POSITION PAPER

A Green Deal for implementing agroecological systems: Reforming the Common Agricultural Policy of the European Union

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1 Reasons for a fundamental redesign of agricultural systems

The rationale and ambition for a deep redesign of agricultural and food systems in Europe is developed in this paper and based on three main documents: The Treaty on the Functioning of the European Union (TFEU) (EU, 2016), the priorities of the European Commission for the future Common Agricultural Policy (CAP) (EC, 2018) for the 2021–2027 period, and the European "Green Deal" (EC, 2019). The major issues we hereby address are climate change adaptation and mitigation, management of natural resources, conservation and restoration of biodiversity and enhancement of ecosystem services, and economic and societal aspects. Then we outline essential components for an agroecological Green Deal in Europe.

1.1 Environmental dimension

Three major documents frame the future of farming and its relationships with environment in the European Union.

First, Article 191 of the TFEU states that "Union policy on the environment shall contribute to pursuit of the following objectives:

- preserving, protecting and improving the quality of the environment,

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- protecting human health,
- prudent and rational utilisation of natural resources,
- promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change".

Second, the European Commission summarised its priorities for the future CAP for the 2021–27 period in nine general objectives reflecting the economic, environmental and social importance of the policy:

1. Support viable farm income and resilience across the European Union (EU) territory to enhance food security;
2. Enhance market orientation and increase competitiveness including greater focus on research, technology and digitalisation;
3. Improve farmers' position in the value chain;
4. Contribute to climate change mitigation and adaptation, as well as to sustainable energy;
5. Foster sustainable development and efficient management of natural resources such as water, soil and air;
6. Contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes;
7. Attract young farmers and facilitate business development in rural areas;
8. Promote employment, growth, social inclusion and local development in rural areas, including bio-economy and sustainable forestry;
9. Improve the response of EU agriculture to societal demands on food and health, including safe, nutritious and sustainable food, as well as animal welfare.

Third, the European Green Deal recently recognised that "Food production still results in air, water and soil pollution, contributes to the loss of biodiversity and climate change, and consumes excessive amounts of natural resources, while an important part of food is wasted. At the same time, low quality diets contribute to obesity and diseases such as cancer" (EC, 2019).

Reaching the objectives of the TFEU and the priorities of the future CAP for the 2021–27 period requires a major change in the way agriculture is practiced and a reform of current policies for reducing the negative impacts identified in the European Green Deal.

Conditioning the level of financial support to European farmers to the area they use for their crops or grasslands and the animals they raise, from the budget of the 1st pillar of the CAP, while encouraging them to invest in powerful machinery and large infrastructure on the basis of the 2nd pillar budget, is far from being neutral with regards to the management of natural resources.

The agro-environmental and climatic measures of the 2nd pillar mitigate these effects, but in a very limited way (Kleijn et al., 2006; Pe'er et al., 2017, 2019, 2020). The final results remain largely negative for environmental quality and biodiversity. Biodiversity indicators, e.g. the common farmland bird index, continue to decline while the common forest species index is stable or increases (Pan-European Common Bird Monitoring Scheme, 2020; Pe'er et al., 2014). This situation is hardly surprising as these measures are applied to a modest part of the agricultural area (17 % of the agricultural area in EU27 excluding UK in 2018) (Agri-Food Data Portal, 2018) and only a limited part of these measures efficiently restore biodiversity, while the vast majority of the agricultural area remains hostile.

In the current "CAP vehicle", the 1st pillar acts like an accelerator of environmental degradation, while the 2nd pillar acts partially as a brake. As the 1st pillar benefits from more fuel (budget) than the 2nd, the vehicle continues to move very quickly towards soil degradation, greenhouse gas emissions, loss of biodiversity and destruction of habitats.

However, the CAP is not the only mechanism that fuels the intensification of agriculture. The close relationship between input retailers and farmers is ambiguous. The main farmers' advisers are indeed also the sellers of commercial inputs despite the existence in some countries of advisory services financed by the State. This has led to excessive use of these products (Eurostat, 2013). Input trade and agricultural advice should be separated. Despite of policies to reduce pesticide use there is even an increase as illustrated for example with France which has an increased consumption in the last years by about 14 % (Lamichhane et al., 2019), and has had the highest ever consumption of pesticides in 2018 (Eurostat, 2019).

By exerting a strong pressure on product price, supermarket chains encourage farmers to prioritise yields at the expense of food quality (Mayer, 1997; Marles, 2017). This also leads to excessive input use.

