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Why and how to regulate animal production and consumption: the case of the European Union[1]

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Abstract

Throughout the world, animal production face huge sustainability challenges. The challenges are exacerbated in the European Union by consumption issues linked, in particular, to the health and environmental impacts of meat consumption, and by the increasing societal concerns linked to animal welfare. Simultaneously, animal production may also provide benefits, notably from an economic and territorial point

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of view. In addition, some livestock systems, notably grass-based systems, may also offer positive climatic and environmental effects. As in many parts of the world, animal production is highly regulated in the European Union, where the consumption of animal products is not (or very lightly) regulated. Many of the negative and positive effects are public goods that are not well taken into account by private actors and markets. Thus, there is legitimacy and scope for public policies aimed at reducing the damages and increasing the benefits of animal production and consumption. The last part of the paper explains how this could be achieved in the European Union through a significantly revised and extended Common Agricultural Policy that more closely follows the principles of public economics.

Keywords: Animal production, animal consumption, European Union, public regulation, public economics

Implications

Animal production and consumption provide both damages and benefits that are often public goods. As a result, they are not well taken into account by private actors and markets, and therefore there is legitimacy and scope for public policies. We propose a set of policy recommendations aimed at minimising the provision of damages and maximising the provision of benefits of animal production and consumption in the European Union.

Introduction

Feeding the planet with environmentally friendly and healthy food systems is a major challenge that can only be achieved by acting simultaneously on demand and supply (Poore and Nemecek, 2018). On the consumption side, huge heterogeneities among countries and households, in terms of food diets, consumption habits, prices, incomes and demography, require actions to be adapted to national and local characteristics. In low-income situations, total caloric intake generally has to be increased and diets better balanced, with a possible rise in the proportion of animal products consumed. By contrast, in higher income situations, total caloric intake is often too high and should be reduced. Food diets should also be more balanced, which may require a reduction in the absolute and relative consumption of animal products (Mora *et al.*, 2018). On the production side, supply should meet demand needs but in a sustainable way. This requires substantial changes in world farming systems by mobilising all possible solutions, from agro-ecology to precision farming, as long as they are sustainable and reduce the climatic, environmental and heath footprints of agriculture, in particular. Clearly, the lower the total demand for agricultural products, the easier it will be possible to satisfy the demand with limited production increases and more sustainable farming systems. It is in that sense that reducing food waste and loss is a win-win strategy, for the Earth (due to the reduced use of natural resources) and for humankind (as more food will be available for consumption).

As in other parts of the world, animal production in the European Union (EU), and upstream and downstream activities that depend on it, may be a significant cause of climatic, environmental and health damage (Buckwell and Nadeu, 2018). Some of this damage is common to animal and crop production. This is the case, for example, of water pollution, whereby the origin of the excess of nitrate in the

waterways can be mineral and/or organic. Other examples are specific to the animal sector, such as the enteric production of methane by ruminants or the use of antibiotics in animal husbandry, which increases the risk of antimicrobial resistance (AMR). Animal production is also the subject of criticism in its wasteful use of natural resources: notably, land and water use could be saved by increasing the share of plant products directly consumed by humans without passing through the filter of animals. Decreasing the share of animal products in food diets could also reduce the negative impacts on health of eating patterns that include excessive consumption of animal products (Bouvard *et al.*, 2015). An increasing additional concern is related to farm animal welfare (European Parliament, 2017). For all of these reasons, a number of researchers, think tanks, non-governmental organisations, and so on recommend reducing the consumption of animal products where it can be considered excessive, and limiting the growth of this consumption by curbing the worldwide generalisation of the so-called "Westernisation of food diets" (Guyomard *et al.*, 2012). A reduction in the consumption of animal products would translate into a reduction in the production of animal products.

However, as seen elsewhere in the world, animal production in the EU may also provide benefits, notably from an economic (around 40% of the value of EU total agricultural production is of animal origin) and a territorial (more than 60% of EU agricultural area is used for feeding animals) point of view. Some livestock systems, notably grassland-based systems, may also provide climate and environmental benefits by sequestering carbon, improving water quality, protecting biodiversity and/or maintaining diversified and open landscapes (Dumont *et al.*, 2019).

There is legitimacy and scope for public policies aimed at reducing the damage and increasing the benefits of animal production and consumption: both damages and

benefits are often public goods that are not well taken into account by markets and private actors when they decide what they want to produce or consume, and how. The objective of this review paper is therefore to provide some general principles for legitimate and efficient public action aimed at regulating animal production and consumption in the EU, taking into account damages and benefits together. Section 2 reviews the economic and social importance of livestock production in the EU. Section 3 describes the climatic, environmental and health challenges. While these challenges are not specific to the EU, addressing them in an efficient way requires public policy interventions to be adapted to European characteristics. Section 4 describes how animal production and consumption is currently regulated in the EU, notably within the Common Agricultural Policy (CAP). This analysis leads us to propose a revision and extension of the CAP instruments in order to limit the adverse effects of animal production and consumption while maximising their benefits. This is completed is Section 5. Section 6 concludes by analysing to what extent the Green Deal launched by the European Commission (EC) in December 2019 (EC, 2019a) is a further step in the right direction.

Economic and social importance of livestock production in the EU

In 2018, the EU-28 was the world leader in milk production at 166 billion litres. At that time, it occupied the second place for pig meat (pork) production with 24 million tons of carcass equivalent (tce), and the third place for both poultry meat production (with 15 million tce) and beef meat production (with 8 million tce) (EC, 2018a; Eurostat 2019). The European net exports of animal products rose by more than

three between 2000 and 2019 when they reached €33.7 billion.[2] Exports are often based on non-price competitiveness criteria related to product safety, traceability and - more generally - quality. They also include relatively low value dairy products and less favoured cuts of meat that EU consumers do not wish to purchase. In a context where the European consumption of animal products is, at best, slightly increasing or stagnating, the economic importance of exports on world markets should be underlined and acknowledged.

In 2016, 55% of EU-28 agricultural holdings held livestock. Between 2005 and 2016, the number of farms with livestock decreased by 38% while the total number of farms declined by "only" 29% (Eurostat, 2019).[3] According to the Animal Task Force (ATF), EU-28 livestock farms accounted for around four million direct jobs in 2010, mainly (more than two-thirds) in the 12 new member states (MS) that adhered to the EU in 2004 or 2007. These direct jobs are, however, on a declining trend in all MS (Hostiou *et al.*, 2020). In addition, they generate both indirect jobs (jobs in activity sectors that depend directly on livestock farming) and induced jobs (jobs created by the expenditure of households employed in direct and indirect sectors). Although complete and standardised data for all MS do not exist, several studies suggest that employment multipliers are likely to be high. For example, in France, the indirect employment multiplier of a "significant" livestock farm corresponding to a 1.3 full-time equivalent would be equal to 1.8, with 0.4 indirect jobs in upstream sectors, 1.0 in downstream sectors, 0.3 in food distribution sectors, and 0.1 in public and semi-public services (Lang *et al.*, 2015). The turnover of upstream and downstream

[2] These trade figures do not include intra-Community trade.

