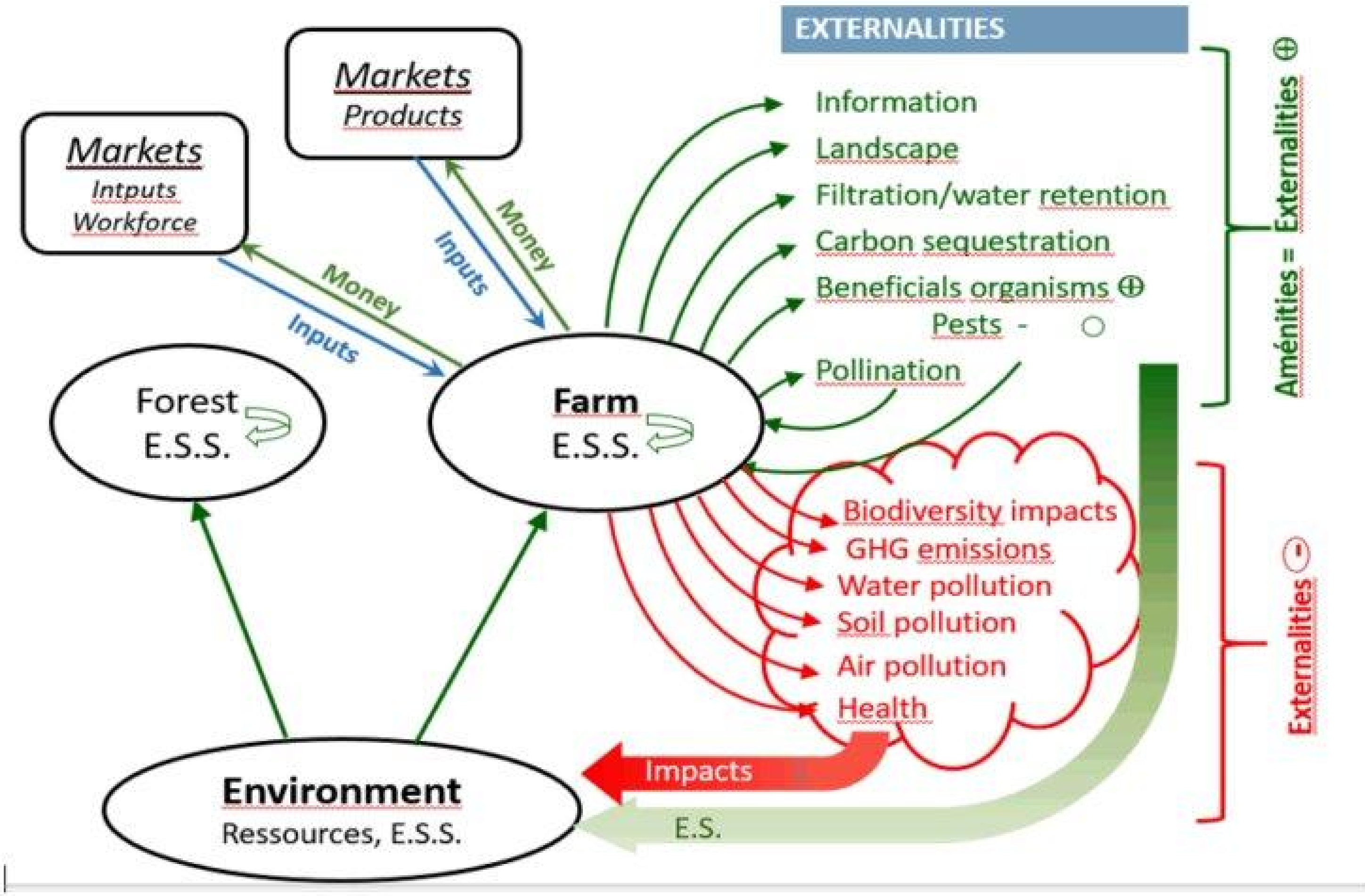

Fig 1. Representation of the positive and negative externalities that might be generated by farming *ESS: ecosystem services*
ES: environmental services (linked to the practices)

Image 2:

Data elements of the externality differentials between organic and conventional farming

	Components	Type of externality	Impact, service, resource used	Organic farming characteristic involved	Effect
	Cross-functional	Regulatory	Mechanisms for pesticide management	lower use of pesticides	
		Information	References produced for agro-ecology	requirements specification	
		Job creation	At the farm level	generally increased workforce	
ENVIRONMENTAL EXTERNALITIES	Soil	Less degradation of soil quality (physical, chemical and biological)	Physical degradation	more soil cover, less tillage	
			Acidification	more types of soil	
			Salinisation	lower use of pesticides	
			Toxification	lower use of pesticides	
				pay attention to copper	
			Eutrophication	fewer nitrogen and phosphorous inputs	
			Physical degradation	lower use of pesticides	
		More ecosystem services	Carbon sequestration	more grasslands, more legumes, more tillage	
			Water cycle regulation (retention)	more organic matter	
	Farming area	Resource	Land use (if the scale changing)	lower yields	
	Water	Resource	Water consumption	less irrigation	
		Fewer impacts on quality	Pesticide pollution	lower use of pesticides	
			Nitrate pollution	fewer nitrogen inputs	
	Air	Impacts on air quality	Particulate pollution, ammonia	?	
		GHG emissions	GSG emission levels	Lower levels of GSG emissions per hectare	
				GHG/kg is more variable	
	Fossil fuel	Consumption for production	Energy consumption report (LCA)	Lower levels of energy consumption per hectare	
				energy/kg is more variable	
		Downstream consumption	Trash, packaging, waste	?	
	Phosphorous	Resource consumption	Lower consumption		
	Biodiversity	Fewer negative externalities	Pesticide-related animal deaths (birds, fish, etc.)	less pesticide pollution	
			Impacts of nitrate on aquatic life	less nitrogen pollution	
			GMOs: reduction in # of crop varieties		
		More ecosystem services	Increased pollination service	little or no pesticides	
			Increased biological pest control	little or no pesticides	
HUMAN HEALTH	Negative impact of inputs	Little or no pesticides	Acute pesticide toxicity	little or no pesticides	
			Chronic toxicity (Parkinson's, cancer, etc.)	Uncertainty on the ratio due to pesticides for different diseases	
			Family suffering and disease		
		Nitrogen fertilisers	Toxicity of NOx nitrogen compounds and fine particles N_2O and NH_3	? / role of livestock in farming	
		Veterinary medicines	Development of antibiotic resistance	lower use of antibiotics	
		Additives	Risk of allergies	47 additives in organic farming vs. 300 in conventional	
	Nutrition	Sanitary quality	Microbiological contamination, mycotoxins, heavy metals, organic pollutants		
		Inputs	More of certain beneficial components	omega-3, antioxidants	
		Diet	Correlation with a healthier lifestyle		
ANIMAL WELFARE	Health Living conditions Pain management	Animal integrity	Fewer mutilations and greater use of analgesia	Requirements and consequences	
		Accessible area for animals	Free range: greater risk of predators		
			Grazing: more exposure to parasites but access to a variety of plants that help control parasites		
			Lower yield. Fewer parasites.		
			More space per animal in buildings, access to the outside		

Positive effect of organic farming — Positive effect of organic farming, but not systematic — Organic farming might have negative effects — Negative effect of organic farming

Positive externalities — Fewer negative externalities — Resource consumption

Disclosure of Interest: None Declared

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