Farmers are currently part of a long industrial chain that starts from a fossil fuel pit and includes also notably the agro-industries that produces inputs, input retailers, agro-food industries that processes agricultural products, and food retailers. It is therefore justified to qualify this agriculture as industrial.

The following sections (1.1.1 to 1.1.4) develop a diagnosis of the current situation regarding the environmental EC priorities for the future CAP.

1.1.1 Climate change mitigation and adaptation, and sustainable energy

Soils managed under industrial cropping systems lost a large part of their natural fertility since the early 1960s (Bellamy et al., 2005; Goidts and Van Wesemael, 2007; Gobin et al., 2011; Jones et al., 2011).

The specialisation of farms has led to dramatic simplification of cropping systems, in which crops, livestock and forestry, once integrated, have become separated and intensified, leading to a very high level of specialisation and dependence on external, synthetic inputs (Peeters, 2012). As a consequence, arable land under current industrial systems receive now much less inputs of carbon in the form of farmyard manure or organic residues.

Moreover, deep ploughing and other intensive soil tillage techniques have destroyed soil structure and, together with the intense use of synthetic nitrogen fertiliser, degraded and oxidised soil organic matter, releasing huge amounts of CO_2 into the atmosphere (Krištof et al., 2014; Reicosky, 1997).

In addition, the production of soluble nitrogen fertilisers, which are applied widely and in high quantities, requires very large amounts of fossil energy for the industrial fixation of atmospheric nitrogen through the Haber-Bosch process. This process therefore contributes to further significant emission of greenhouse gases (Kyriakou et al., 2020).

Since highly simplified agroecosystems are also very likely to suffer from weeds, pests and diseases outbreaks, agrochemical use, which requires intense use of fossil energy for their production and application), is stable or still growing in some countries (Eurostat, 2020a).

The total energy efficiency of agricultural production has declined considerably in recent decades, being now inversely proportional to the amount of fossil energy injected into the agricultural and food systems. Pimentel and Heichel (1991) calculated for instance energy flows in hand-powered sustainable agricultural systems, in draft animal agricultural and agroforestry systems, and in contemporary intensive agriculture which provides an idea about the historical evolution of energy efficiency of agricultural systems in Europe. It is now estimated that "every calorie of food energy produced and brought to the table represents an average of 7.3 calories of fossil energy inputs" (Heinberg and Bomford, 2009).

Climate change mitigation and adaptation in industrial production systems pose a significant challenge, since the use of few species grown in monocultures with low genetic diversity are much more vulnerable to climate and biotic stresses (Altieri et al., 2015). When combined with low levels of organic matter in soils – that reduces soil water holding capacity and nutrient cycling – it results in strongly decreased resilience of farming systems towards disturbance from climate change (Lal, 2004; Iglesias et al., 2012).

1.1.2 Sustainable development and efficient management of natural resources such as soil, water and air

The recent development in agriculture has not led to sustainable and efficient management of natural resources, but rather the contrary. Soils have been heavily degraded since the 1960s, mainly because of the processes referred to in section 1.1.1. They have lost a significant portion of their natural fertility. Their structure has deteriorated, resulting in significant erosion and lower water holding capacity. Soil life has been greatly reduced in biomass and in diversity especially with regard to fungi and earthworms (Hiederer, 2018; Mission Board for Soil health and food, 2020).

The overuse of nitrogen and phosphorus fertilisers and agrochemicals such as herbicides, pesticides and fungicides used in industrial agriculture have polluted many surface and ground water (European Environment Agency, 2018).

The atmosphere has been polluted not only by CO_2 emissions caused by the processes described in section 1.1.1, but also by N_2O emissions from synthetic and organic nitrogen fertiliser use. The atmosphere has also been contaminated by some agrochemicals, especially at the time of application to crops, harvest operations and by the excess and improper use of these chemicals (Dubus et al., 2000).

1.1.3 Protection of biodiversity, enhancement of ecosystem services and preservation of habitats and landscapes

Sixty years of industrial agriculture have had a huge and unprecedented negative impact on the different forms of biodiversity in rural areas. In fact, overexploitation and agriculture have been recently recognised as the most prevalent threats for several species, especially endangered ones (Maxwell et al., 2016). The mechanisms that explain this biodiversity decline vary by organism and habitat. They can be either physical (e.g. homogenisation of habitat and landscape; elimination of ecological infrastructures; changes in grassland cutting frequencies and stocking rate; ploughing and other intensive tillage practices in arable land), chemical (e.g. application of synthetic nitrogen in grasslands that favours a small number of fast-growing plant species compared to all other species, agrochemicals that directly suppress target and non-target plants, insects or fungi), or mechanical through the traffic of heavy agricultural machinery and the tools used for tillage, weeding and harvesting (e.g. tillage done quickly after harvest thanks to the increasing power of tractors buries fallen grain that become inaccessible to birds that once used them to build up pre-wintering or migration body reserves) (Henle et al., 2008; Pe'er et al., 2014).