[3] In the EU-27, excluding Croatia.

industries is another illustration of the knock-on effect of livestock farming. In 2013, this figure exceeded €400 billion for the EU-27 (ATF, 2017).

Of course, the place of animal production in national agricultural economies and in rural territories varies greatly from one MS to another. The top five producers (in decreasing order, France, Germany, the United Kingdom, Italy and Spain) account for around 60% of the EU-28 supply. In 2016, the proportion of agricultural holdings with livestock varied from more than 90% in Ireland to less than 14% in Italy (Eurostat, 2019). At that time, livestock intensities - measured by livestock units (LU) per hectare - varied from less than 0.2 LU units in Bulgaria to 3.8 LU in the Netherlands (Greenpeace, 2019). In addition, these country figures mask important infra-national disparities in both low- and high-density countries. In a context where the environmental pressures of livestock farming crucially depend on animal densities, it is primarily at the regional and even infra-regional level that climatic and environmental damage should be assessed and corrected (Dumont *et al.*, 2019). This is even more true for livestock farming, notably ruminant farming, which remains an essential life support in many European rural areas where economic alternatives are rare, including agricultural alternatives that would not be viable.

Disservices and services linked to animal production and consumption

Impacts on land use

Livestock activities are secondary or tertiary processors of plants and thus require more land than crops to provide the same levels of calories or proteins (de Vries and de Boer, 2010). Increases in the demand and supply of animal products therefore have a greater responsibility than crops in the agricultural land expansion required to feed the planet, at the expense of natural, semi-natural or forest areas.

However, this statement must be qualified by the fact that animal proteins have a higher biological value than plant proteins (FAO, 2013). In addition, farm animals, notably ruminants, use plant by-products, grasslands and marginal lands that cannot be readily cultivated and directly mobilised for human consumption (Mottet *et al.*, 2017).

European forest areas have been increasing for several years in the EU. This does not mean that the EU has no responsibility for the world's deforestation. According to the most recent estimates (EC, 2019b), the EU would be responsible for around 10% of global deforestation through the import of several products (mainly timber, rubber, cocoa, meat, maize, soya and palm oil). European animal production and consumption contribute to this embodied deforestation through the import of meat and, most importantly, of animal feed ingredients. Cereals used for feeding European livestock are largely of domestic origin. By contrast, in 2017-2018, the EU produced only 30% of proteins - excluding forages – used for feeding livestock, importing 24.8 million tons of protein ingredients, of which 18.8 million tons were soya. This dependency has induced a large number of reports and plans aimed at developing domestic protein production, at the EU or MS level, but without significant success to date.[4]

Climatic and environmental impacts

[4] The EU protein deficit has slightly decreased since 2000 thanks to the development of first-generation biodiesels supported by proactive policies that have allowed an increase in the supply of domestic cakes. However, first-generation biofuels are increasingly criticised because their environmental benefits - notably in terms of reductions of greenhouse gas emissions - would not be automatic, and because their development may conflict with food security (Mohr and Raman, 2013).

According to the European Environmental Agency (EEA), in 2017, the EU-28 farm sector generated around 11% of total European greenhouse gas (GHG) emissions, in carbon dioxide equivalent (EEA, 2019). Farm animals produced almost 60% of this percentage through the enteric fermentation of ruminants leading to methane emissions (CH_4) and through the management of animal manure for all species, notably leading to nitrous oxide emissions (N_20). Lesschen *et al.* (2011) estimated that dairy and meat cattle accounted for 80% of total livestock GHG emissions, ahead of pork (16%) and poultry (4%). When accounting for emissions related to the production, transport and processing of feed, the livestock sector would be responsible for around 80% of European agricultural GHG emissions, both within and outside of the EU borders (Leip *et al.*, 2015). As a result, reducing agricultural GHG agricultural emissions would require - as a priority - diminishing CH_4 and N_2O emissions linked to farm animals, notably ruminants. This must be achieved by taking into account the high variability of emissions depending on livestock systems (Dall-Orsoletta *et al.*, 2019) and carbon storage capacities in soils under grassland, particularly permanent grassland, that can partly offset gross emissions (Klumpp and Fornara, 2019).

Livestock can generate other environmental damage of varying intensity, depending on the species and production systems. Gaseous emissions of ammonia, nitrogen oxides and volatile organic compounds have direct negative effects on the quality of the environment by contributing to the formation of fine particles and the eutrophication of aquatic environments. In particular, livestock is responsible for about 80% of total ammonia emissions in the EU (EEA, 2019). The specialisation of farms and the geographical concentration of animal production have progressively induced regional nutrient imbalances, notably for nitrogen and phosphorus, which

are the source of the diffuse pollution of soil, water and air. According to Leip *et al.* (2015), livestock activities are largely responsible for nutrient leakages from rivers into coastal waters, ranging from 23 to 47% for nitrogen and from 17 to 26% for phosphorus, depending on the geographical areas. The specific contribution of livestock to biodiversity loss, both directly and indirectly through animal feed, is more difficult to quantify (Buckwell and Nadeu, 2018). The main direct negative impact is linked to the conversion of grassland into cropland. The main indirect negative impact is linked to the removal of natural and semi-natural habitats favourable to wild fauna and flora.

The magnitude of the damage caused largely depends on livestock systems and the territories in which they are implemented (Dumont *et al.*, 2019). At the territorial level, a key parameter is the balance between stocking rates (the number of LU per area unit) and the environment's ability to produce feed and to absorb animal manure. In areas (11% of European utilised agricultural area) where grassland surfaces are rare and livestock systems are intensive (a high number of animals per area unit, high productivity per animal, important use of inputs purchased outside the zone), damage to the different environmental compartments is particularly significant.[5] This is not necessarily the case in grassland areas (33% in European utilised agricultural area) and in mixed crop-livestock areas (32% of European utilised agricultural area), which also generate some environmental benefits. Grassland, especially permanent grassland, provides numerous environmental services by storing carbon, purifying water, preserving biodiversity and maintaining

[5] However, corresponding livestock farms are efficient in terms of fossil fuel use and GHG emissions per kilogram of the final product.

open landscapes. In the same way, the balanced spatial association of crops and animals allows the biogeochemical cycles of carbon, nitrogen and phosphorus to be more regulated, which contributes to an improvement in soil quality (structure, content in organic matter) and to the preservation of a diversified landscape framework favourable to wild fauna and flora (Martin *et al.*, 2020).

Heath impacts

Animal production is increasingly questioned because of health considerations. The two main health issues are related to the impact of the use of antibiotics in livestock on AMR, and to the adverse effects on an individual's health due to the excessive consumption of animal products, notably meat.