These physical, chemical and mechanical mechanisms can be direct or indirect. The use of herbicides, for example, has a direct effect in eliminating or drastically reducing the abundance of dicotyledonous plant species and an indirect action in reducing the abundance of pollinating insects for which these plants are a food source, and that of birds feeding on these insects. The application of pesticides eliminates many of the needed beneficial insects that can reduce crop pests, but also pollinators necessary for the production of fruits and vegetables (Ndakidemi et al., 2016).

Land use change imposed a drastic change in agricultural landscape, generating several detrimental effects to habitats and biodiversity; a main example is the large proportion of hedges and hedgerows networks that have been removed or degraded, to facilitate the movements in the fields of machines of increasing size. Additionally, drainage of wetlands, for "enhancing" the areas and providing new agricultural land, has led to drying of several important biotopes. As a result, many habitats have disappeared from landscapes and been replaced by large, much more uniform blocks of land (Stoate et al., 2001, 2009).

What is now becoming dramatically evident is also that the loss of habitat and biodiversity are contributing to the emergence of diseases in wildlife that may be sources of new severe infections in humans (Sattenspiel, 2001; Johnson et al., 2020)

1.1.4 Response of EU agriculture to societal demands on safe, nutritious and sustainable food, as well as animal welfare

The diversity of food products, especially fruits and vegetables, has increased in Europe in recent decades, mainly thanks to the import of tropical products or products long consumed in Europe but produced today in countries of the

South, for example in the counter season. These products do not always meet the Application of Sanitary and Phytosanitary Measures (the "SPS Agreement" of the WTO) (EU, 2000). The production of such fruits and vegetables in these countries can have disastrous consequences. For example, the rapid development of avocado cultivation in Mexico has led to massive deforestation in the wooded mountains of Michoacan[14].

Studies have shown that the nutritional values of many foods have decreased during the 20th century, particularly with regard to their mineral and vitamin content as a result of the use of industrial farming techniques and new more productive cultivars (Mayer, 1997; Marles, 2017).

In the meantime, the European Union has increased its domestic protein production deficit, largely due to a significant gap in legume production for food and feed compared to what is needed, feasible and desirable (Zander et al., 2016). This contributes to diet unbalances in both humans and livestock.

Feeding livestock with grains (cereals, soybean) instead of grass has not only negative environmental implications, but also affects the fatty acid composition of meat and dairy products. Total fatty acids, saturated fatty acids and omega-6/omega-3 levels have increased. In contrast, Combined Linoleic Acid levels, with anti-cancer properties, have declined (French et al., 2000; Alfaia et al., 2009; Saini and Keum, 2018; Davis et al., 2020). A large proportion of grains in livestock diets has also negative impacts on animal health, leading to excessive use of veterinary medicines (EFSA, 2008). This applies to ruminants that can potentially be fed on grass only but also to monogastrics that can use up to 30 to 50 % of grass in their diet (Crawley, 2015; Stødkilde et al., 2018).

However, it is mainly food processing and additions of sugar, saturated fatty acids and salt, downstream of agricultural production, that are known to cause obesity, malnutrition, and related non-communicable diseases (Swinburn et al., 2019). Changes in consumption habits and an increase in the share of processed products in diets are the main cause of major public health problems, with collective costs accounting for 10 to 12 % of total health care costs and that will soon exceed those of alcohol or tobacco-related diseases (WHO/FAO, 2002). Although this is not a direct consequence of the CAP, it should be duly taken into account in an agricultural and food policy approach.

Factory farming of pigs, poultry and sometimes cattle cause promiscuity problems resulting in the spread of diseases, that are partly controlled by antibiotics. Routine and preventative antibiotic use induce the development of resistance phenomena, selecting also human pathogenic bacteria and posing a threat to the entire society. Regarding animal welfare, stress is permanent for these sensitive animals, raised in conditions far from those of their wild ancestors and that do not allow the expression of basic social behaviours (D'Silva, 2006; Anomaly, 2015). Moreover, factory farming creates favourable conditions for the emergence of future human pandemics (Anomaly, 2015).

1.2 Economic dimensions

The importance of agricultural production in the EU, as well as food abundance on supermarket food shelves, give the impression that the system is highly productive. In reality, the agricultural and food system of the EU has become much more import-dependent[15], more unequal, less resilient at both the macro- and micro-economic levels, and finally with a low level of food security and sovereignty. It has also become less value-adding and more value-extracting out of our collective natural capital. This can be reviewed against the CAP objectives, as set out in the treaties. Article 39 of the TFEU (EU, 2016) states that "the objectives of the common agricultural policy shall be":

a) "to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilisation of the factors of production, in particular labour";

Far from being optimal, the use of production factors has been strongly skewed by the combined impact of various policies on their relative prices. As in other sectors, the cost of labour, whether self-employed or salaried, is subject to compulsory levies, taxes and social contributions, while investment is helped by subsidies, and in many member states, agricultural fuel oil is benefitting from tax exemption. The main CAP subsidy being paid per hectare also skews the production model in favor of larger farms despite the fact that it is often captured by landowners, not necessarily farmers (Neill and Hanrahan, 2013; Valenti et al., 2020). Hence, labour productivity as measured by value added (VA) per full time equivalent (FTE) (VA/FTE) has been maximised at the expense of other factors of production. This model of specialisation and monoculture has also become increasingly extractive in value on "nature capital" through the destruction of natural assets and the production of negative externalities.

b) "thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture";

The increase in the income of those working in agriculture has been the corollary of the increase in VA/FTE, with a drastic reduction of the labour force in agriculture. A significant segment of farmers is kept below the poverty line promoting a continuous flow of people and families leaving the agricultural sector with social deleterious consequences. This model is economically justified by the fact that it pretends to select the best performing players. It is now clear that rather than a "selection of the fittest", the system selects to a large extent the most "extractive players", in terms of tapping nature capital. The VA of agriculture is largely over-estimated as it hides a value extracted from our collective net asset. For the US, Muller et al. (2011) estimate the gross external damages of agriculture up to 38 % of the VA.

[14] www.wri.org/blog/2020/02/mexico-avocado-industry-deforestation

[15] Although, it can be argued that the EU is a net exporter of agricultural products and food, that does not include the direct and indirect dependency on fossil fuels which is nearly entirely imported.

c) "to stabilise markets";

Prices for agricultural inputs and outputs are largely globalised, and the CAP has little influence on them. However, by favouring a specialised agribusiness model that competes globally rather than favouring mixed farms to meet local demand and support local communities, the CAP has exposed an increasing share of farmers to fluctuations in world prices. Farmers find themselves "price takers" in the face of highly concentrated sectors upstream (seeds, fertilisers, equipment) and downstream (purchasing centres from retailers and processing industries). This has contributed to a much faster increase in input prices relative to that of agricultural products, and thus to the erosion of farmers' incomes. Over the last three decades, the output price indices progressed by an average of 1.1 % per year, while the price of most of the inputs increased by around 3 % yearly (own calculations on the basis of data from IMF, World Bank, USDA, Eurostat, Fertilizer International). The deterioration of the "terms of trade" for farmers is illustrated by the contrast between evolution of the VA in volumes which grew steadily over the last two decades by around 0.7 % p.a., while the VA deflated by the consumer prices declined by around -0,8 % p.a. over the same period (Eurostat, 2020b). It should be noted, that after a strong decline in the first decade it started to recover between 2010 and 2018, thanks to the reduction of the intermediate consumption which peaked at 57.7 % of the production in 2009 to decline to 54.1 % in 2018.

d) "to assure the stability of supplies";

Supply security goes hand in hand with the resilience of the sector. While there is a strong decline in environmental resilience (see section 1.1), economic resilience also raises questions both at the farm and macroeconomic levels. At the micro level, the resilience of specialised farms (which are by definition very simplified in terms of products, and exposed to price fluctuations as explained above), is inevitably lower, as evidenced by repeated crises in multiple sub-sectors. At the macro level, the massive dependence of the production model on fossil fuels almost entirely imported from a limited number of non-European regions makes security of supply very precarious in the event of geopolitical or other crises especially in the Middle East or Russia (Darnhofer, 2014).

e) "to assure that supplies reach consumers at reasonable prices".

The CAP has certainly helped to reduce the cost of food for consumers in the available income of European households. However, downward pressure on prices has contributed to the development of production methods that have favoured the quantity and standardisation of products at the expense not only of the environment, but also of the nutritional quality of the products (see section 1.1.4). On the other hand, it would be natural that farmers receive a fair price for their products.