In the early 2000s, around 25,000 Europeans died each year from infections caused by antibiotic-resistant bacteria (WHO, 2011). Part of the problem is of an agricultural origin, in a context where humans and animals share the same pharmacopoeia and where livestock farms are significant consumers of antibiotics. After banning the use of antibiotics as growth promoters in 2006, in 2018, the EU decided to ban their prophylactic uses in livestock farming from 2022. It also decided to reserve the most critical antibiotics for human medicine only, and to require that imports comply with European standards (EC, 2018b). At the start of the 2000s, antibiotic use in the EU was twice as high in veterinary medicine as in human medicine, with half for prophylactic uses (Buckwell and Nadeu, 2018). Since that date, the agricultural use of antibiotics has significantly decreased, notably in MS where this use was initially high. However, current use varies a lot among MS, according to the European Medicines Agency (EMA), from a maximum of 450 milligrams per kilogram of animal biomass in Cyprus, to less than 20 milligrams in Finland and Sweden (EMA, 2018).

These national gaps can be explained by the differences in composition of animal populations, livestock systems and organic farming development. They are also explained by more (or less) rational uses of antibiotics and varying rearing intensities among these countries. It is important to note that the intensification process of livestock can increase the risks of zoonotic disease emergence and re-emergence. However, the complexity of the underlying mechanisms limit the ability to predict these risks with any precision (Jones *et al.*, 2013).

The average per capita consumption of animal products is high in the EU, both in absolute terms (twice as high as the world average) and with respect to nutritional recommendations. In 2018, each individual European consumed 69.5 kg of meat and 236 kg of milk equivalent annually. According to Buckwell and Nadeu (2018), these consumption levels were much higher than recommendations for meat and only slightly higher than recommendations for milk. An excessive consumption of fats, notably saturated fats present in animal products, is an explanatory factor for individuals who are overweight and obese, and the associated chronic diseases. In addition, an increasing number of research works suggests a positive link between the risks of several cancers and high consumption levels of red or processed meat (Pierre, 2016). As a result, in October 2015, the International Agency for Research on Cancer (IARC) classified the consumption of red meat as “probably carcinogenic for humans” and the consumption of processed meat as “carcinogenic for humans” (Bouvard *et al.*, 2015). In particular, the risk of colorectal cancer would increase by

+17% for each additional consumption of 100 grams of red meat per day, and by +18% for each additional consumption of 50 grams of processed meat per day.[6]

Even if the excessive consumption of animal products must be avoided, it is important to recall the nutritional benefits of meat products consumed in accordance with recommendations (INRA, 2019). Meat products provide proteins of high nutritional quality containing the nine essential amino acids in adequate proportions, that are easily and quickly assimilable. They are a unique source or are very rich in several micronutrients (vitamins, selenium, zinc) and various bioactive components. In the same way, dairy products are important sources of nutrients (calcium, iron, magnesium) that are essential for bone development. Consuming a sufficient level of animal products is highly recommended for specific populations, notably older people for whom meat consumption helps to limit the risks of sarcopenia and iron anaemia, and women of childbearing age in order to prevent iron deficiencies. Several researches have highlighted the risks of nutritional deficiencies and the negative health outcomes of unbalanced food diets that may too severely limit or ban animal products, including meat (Key *et al.*, 2006; de Smet and Vossen, 2016).

Farm animal welfare

The welfare of farmed animals is a primary concern of European citizens: 94% of them value animal welfare, and 82% consider that farmed animals should be better protected (EC, 2016). For several decades, this concern was limited to the repression of acts of cruelty. It now extends to all conditions relative to the rearing, transport and slaughtering of farmed animals. Advances in scientific knowledge on

[6] This carcinogenic effect is not related to meat consumption *per se*, but to chemical substances that develop during the preparation, preservation and/or cooking processes.

the pain, suffering and the consciousness of animals have led to the official recognition of animals as sentient creatures, both at the EU level (enshrined in the EU Treaty of Amsterdam in 1997) and in several MS. At the EU level, several conventions of the Council of Europe and several directives reflect this recognition (Mormède *et al.*, 2018). They essentially correspond to a preventive approach through, on the one hand, the prohibition or limitation of certain practices that potentially generate pain and suffering and, on the other hand, the simultaneous obligation to use some practices to increase the welfare of animals and, in particular, to encourage the expression of their natural behaviour.

Regulations therefore seek to limit - and, if possible, to eliminate - the negative emotions of pain and suffering, fear and frustration that may be experienced by farmed animals, and to promote the positive emotions of comfort, joy, pleasure, etc. Are these regulations sufficient? To answer this question, it is important to set the limits between what is acceptable and what is not. Science alone cannot answer this question, although it can shed light on the debate by proposing objective indicators of animal welfare based on the internal emotional state of animals and by analysing how different farming, transport and slaughtering practices may have an impact on these indicators.

The two practical questions that must be addressed are; first, what is the optimal level of farm animal welfare, and second, what are the modalities of public intervention required to achieve this level at the lowest possible cost for the whole society? As noted by the Farm Animal Welfare Committee (FAWC), public intervention is required in a context where animal welfare is a public good. Improving animal welfare benefits all of those who demonstrate concern (FAWC, 2011). Intervention at a supranational scale is justified in order to avoid the double penalty

of unilateral actions by a single country; first, an economic penalty induced by competitiveness distortions, and second, an animal penalty, insofar as competing countries that are less regulated would have an incentive to produce more animal products so that, ultimately, animal welfare would be globally degraded (Treich, 2018).

Animal public policies in the EU

Livestock holdings and the supply of livestock and livestock products are mainly regulated at the EU level within the CAP, complemented by a few national measures. By contrast, the consumption of animal products is essentially regulated at the MS level. Consumption regulations are much weaker than production regulations.

Livestock supply regulations within the CAP

The current CAP, which will apply at least until 1 January 2023, is composed of two pillars. The first pillar, totally funded by the EU budget, includes income support direct aids that represent the majority of CAP expenditure (€41 billion in 2018). It also includes market support spending, but for much lower amounts (less than €3 billion). The second pillar is co-financed by national and/or regional authorities, with EU expenditure equal to €14 billion spread over a number of measures. European holdings keeping livestock receive around 60% of these payments.

Market support and protection measures

Following the progressive suppression of producers' price guarantee measures and export subsidies, the European market for animal products today is directly supported by import tariff and non-tariff measures only. Although they were reduced

following the multilateral agricultural agreement of the Uruguay Round that concluded in 1994, the Most Favoured Nation (MFN) tariffs on EU imports of animal products remain high: nearly 50% for meat, 33% for processed meat and 30% for dairy products and eggs (Lawless and Morgenroth, 2016). The MFN tariffs continue to protect the European market, to limit imports from third countries and to maintain high domestic prices. The larger share of EU imports is thus achieved through agreements that include lower tariffs for predetermined quantities (tariff rate quotas). The failure of multilateral discussions in the Doha Round of the World Trade Organisation (WTO) has led the EU to negotiate numerous bilateral trade agreements with a high number of developing and developed countries. The question of tariff concessions on the imports of animal products that the EU accepts - or could accept in the framework of these bilateral agreements - is a sensitive issue, mainly because of their potential impacts on domestic animal production levels, prices and incomes.