1.3 Social and societal aspects

Among the priorities of the European Commission for the future CAP for the 2021–27 period (EC, 2018), priorities 1, 3, 7, 8 and 9 (see section 1.1) are related to social and societal topics.

The social question in agriculture is strongly related to the profitability of farming activities and with risk perception especially by young farmers. Moreover, access to land is difficult for young farmers. The average farmers' age in the EU is close to 55 years. There is a great lack of generational renewal (European Parliament, 2020). The number of farmers is thus still declining very fast (Eurostat, 2018). The number of farms in the EU decreased for instance by about 30 % in the short period between 2005 and 2016 (Eurostat, 2020c). There is a high risk that in 5 to 10 years' time the number of family farms will be extremely low in the EU.

1.4 Recent developments

Compared to the former CAP, the current proposition of the European Commission introduced the concept of 'eco-schemes' on top of the existing conditionality rules of the 1st pillar. These eco-schemes complete the range of the 'agro-environmental and climate measures' of the 2nd pillar. The support to organic farming is now included in the eco-schemes. They include also supports to agroforestry, carbon farming, precision farming, and a package of measures such as enhanced crop rotation, better fertilisation, and the implementation of an ecological network on the farm.

The new, enhanced version of conditionality is presented as essential for mitigating climate change, conserving biodiversity, protecting wetlands and peatlands, improving animal welfare and food safety.

If the reform of conditionality and the introduction of the concept of eco-schemes are steps forward for more sustainable systems, they don't adopt a holistic approach and are thus not sufficient for implementing agroecological systems.

The revival of farm independent advisory services is certainly very positive on the condition that advices stimulates farmers to move into the right direction.

Another positive objective is the attempt to build a fairer subsidy distribution system for reducing the inequalities of the current system (about 80 % of the amount of subsidies are distributed to about only 20 % of all beneficiaries). The project is to achieve this objective by the capping of subsidies at 100.000 Euro/year per farm in order to better support small and medium-size farms. Although this objective is laudable, it is unlikely that it will be sufficient for reversing the trend of the fast farmers' population decline.

The CAP has to contribute at least 40 % of climate-related expenditure. However, without a system change the concrete impact on the mitigation of climate change will be modest. Without this change, fossil fuel consumption for the synthesis of nitrogen fertiliser and for agricultural machines for instance, will not be sufficiently reduced. Not enough carbon will be sequestered in agricultural soils. The trend of carbon dioxide and other GHG emissions will be maintained or even increased.

The latitude for member states to largely adapt the European Commission proposals through their national

CAP strategic plans is likely to decrease the efficiency of the CAP reform proposal given the lack of enthusiasm of certain member states to improve the impact of their agricultural systems on the environment.

The 'Farm to Fork strategy' of the Green Deal aims at developing a fairer, healthier and more environmentally friendly food system. With regard to food quality and the stimulation of food processing and retailing by farmers, only an 'Action Plan' has been drafted at this stage. An implementation and financed programme has still to be designed and adopted.

2 The principles and goals of the reform

2.1 The guiding principles

In 1992, the CAP was radically reformed to integrate the rules of international trade and avoid the perverse effects of the previous policy, including surplus production. Support mechanisms through minimum prices have been replaced by direct aid, mainly per hectare and livestock head.

The perverse effects of the current policy, despite some corrections introduced since then, must lead to a new reform of the same magnitude. It must also be part of the Union's objectives set out in the Green Deal in terms of carbon neutrality by 2050, safeguarding biodiversity, reducing the use of agrochemicals and synthetic fertilisers, and the nutritional quality of production accessible to all.

The two overarching principles of the reform proposed in this paper should be:

First: "Do not harm", the cornerstone of the European Green Deal. This means that all the current measures of the CAP that induce unsustainable production models or behaviours should be phased out.

Second: "Public money for public good". Taxpayers' money should not be used for supporting the production of marketable goods or services, as it introduces market distortions and biases in the production modes. Marketable goods and services should be paid by market prices. This should be helped by favouring production for local markets and value added and differentiated products. Taxpayers' money should be essentially, if not exclusively, used to support the production of public goods such as biodiversity, healthy soils, clean water and air, healthy food, diversified landscapes. A real production of public goods by farmers, that is not remunerated by the market, is expected. This public good production is also a positive element for agricultural production as it conserves and restores agricultural biodiversity and soil fertility.

2.2 The main goals of the reform proposed

The main objectives of the CAP as stipulated in Article 39 of the TFEU remain valid and should not be forgotten. They should be implemented with the following additional features to fully embed the sustainability dimension.

2.2.1 Ecologically based agriculture

Climate and biodiversity crises must be taken into account in a new European agricultural and food model. Soil will need to be regenerated by sequestering carbon (Freibauer et al., 2004), improving fertility and increasing their microbial, floral and faunal diversity. This will have the positive effect of controlling pathogens and reducing disease as well as better coping with more frequent and intense weather anomalies. Habitats and agricultural, functional and heritage biodiversity will need to be restored and conserved. This will reduce pest populations. All of this will support mitigation of climate change and increase the resilience of agricultural systems to extreme weather events.

Transformed as such, agriculture will become more resilient and crop yield could be maintained. Nevertheless, agriculture will also have to become less reliant on fossil fuel. It will have to reduce drastically the use of synthetic fertilisers and agrochemicals, and of livestock feed imported from other continents, mostly produced in unsustainable ways. It will have to sell most of its products in short and local food supply chains.

2.2.2 Agricultural aid, climate and biodiversity

The time has come to no longer pay farmers to practice their job according to a business-as-usual model because the pricing mechanisms do not allow them to be paid sufficiently and fairly for their work. Agricultural aids should be paid on the basis of the production of common (or private) goods enjoyed by society as a whole, namely ecosystem services and biodiversity. This would make sense to taxpayers and give agriculture new prospects.

The European Green Deal stipulates that "European farmers and fishermen are key to managing the transition. The Farm to Fork Strategy will strengthen their efforts to tackle climate change, protect the environment and preserve biodiversity. The common agricultural and common fisheries policies will remain key tools to support these efforts while ensuring a decent living for farmers, fishermen and their families". The Commission's proposals for the Common Agricultural Policy for 2021 to 2027 stipulate that "at least 40 % of the common agricultural policy's overall budget and at least 30 % of the Maritime Fisheries Fund would contribute to climate action" (EC, 2019).

2.2.3 Maintaining family farms and vibrant rural communities

Creating new perspectives for European family farms would require increasing their profitability by decreasing production costs, especially those of commercial inputs, and increasing revenue by targeting quality products, by processing the products and selling them in short and local supply chains, at least partly. Complementary activities such as agritourism or part-time jobs are also possible solutions. Decreasing input use is feasible by replacing fossil-fuel based products by the ecosystem services provided by biodiversity (e.g. nitrogen fertilisers by biologically fixed nitrogen by legumes, insecticides by natural enemies of crop pests). This is perfectly possible since species of the agroecosystem can biologically fix large amounts of nitrogen, can regulate weeds, pests and diseases, support recycling of nutrients, and secure pollination and other vital functions. This requires the strong development of agroecological practices (Wezel et al., 2014) on large scales for the restoration of soil life with reduced or no-tillage; continuous soil cover; direct seeding into cover crops; the development of a dense ecological network (such as herbaceous strips or hedges); the choice of climate-resilient crop species, cultivars and mixtures; intercropping (including agroforestry); long and diversified crop rotations; crop/livestock integration; rotational grazing; and the use of low-demanding livestock breeds that can transform grass into meat, eggs and dairy products.

Adopting these practices, measures and strategies would greatly facilitate the transmission of farms to the next generation, but would also stimulate the creation of jobs in related processing and marketing activities. Maintaining farms in rural areas is also an opportunity to develop new activities in these areas if economic activities are re-localised, thus also contributing to the social revitalisation of rural territories and therefore to rural development.

Since small-scale family farms get much less support than large industrial farms while they create more jobs per hectare, this trend should be counteracted by an adequate mechanism, supporting people and not hectares.

2.2.4 The systemic approach of agroecology

Dealing with crises, developing a system that is truly up to the challenge and adopting a systemic approach is essential. Only this approach can, with the support of analytical approaches, respond to the above-mentioned stringent issues. This approach should integrate environmental, social and economic components while being technically realistic. With regard to the restoration of biodiversity, this ecologically based system should provide favourable conditions for life forms on the entire agricultural area and not only on a limited area of land.

This system approach exists, and its name is agroecology. It has been defined by the Food and Agriculture Organization of the United Nations (FAO) in its memorandum "The 10 Elements of Agroecology" (FAO, 2018) and, in an even more detailed manner, in the report of a FAO High-Level Panel of Experts on food security and nutrition (HLPE, 2019). Agroecology became increasingly institutionalised within United Nations Organizations (Loconto and Fouilleux, 2019).