Decoupled and coupled income support direct aids, cross-compliance and greening

EU livestock holdings benefit from the two generic income support measures of the first pillar; namely, basic income support direct aids and greening direct aids. Both types of aids are decoupled; that is, they are disconnected from production choices and levels in order to comply with WTO requirements of the so-called green box. These aids are granted in the form of payments per eligible hectare. This second characteristic implies that the larger the size in hectares, the higher the amounts of decoupled direct aids received by the farm. This positive correlation is a strong incentive to expand the size of holdings. It also raises the question of the unequal distribution of decoupled direct aids among farm holdings in a context where they

still include an historical component, implying that payments per hectare are much higher with intensive farms (high land productivity). On the other hand, decoupled direct aids also represent a large share of agricultural incomes for a large number of holdings. This implies that their reduction, or any change in their repartition, could affect the viability of numerous farms (Chatellier and Guyomard, 2020).

Both types of decoupled direct aids are subject to the so-called cross-compliance. In a first attempt to link CAP payments to minimal environmental requirements, they are granted only if farmers comply with Statutory Management Requirements (SMR) relating to environmental protection, food safety, public, animal and plant health, and animal welfare, plus obligations of Good Agricultural and Environment Conditions (GAEC) corresponding to basic farmland management rules. Non-compliance causes a reduction in payments. These reductions, and the way in which they are applied, are too weak to be dissuasive.

The greening of the CAP introduced within the 2013 CAP reform consists of three additional requirements that primarily target carbon sequestration and biodiversity preservation through: first, a minimal diversity of crops; second, the maintenance of permanent grassland at national or regional levels; and third, the management of at least 5% of arable land as Ecological Focus Areas (EFA). Green payments account for 30% of the national envelopes of first-pillar direct payments. Because smaller farms are excluded, the greening scheme covers “only” 70% of the EU agricultural area.

In addition, any MS has the option to maintain part of the first-pillar direct payments as coupled aids: up to a maximum of 13% with the option to go up to 15% if the additional 2% is targeted on protein plant production (fodder legumes for feed and grain legumes for human consumption). Eligible animal productions exclude pig and

poultry farms, except for organic farming holdings. In 2019, 27 out of 28 MS granted coupled direct aids to the value of €4.2 billion (EC, 2019c). Around 75% of these coupled direct aids were targeted to beef cattle (40%), dairy cattle (21%) and sheep and goats (13%). Because coupled support is limited to existing cattle heads, and only when there is a risk of agricultural land abandonment, insufficient product supply and/or adverse market effects, incentives to increase supply are theoretically limited. This argument can be questioned, notably because granting coupled direct aids to a sector in difficulty results in supply increases directly relative to a counterfactual scenario without corresponding aids.

Second pillar measures

European livestock farms can also benefit from several measures of the second pillar. Specifically, these are payments for Less-Favoured Areas (LFA) that were implemented in the early 1970s and payments for Agri-Environment and Climate Schemes (AECS) that became compulsory for all MS within the 1992 CAP reform. European farms can also benefit from organic farming aids, investment aids and economic aids aimed at developing official signs of quality, on-farm processing of farm products, short supply chains, etc. At the EU level, livestock holdings receive around two-thirds of the second pillar aids. LFA payments benefit specialised livestock farms and mixed cropping-livestock farms proportionally more, simply because they are more numerous and cover a larger share of eligible land area. This is also the case for AECS and investment aids (even if available statistics do not allow amounts to be quantified with any precision). AECS payments support farmers operating (more) environmentally friendly practices. These payments acknowledge that at least some of these practices can compete with

competitiveness objectives and induce higher production costs that justify compensation. The latter is limited to additional costs or income losses. Compulsory for MS but optional for farmers, AECS measures cover around 25% of the EU agricultural area with important variabilities among MS.

Climatic and environmental assessment

Climatic and environmental issues of EU agriculture are thus mainly addressed within the CAP trough cross-compliance, greening, AECS, and, to a lesser extent, LFA payments.[7] Cross-compliance and greening requirements are clearly too weak to generate significant climatic and environmental benefits (Pe'er *et al.*, 2019; Dupraz and Guyomard, 2019). The ecological efficiency of AECS is greater but limited by several drawbacks (Cullen *et al.*, 2018): support expenditure is modest, at less than €5 billion per year; private and public transaction costs are high; targets are numerous but potentially conflicting; windfall effects are frequent; etc. The incentives they provide are too low to do more than - at best - the conservation of localised ecological benefits.

Public policies targeted on consumption issues

Within the CAP, dairy products benefit from the so-called School Milk Programme, which combines the distribution of dairy products with educational activities. All agricultural products are eligible for promotional aids that aim to encourage the consumption of European products. The budgetary support granted under these two headings is modest, valued at a few hundred million euros per year.

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[7] The first and main objective of LFA payments is to compensate for the lower incomes earned by farmers located in disadvantaged areas. These payments can also be justified on the grounds that maintaining agricultural activity in these areas is beneficial for the environment because it limits farmland abandonment, maintains open and diversified landscapes and preserves biodiversity.

More generally, while the supply of animal products is subject to significant regulations at the EU level, demand is not, whether under consumption support or measures aimed at modifying inadequate food diets. Furthermore, consumption measures are essentially implemented at the MS level. Until now, nutritional policies have sought to advise on the health benefits of more balanced food diets in the form of dietary recommendations, information campaigns and/or nutritional labelling (Détang-Dessendre *et al.*, 2020). Dietary recommendations provide simple messages for consumers on different groups of products. In the case of meat, the general message is to limit consumption with, in some MS, an invitation to try alternative protein sources. Recommendations vary from one MS to another (Springmann *et al.*, 2020). For red meat, numerous MS recommend a maximum of 500 grams per week. This quantity may be lower (300 grams per week in the Netherlands), and even much lower (one serving per week in Greece). In the case of processed meat, recommendations are to limit, and sometimes avoid (Greece), consumption. In the case of milk and dairy products, recommendations are less heterogeneous (two or three portions per day).

Public policy recommendations

The analysis presented in the previous sections can be summarised by three main points. First, animal production in the EU faces significant challenges on all dimensions of sustainability, including the health dimension, which also encompasses their acceptability by at least a part of the European population. Second, even if some livestock systems and territories provide positive ecosystem services, numerous European livestock farms and territories are not located in a secure operating space within which they can develop in a sustainable way

(Buckwell and Nadeu, 2018). Third, this is to a large part due to the failure of the CAP in not being able to favour the development at a large scale of more environmentally friendly livestock systems, and, more generally, more environmentally friendly farming systems. In addition, policy measures that favour the adoption of less caloric and more balanced food diets have failed.