The agroecological approach redesigns the conventional agricultural system based on the principle that the role of external inputs can be replaced, or at least strongly reduced, by ecological processes, while production levels can be maintained.

Thanks to its systemic approach explained above, agroecological systems are often more profitable than industrial agriculture as recently shown by a panel of around thirty European scientists (van der Ploeg et al., 2019).

Other agricultural systems or techniques are related to agroecology, such as organic farming, biodynamic agriculture, permaculture, conservation agriculture, agroforestry, low-input agriculture, carbon farming, or integrated pest control. The most widespread and known system, organic farming, may be represented by farms that are more or less agroecological because they adopt agroecology principles to a variable extent. Organic farms are recognised as organic because they respect the official organic specifications under a label, and which gives them access to higher subsidies and usually higher prices for their products. The respect of these rules is certainly not always sufficient for concluding that a farm is agroecological, but it is widely acknowledged that organic farming contributed significantly to the implementation of more sustainable agricultural systems well beyond the boundaries of this system (EC, 2019). In contrast, there is no agroecological label, yet. Agroecology is a process of progress based on a progressive adoption of the complete set of agroecological principles. It is the systemic combination of specific practices related to the set of principles that generates the characteristics and results described above.

3 Measures for an agroecological CAP

3.1 Support people not hectares

Current subsidies to European agriculture have led to a very strong distortion of the relative costs of production factors in favour of surface, energy and capital intensity and against labour. This distortion has led to highly extractive and unsustainable production models which also contribute to job redundancy, unemployment and overexploitation of socially weaker workers. That is a clear breach to the "Do not harm" principle. Just as the energy transition begins with the phasing out of fossil fuel subsidies, the new CAP must abandon subsidies to unsustainable practices and/or conflicting with the EU's environmental and social objectives.

In general, agricultural practices compatible with respect for the environment, the fight against climate change, short circuit feeding, etc. are more labour intensive. It is therefore counterproductive to maintain a policy that subsidises most factors of production except the most crucial one: labour.

The replacement of subsidies per hectare (or per livestock head) with a base income per FTE would correct this distortion, at least partially, given the usual social and income tax levies. This base income would be conditional on strict compliance with environmental rules, to a declared activity on a farm.

This base income could be financed not only by the phasing out of the current pillar 1 subsidies that are distributed on a surface basis, but also by the introduction of charges on practices that contribute to depleting our common natural capital (use of agrochemical or chemical fertilisers), based on the "polluter pays" principle.

In addition, innovative approaches could be developed to sustain the thousands of seasonal workers employed in agriculture that are living in precarious conditions.

3.2 Public money to produce public goods

European agriculture provides, or has the potential to provide, public (or common) goods that benefit society as a whole. Among these, the three main public goods are the sequestration of carbon in agricultural soils, the restoration of rural biodiversity and the development of the ecological network that structures landscapes.

Ecosystem services are declining, and they are better provided by small-scale farms in a heterogeneous landscape matrix (Perfecto and Vandermeer, 2010). However, small-scale family farms get much less support than large industrial farms. This would be corrected by the basic farmer income proposed in section 3.1, strongly conditioned on good environmental practices, including on compliance with reduction of nutrient excess and pesticide dependency.

As a complement to the former measure (see section 3.1), replacing EU and national current subsidies per hectare or by livestock head by direct payments for the production of public goods in the context of a quality food production would give meaning to the CAP. From the farmers' point of view, they would no longer be paid to do their ordinary job only, as seen to provide high yields for different commodities. The present monetary support is a kind of assistance because of the insufficient profitability of their activity. The future should be the production of common goods that are not otherwise paid because they are not marketable. From the citizens' point of view, their taxes will no longer be spent to the bottom of a profit to subsidise a declining sector but for the actual production of public goods which they can enjoy and profit concretely in a long-term perspective.

The payment per ton of carbon sequestered in soils can be based on two alternative systems: periodic and geo-localised analysis of soil carbon content or the adoption of a fairly simple grid that assesses carbon sequestration on the basis of agricultural practices. When these amounts of carbon are assessed, a value must be assigned to the ton of carbon that is high enough to motivate farmers to opt for sustainable practices (Eco-Logic et al., 2020). The subsidies would be reverted in case of reversal of the practices, in application of the polluter-payer principle.

The payment based on the length, the density and quality of ecological networks is easy to implement. These data can be measured by a combination of aerial detection (remote sensing) and field record. Then a price must be given to the quantity of each type of habitat.