Of course, the objective hierarchy varies depending on species, systems, territories and consumption patterns. However, in all cases, these objectives should be focused simultaneously on the following:

- reducing the negative climatic, environmental and health impacts of animal production and consumption, notably by reducing GHG emissions, nutrient leakages into the environment and antibiotic use; and improving animal welfare and reducing the consumption of animal products when the latter does not comply with nutritional recommendations;
- increasing the provision of amenities, notably those associated with grassland-based systems (carbon storage, biodiversity preservation, water purification, and the maintenance of diversified and open landscapes);
- offering higher and more stable incomes to livestock farmers, notably with animals adapted to multiperformance (fertility, longevity, etc.) and with more flexible holdings responding to market opportunities (including the possibility of shifting to plant productions);
- providing better working conditions to all actors within the food animal chain; not only livestock farmers, but also transport, slaughtering and transformation actors;
- and, more generally, reconciling livestock and society in the framework of peaceful relationships, recognising the complexity of the question and that

animal production and consumption does have adverse effects (that should be reduced) and positive impacts (that should be maximised)

Current policies, be they defined at the EU or MS level, are deficient in many, if not all, of the objectives listed above. This is despite the progressive integration of climatic and environmental objectives and instruments into the CAP, and is also despite the high direct aids granted to livestock farmers within the CAP. The positive side to granting high direct aids to livestock farmers is that it provides important room for manoeuvre in terms of reorienting this support towards greater sustainability. However, because CAP aids represent a high share of livestock farmers' incomes (sometimes more than 100%), their necessary reorientation can only be gradual in order to limit economic risks. On the other hand, this income dependency to aids should not be used - as has too often been the case in the past - as a pretext to maintain a situation of status quo, where barely anything would change.

In that general context, this section provides policy recommendations based on simple but robust principles of public economics (Salanié, 2000; Laffont, 2008) and of fiscal federalism (Oates, 1972).

Ensuring the agro-ecological transition of livestock farms within the CAP

European livestock farmers must resolutely engage in the agro-ecological transition of their production systems in order to minimise climatic, environmental and health impacts, and, possibly, to increase the provision of amenities. The CAP must promote this necessary and urgent change. It will do so more effectively (i.e., in the most efficient way) if it relies as closely as possible on lessons from the theory of public economics, which is far from being the case in the current CAP.

A stricter application of the Polluter Pays Principle

An optimal or first-rank policy requires a much more systematic and rigorous application of the Polluter Pays Principle (PPP). This could be achieved through the taxation of the main determinants of agricultural GHG emissions (nitrogen fertilisers and cattle populations) and environmental damages, notably biodiversity loss in agro-ecosystems (excess nutrients, synthetic pesticides and veterinary products). Such a taxation scheme should send the right price signals to all actors within the food chain. However, taxation policies are the sovereign prerogatives of MS, and there is no doubt that it will be very difficult - if not impossible - to obtain a political agreement on a taxation scheme at the EU level. Because climate and biodiversity are global public goods, it is crucial that the PPP applies an implementation scale at the EU level that will have the additional benefit of limiting competitiveness distortions among MS. Fortunately, a similar climatic and environmental outcome can be achieved through the current or planned instrumentation of the CAP,[8] more specifically, by considerably reinforcing conditionality requirements, removing derogations and adaptations that contribute to make them poorly efficient and by making penalties for non-compliance truly dissuasive (Détang-Dessendre *et al.*, 2020).

An improved legitimacy and efficiency of the Provider Gets Principle

A more systematic and rigorous implementation of the PPP would enhance the legitimacy of its counterpart, the Provider Gets Principle (PGP), which underlies (but only partially) the AECS of the current CAP, and would underlie both the AECS and

[8] The proposals for the CAP after 2020 presented by the EC in June 2018 (EC, 2018a, b and c) would maintain the cross-compliance requirements that would be augmented by including the three greening criteria. Cross-compliance and greening would be grouped under a new single title called conditionality.

the ecoscheme in the future CAP.[9] Additional climatic and environmental efforts that go beyond regulatory minima defined by conditionality requirements should be encouraged. Payments should not be limited (as is the case today) to the compensation of additional costs or profits foregone. They should be proportional to ecological benefits that a shift from an obligation of means (practices) to an obligation of results (impacts) will make easier. Given the diversity of these benefits and their variability depending on systems and territories, a service package approach is an interesting avenue to explore. We will illustrate this point with the example of grasslands.

Permanent and temporary grassland areas have been eroded for a long time in the EU due to a lack of adequate protection (Huyghe *et al.*, 2015). The decrease in permanent grassland appears to have ceased since the start of 2000, thanks in particular to cross-compliance and greening measures aimed at their maintenance. However, these areas have continued to decline in some regions, even in the most recent years (for example, in France, in the regions of Hauts-de-France and Normandy). Beyond minimal conditionality requirements, there is legitimacy to remunerate the numerous ecological services provided by grasslands, and to increase remuneration amounts with the quantity and quality of services they provide. To that end, a new regulatory definition of grasslands should be proposed based on their age, composition (plant species) and management. This is because these three characteristics are the main determinants of the quantity and quality of ecological services that grasslands can provide (Smith, 2014; Kruse *et al.*, 2016).

[9] The proposals for the future CAP would include a new instrument in the first pillar, the so-called ecoscheme. Like the AECS, the latter would compensate and possibly remunerate farmers for climatic and environmental efforts above conditionality requirements. Unlike the AECS, the ecoscheme would be totally funded by the EU budget by means of annual contracts.

For the sake of simplicity, we propose to define permanent grassland as land used to grow grasses or other herbaceous forages that are not included in the crop rotation for 10 years or more (instead of the current five years or more). Conditionality requirements would be based on this revised definition of grassland. They would be supplemented by payments for climatic and environmental services on the basis of a five-level grid corresponding to: (i) temporary grassland; (ii) temporary grassland of less than five years with legumes; (iii) temporary grassland of more than five years with legumes; (iv) intensively managed permanent grassland where intensification will be assessed by a criterion of stocking rate per hectare; and (v) extensively managed permanent grassland. The package of climatic and environmental services provided by grassland areas increases along this gradient: this must be same for payments.

These payments for ecological services could be financed by using a share of the envelope of decoupled and coupled direct aids. Ideally, coupled direct aids to livestock (slightly more than €3 billion per year) should be suppressed, because they suffer from numerous drawbacks. They are less efficient income support measures than decoupled direct aids and second-pillar payments, partly because they generate high administrative costs (Ciaian *et al.*, 2013). They do not provide incentives to optimise animal performance, nor the total productivity of production factors (Rizov *et al.*, 2013). They contribute to maintain livestock farmers in the productions that are supported in this way, and in doing so, limit the necessary adaptation and reorientation in response to market demands and consumer expectations. This is all the more so as investments in livestock materials and buildings are designed with these coupled directs aids in mind, which increases the fixation in beneficiary productions. One could object that livestock coupled direct

aids contribute to maintain activity in LFA, simply because beneficiary holdings are mostly located in these territories. However, there exists an instrument of the second pillar that precisely targets this objective of maintaining agriculture in the entire European territory by compensating higher production costs in disadvantaged areas. Rather than use two instruments for the same objective, it would be more efficient to use the measure of aids for the compensation of natural handicaps for a territorial objective, and to replace coupled direct aids to livestock by payments for climatic and environmental services that sustainable livestock systems - notably grassland-based systems - can provide.