Several agricultural practices, in particular various agroecological practices, that sequester carbon in soils are also those that restore, conserve or enhance soil and aboveground biodiversity. Moreover, the development of the ecological network is the basis for the recovery of biodiversity that could spread above the soil surface. However, additional measures in favour of biodiversity are to be foreseen for the conservation of certain habitats or species. Moreover, the current agro-environmental schemes provide a good basis for pricing these measures.

All these public good related measures supported by direct payments have the potential to improve net income of farmers and resilience of the agricultural production. The two previous main measures, "Support people not hectares" and "Public money for public goods", constitute the two pillars of the reform proposal. The first one aims at stabilising farmer's populations and should thus be seen as transitional. It should be abolished when the objective is reached, the second measure becoming the central one. The main measures have to be completed by accompanying measures.

3.3 Other measures supporting the transition towards agroecology

Even if agroecological farming appears to be more profitable than industrial agriculture on the medium-term (van der Ploeg et al., 2019), farmers who want to convert to agroecological farming face difficulties in the first years. They have to make new investments, while soil fertility restoration and adaptation of cropping practices take time, and new markets have to be developed. New tools adapted to agroecological systems and practices are needed. Transition towards a new system is thus difficult and risky.

The implementation of a training network with well-trained advisers in transition towards agroecological systems is therefore essential. Their role would be to mentor farmers' groups. They will help the majority of farmers to avoid the mistakes of the pioneers of agroecology. They will facilitate and speed up the transition and adaptation of agroecological practices to the local pedo-climatic and socio-economic context.

A network of innovative agroecological farms should be set up and promoted. These farms could be used as "agroecological lighthouses from which principles may radiate out to local communities, helping them to build the basis of an agricultural strategy that promotes efficiency, diversity, synergy, and resiliency" (Nicholls and Altieri, 2018).

The reduction of current subsidies for large machines and buildings will free financial means for the creation of a new fund for facilitating the development and purchase of agroecological tools and equipment.

Creating land banks (inspired by the French "SAFER"[16] and other examples) at European scale or in all member states would facilitate young and small farmers to buy or rent land on the basis of a project that is relevant and consistent with the goals of the 'Green Deal' and the future 'Farm to Fork' programme.

All the previous supporting measures should be co-financed by member states.

In coherence with the Green Deal, the CAP should be coordinated with other policies. The context and the rationale of this cross-cutting approach cannot be described and justified in this document. It can just be said that this coordination between the CAP and other policies and the private sector is necessary for questions of policy coherence and efficiency.

The phasing out of subsidies on fossil energy and external inputs should be implemented in coordination with other EU policies and the phasing out of loans to fossil fuel extraction and to industrial nitrogen fixation in coordination with the private sector (notably banks).

The CAP should also be coordinated with public health policies and the private sector for reducing food waste and combat obesity, malnutrition, and related non-communicable diseases.

[16] www.safer.fr

4 Conclusion

The policy proposed in this paper should result in a better distribution of income for farmers and overall a better margin for their activities. The public good production would be supported by taxpayer money, while food production margins would benefit from the reduction of costly inputs while the reorientation of the production toward quality products, local markets and value productions should result in better prices. Increasing the share of the production devoted to the local market and alternative distribution channels, would increase the contractual power of farmers as relative to concentrated industrial buyers. Overall, the exposure to the volatility of world prices would be significantly mitigated.

The value for the final consumer would increase in line with the improved nutritional quality of the products. This should not necessarily be seen as a negative issue undermining people's spending power. It should rather be seen as an opportunity to rebalance distribution of added value along the food supply chain, while providing consumers with acceptable price, better quality food which is value for money, empowering them, and reducing food waste. First, fair distribution of added value and adequate remuneration of farmers will be favoured by short food supply chains typical of agroecological production. Second, increased supply of high quality, local and seasonal food will favour rebalancing of food offer and supply thereby diminishing food waste. Third, fostering agroecological food systems will (re)educate consumers towards values like seasonality of production or avoidance of mass purchase of non-fresh and overly processed food, and make them aware that they can play an active role in fostering local socio-economic wealth, and in sustaining their own and environmental health. In this way, consumers will also learn what is the dark side of cheap food (unbalanced added value distribution, unfair remuneration of farmers, environmental degradation, borderline or illegal exploitation of seasonal and migrant work).

Lastly, as negative externalities of the present industrial agricultural systems are paid currently by taxpayers, reducing them will allow reducing needed taxes (to fund also the CAP and health care systems) which could counterbalance the potential increase of final food prices for consumers as mentioned above.

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