The same rationality based on a consistent and balanced use of both the PPP and the PGP could also apply to animal welfare. The latter can be considered as a global public good. As a result, its optimal provision requires an intervention of public authorities at the EU level. Minimal requirements should be reflected in the conditionality criteria (that are very likely insufficient on this point in the current CAP). Efforts that go beyond these minimal requirements should also be encouraged by payments for animal welfare services based on performance obligations; that is, direct measures on animals and herds.[10]

Supporting livestock farmers' incomes in a dynamic perspective

The weight of the different aids of the current CAP in livestock farmers' incomes requires a transitional period. It is clear that an increased implementation of the PPP and the PGP along the lines described above could threaten the economic viability

[10] In a more general way, the shift from an obligation of means to an obligation of results would facilitate the development of payments for ecosystem services that would be funded, not only by taxpayers, but also by intermediate and final users. The development of market solutions would allow the CAP budget constraints to be alleviated.

of numerous European livestock farms if applied too suddenly and without adequate consultation. On the other hand, there is some urgency to reduce the climatic and environmental footprint of European livestock. The path of the necessary agro-ecological transition of livestock systems, and, more generally, all farming systems, is thus narrow. Four measures could enlarge this path and minimise adverse income effects. First, a temporary risk premium could be granted to any farmer firmly committed to the agro-ecological transition, along the lines of premiums paid to farmers in their conversion towards organic farming. Second, the product of any ecological tax could be maintained in the farming sector through a bonus-malus scheme, which would encourage “virtuous” farmers and penalise “less virtuous” farmers. Third, agricultural trade agreements signed by the EU should include identical climatic, environmental and health requirements to ensure a fair and level-playing field among MS. Finally, investment aids granted through the second pillar should be increased, provided that farmers prove that supported investments allow the reduction in the consumption of fossil energy, the reduction in climatic and environmental damages and an improvement in animal welfare.

Beyond the CAP, do we need to regulate the consumption of animal products?

As shown in Section 3, the consumption of animal products - notably the excessive consumption of red and processed meat - is not without negative consequences on human health, the climate and the environment. These negative impacts justify consumption regulation policies. However, justifications are not automatic for all, and vary in function of the nature of impacts.

In the case of health, a first possibility is to consider the consumer as being sovereign, responsible for her/his food choices. According to this first logic, a

deleterious effect on health due to an inadequate consumption pattern is only a matter of private choice and does not give rise to intervention by public authorities. This first vision suffers from two flaws. First, because national health systems are essentially funded by taxpayers, as a result, health costs are largely borne by the community as a whole and not by individuals. This situation corresponds to a negative externality justifying the intervention of public authorities to correct the problem at its source, thereby changing inadequate food diets. Second, health effects linked to unsuitable eating patterns appear only in the long term. It is thus very difficult for the consumer to integrate negative health effects in her/his short-term decisions. These two drawbacks justify a “paternalistic” policy (Griffith and O’Connell, 2010).

In the case of climatic and environmental impacts, the theory of public economics recommends intervention as the source of the externality, here to act on supply-side processes. However, supply regulations are difficult to design and implement in an optimal way, notably because they require pollution levels to be measured at the farm level, taking into account the specificities of territories in which they are located. Information needs are enormous, and their collection is complex and costly. As a consequence, public authorities may consider - as a valuable alternative or as a complement – the simultaneous regulation of consumption patterns. This raises two main questions, linked to the choice of consumption regulation instruments and to the geographical level of their implementation.

Consumption regulation instruments

Three main types of policy instruments can be used to influence the consumption of animal products: first, fiscal instruments; second, instruments aimed at providing more and better information; and third, behavioural instruments.

To date, only very few MS have introduced taxes to limit the consumption of animal products. In 2011, Denmark introduced a tax on saturated fatty acids (SFA) in order to reduce their consumption. More specifically, it introduced a tax of €2.15 per kilogram of SFA on products (butter, margarine, etc.) containing more than 2.3 grams of SFA per 100 grams of product. This policy resulted in a 10-15% decrease in SFA consumption (Jensen and Smed, 2013). It also led some consumers to switch to lower priced distribution channels. The tax was withdrawn in 2013 because of the high administrative costs of the scheme, controversies over its inflationary effects, cross-border purchases and the negative impacts on the economic results of firms.

Various papers have tried to simulate the impacts on health and GHG emissions of food taxation/subsidy schemes based on the content of GHG in products. Results can be summarised in five points (Doro and Réquillart, 2020): (i) animal products and notably meats are the most heavily taxed products; (ii) the consumption of red meat is the most impacted because it is the most taxed; (iii) the consumption of white meat is less impacted, not only because it is less taxed but also because it partially replaces red meat; (iv) GHG emissions of food diets are reduced, but only to a limited extent (less than 10% even when taxes are based on high carbon prices); and (v) the health impacts of taxes depend on the scheme design: in revenue-neutral scenarios, impacts on health are highest when meats are taxed and tax revenues are used to subsidise the consumption of fruits and vegetables.

By contrast, many MS have set up information campaigns as part of their nutritional policies. The most famous example of such an information campaign is the “eat five fruit and vegetables a day” recommendation. Campaigns aimed at increasing the consumption of fruit and vegetables have a positive impact on consumption levels of these products that is, however, only modest (Capacci and Mazzocchi, 2011). Interestingly, Castiglione and Mazzocchi (2019) showed that in the United Kingdom, the increased consumption of fruit and vegetables was accompanied by a decreased consumption of meat. Information campaigns aimed at changing meat consumption patterns are less developed, and their effects are less known. However, simulation work suggests that such campaigns targeted at meat consumption would increase social welfare. Such simulation work using French data suggests that in the case of red meat, they would lead to a reduction of the GHG emissions of diets while generating positive health impacts (Irz *et al.*, 2016).

Food labels provide information to consumers that allow them to better select products according to characteristics that would otherwise be difficult to assess (production methods, content in GHG, nutritional score, etc.). Labels can help guide consumers’ choices towards healthier and/or more environmentally friendly food products. Corresponding products are generally more expensive. They will be bought only if consumers have a positive willingness to pay (WTP). Numerous studies show that this WTP is positive for attributes related to product safety and health, but is much less positive for environmental attributes. This difference can be explained by the fact that the first characteristics have a direct impact on the consumer who consumes the product, while environmental characteristics do not have such a direct impact, suffering from the well-known problem of financing public goods: even if a consumer cares about the environment, she/he will be relatively

reluctant to pay a price premium for more environmentally friendly food products because of the small impact of her/his individual consumption on the environment.

Food consumption is more than the sole economic act of choosing a basket of goods. It includes hedonic, historical, cultural, social and religious dimensions that contribute to explaining why it is so difficult to change food consumption behaviours. Nevertheless, it is worth attempting to change behaviours by creating new norms. The latter can be the result of public and/or private actions, as well as of initiatives developed by associations, as, for example, the meatless Monday campaign that started in the United States in 2003 and today extends to more than 40 countries. Easy to understand, this type of campaign can help the consumer “to take the plunge” in changing entrenched habits. It can also have an impact on the supply side; for example, by leading restaurant owners to change their menu for one day of the week.

Several experiments with nudges - positive reinforcement and indirect suggestions as ways to influence the behaviour of individuals or groups of individuals - have been implemented with the aim of changing food consumption patterns. Impacts would be positive but limited in scope (Cadario and Chandon, 2019). For example, making it easier to choose a vegetarian menu in a restaurant would increase the choice of this menu by six percentage points (Kurz, 2018). Implementing targeted communication by providing comparative information to targeted people is also a solution. Facilitated by the development of information and communication technologies, the development of this type of communication is not without its drawbacks: implementation costs, credibility of messages, risks of manipulation, etc. (Kurz, 2018).

Geographical level of implementation: at the EU or MS level?

To date, nutritional policies have been essentially designed and implemented at the MS level. This spatial scale can be justified for at least two reasons: first, because there is no spatial externality in this domain; and second, because it is therefore possible to take account of national heterogeneities in diets and preferences. The latter depends on the macro-economic context (income levels of the different socio-professional categories) but also on non-economic factors, such as history, tradition or culture. The rationale for maintaining nutritional policies at the MS level is reinforced by the fact that a large portion of costs related to the adverse health effects of too caloric and unbalanced diets are borne at the national level (production losses, health insurance costs, disability pension expenditures, etc.). These costs remain high today. They should increase in a trend scenario, and call for an important strengthening of current nutritional policies, using the full range of tools described above.

This does not mean that there is not a role for European policies, including the CAP. In particular, the universal nature of nutritional recommendations means that the broad outlines of these policies would benefit from being defined at the EU level. They would then be adapted to country specificities; notably, the differences in consumers' preferences and food baskets.

Conclusion

European livestock is at a crossroad. Its production and management should urgently and significantly evolve in order to reduce its climatic and environmental footprint. From that perspective, the Green Deal launched by the new EC in December 2019 is an opportunity for further investigation. The latter "resets the EC commitment to tackling climate and environmental-related challenges that is this

generation's defining task" (EC, 2019a). While the EC communication on the Green Deal draws the general framework for the whole EU, its application to farm and food systems is detailed in the new EU Biodiversity Strategy for 2030 and, more importantly, in the Farm to Fork Strategy (F2FS), both released in May 2020 (EC, 2020a, 2020b).

The Green Deal objectives are extremely ambitious, including for EU farm and food systems, for which it sets several quantitative reduction targets by 2030 for pesticides, fertilisers and antibiotics, and quantitative increase targets by the same date for organic farming, protected areas and agricultural areas under high-diversity landscape features. Its focus on the three related issues of climate, environment (notably biodiversity) and health are welcome, and should be encouraged and supported for all EU activities in general and also for farm and food activities in particular. The whole and holistic approach adopted by the Green Deal, recognising the need to act on all compartments of the food chain in an articulated and consistent fashion, is also welcome, and should be encouraged and supported. It is at odds with the route followed by the CAP reform process that, since 1992, has continuously placed agriculture and its evolution at the heart of discussion and new measures. The June 2018 proposals for the future CAP are no exception. These proposals raise the first question of the capacity of the future CAP to contribute to achieve the Green Deal objectives related to farm and food systems. Our recommendations presented in Subsection 5.1 of this paper aim at defining the guidelines that would allow the compatibility between the Green Deal and the next CAP to be maximised. However, acting only on supply is not sufficient and should be completed by demand measures, at both the EU and MS levels.

Recommendations presented in Subsection 5.2 provide guidelines for supplementing CAP measures focused on supply.

Ethics approval

Not relevant for this review paper.

Author contributions

All authors designed and performed the reviews. V.C. wrote the first draft of Section 2. J.-L.P. and Z.B-M. wrote the first draft of Section 3. C.D.-D. and H.G. wrote the first draft of Section 4. L.D., H.G. and V.R. wrote the first draft of Section 5. Z.B-M., J.-L. P., V.R. and H.G. made the final editing revisions of the paper.

Declaration of interest

The authors declare no competing interests.

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References

Animal Task Force (ATF), 2017. Why is European animal production important today? ATF, Facts and Figures, Brussels, Belgium, 5 p.

Bouvard, V., Loomis, D., Guyton, K.Z., Grosse, Y., Ghissassi F.E., Benbrahim-Tallaa L., Guha N., Mattock H., Straif K., 2015. Carcinogenicity of consumption of red and processed meat. Lancet Oncology 16, 1599-1600.

Buckwell, A., Nadeu E., 2018. What is the safe operating space for EU Livestock? RISE Foundation, Brussels, Belgium, 108 p.

Cadario, R., Chandon, P., 2019. Which healthy eating nudges work best? A meta-analysis of field experiments. Marketing Science 39(3), 465-486.

Capacci, S., Mazzocchi, M., 2011. Five-a-day, a price to pay: An evaluation of the UK program impact accounting for market forces. Journal of Health Economics 30(1), 87-98.

Castiglione, C., Mazzocchi, M., 2019. Ten years of five-a-day policy in the UK: Nutritional outcomes and environmental effects. Ecological Economics 157, 185-194.

Chatellier, V., Guyomard, H., 2020. PAC et revenus agricoles. In Quelle politique agricole commune demain ? (Eds. C. Détang-Dessendre, H. Guyomard). Editions Quae, Versailles, France, pp. 43-61.

Ciaian, P., d'Artis, K., Gomez y Paloma S., 2013. Income distributional effects of CAP subsidies. Outlook on Agriculture 44 (1), 19-28.

Cullen, P., Dupraz, P., Moran, J., Murphy, P., O'Flaherty, R., O'Donoghue, C., O'Shea, R., Ryan, M., 2018. Agri-environment scheme design: Past lessons and future suggestions. EuroChoices 17 (3), 26-30.

Dall-Orsoletta, A.C., Leurent-Colette, S., Launay, F., Ribeiro-Filhoa, H.M.N., Delaby L., 2019. A quantitative description of the effect of breed, first calving age and feeding strategy on dairy systems enteric methane emission. Livestock Science 224, 87-95.

Détang-Dessendre, C., Guyomard, H., coordinators, 2020. Quelle politique agricole commune demain ? Editions Quae, Versailles, France, 305 p.

Détang-Dessendre, C., Guyomard, H., Réquillart, V., Soler, L.-G., 2020. Changing agricultural systems and food diets to prevent and mitigate global health shocks. Sustainability 12 (16), 6462.

De Smet, S., Vossen, E., 2016. Meat: The balance between nutrition and health: A review. Meat Science 120, 145-156.

De Vries, M., de Boer, I.J.M., 2010. Comparing environmental impacts for livestock products: A review of life cycle assessments. Livestock Science 128 (1-3), 1-11.

Doro, E., Réquillart, V., 2020. Review of sustainable diets: are nutritional objectives and low-carbon-emission objectives compatible? Review of Agricultural, Food and Environmental Studies, doi: 10.1007/s41130-020-00110-2.

Dumont, B., Ryschawy, J., Duru, M, Benoit, M., Chatellier, V., Delaby, L., Donnars, C., Dupraz, P., Lemauviel-Lavenant, S., Méda, B., Vollet, D., Sabatier, R., Dupraz, P., Donnars, C., coord., 2019. Review: Associations among goods, impacts and ecosystem services provided by livestock farming. Animal 13 (8), 1773-1784.

Dupraz, P., Guyomard, H., 2019. Environment and climate in the Common Agricultural Policy (CAP). EuroChoices 18 (1), 18-25.

European Commission (EC), 2016. Attitudes of European towards animal welfare. Special Eurobarometer 442, March 2016, EC, Brussels, Belgium, 88 p.

European Commission (EC), 2018a. EU Agricultural Outlook: For markets and income, 2018-2030. EC, Brussels, Belgium, 128 p.

European Commission (EC), 2018b. Questions and Answers on the new legislation on Veterinary Medicinal Products (VMP) and Medicated Feed. EC, Brussels, Belgium, Fact Sheet, 26 November 2018, 3 p.

European Commission (EC), 2019a. The European Green Deal. EC, Brussels, Belgium, COM (2019) 640 final, 11.12.2019, 24 p. + Annex.

European Commission (EC), 2019b. Stepping up EU Action to protect and restore the world's forests. EC, Brussels, Belgium, COM (2019) 352 final, 23.7.2019, 22 p.

European Commission (EC), 2019c. Voluntary coupled support. EC, Brussels, Belgium, Informative Note, 39 p.

European Commission (EC), 2020a. EU Biodiversity Strategy for 2030 - Bringing nature back into our lives. EC, Brussels, Belgium, COM (2020) 380 final, 20.5.2020, 23 p. + Annex.

European Commission (EC), 2020b. A Farm to Fork Strategy – For a fair, healthy and environmentally-friendly food system. EC, Brussels, Belgium, COM (2020) 381 final, 20.5.2020, 20 p. + Annex.

European Environment Agency (EEA), 2019. Annual European Union greenhouse gas inventory 1990-2017 and inventory report 2019. EEA, Brussels, Belgium, 962 p.

European Medecines Agency (2018). Annual Report 2018. EMA, Brussels, Belgium, 100 p.

European Parliament, 2017. Animal welfare in the European Union. European Parliament, Brussels, Belgium, Study for the PETI Commission, 78 p.

FAO, 2013. Dietary Protein Quality Evaluation in Human Nutrition: Report of an FAO Expert Consultation. Food and Nutrition Paper 92, FAO, Rome, Italy, 79 p.

Farm Animal Welfare Committee (FAWC), 2011. Economics and farm animal welfare. Report of the FAWC, London, United Kingdom, 52 p.

Eurostat, 2019. Agri-environmental indicator - livestock patterns. Eurostat, Statistics Explained, Data from January 2019, Brussels, Belgium (online publication).

Greenpeace, 2019. Feeding the problem: The dangerous intensification of animal farming in Europe. Greenpeace, Brussels, Belgium, 20 p.

Griffith, R., O'Connell, M., 2010. Public policy towards food consumption. Fiscal Studies 31 (4), 481-507.

Guyomard, H., Darcy-Vrillon B., Esnouf C., Marin M., Russel M., Guillou M., 2012. Eating patterns and food systems: Critical knowledge requirements for policy design and implementation. Agriculture and Food Security, 1-13.

Hostiou, N., Vollet, D., Benoit, M., Delfosse, C., 2020. Employment and farmers' work in European ruminant livestock farms: A review. Journal of Rural Studies 74, 223-234.

Huyghe, C., Peeters, A., de Vliegher, A., 2015. The prairie in France and Europe. Paper present at the colloquium on methods and results of the Climagie project, November 25, 105, Poitiers, France, 13 p.

INRA, 2019. Quels sont les bénéfices et les limites d'une diminution de la consommation de viande. Note et Infographie, INRA, Paris (online publication).

Irz, X., Leroy, P., Réquillart, V., Soler, L.-G., 2016. Welfare and sustainability effects of dietary recommendations. Ecological Economics 130, 139-155.

Jensen, J., Smed, S. 2013. The Danish tax on saturated fat – short run effects on consumption, substitution patterns and consumer prices of fats. Food Policy 42, 18¬ 31.

Jones, B.A., Grace, D., Kock, R., Alonso, S., Rushton, J., Said, M.Y., McKeever, D., Mutua, F., Youg, J., McDermott, J., Pfeiffer, D.U., 2013. Zoonosis emergence linked to agricultural intensification and environmental change. Proceedings of the National Academy of Sciences 110 (21), 8399-8404.

Key, T.J., Appleby, P.N., Rosell, M.S., 2006. Health effects of vegetarian and vegan diets. Proceedings of the Nutrition Society 65 (1), 35-41.

Klumpp, K., Fornara, D.A., 2019. The carbon sequestration of grassland soils - climate change and mitigation strategies. Proceedings of the 27th General Meeting of the European Grassland Federation, Cork, Ireland, 17-21 June 2028, pp. 509-519.

Kruse, M., Stein-Bachinger, K., Gottwald, F., Schmidt, E., Heinken, T., 2016. Influence of grassland management on the biodiversity of plants and butterflies on organic suckler cow farms. Tuexenia 36, 97-119.

Kurz, V., 2018. Nudging to reduce meat consumption: immediate and persistent effects of an intervention at a university restaurant. Journal of Environmental Economics and Management 90 (C), 317-341.

Laffont, J.-J., 2008. Fundamentals of Public Economics. MIT Press, Cambridge, Massachusetts, 275 p.

Lang, A., Perrot, C., Dupraz, P., Tregaro, Y., Rosner, P.-M., 2015. Les emplois liés à l'élevage français. GIS Elevages Demain, Paris, France, 444 p.

Lawless, M., Morgenroth, E.L., 2016. The product and sector level impact of a hard Brexit across the EU. Economic and Social Research Institute (ESRI), Dublin, Ireland, Working Paper n° 550, 29 p.

Leip, A., Billen, G., Garnier, J., Grizzetti, B., Lassaletta, L., Reis, S., Simpson, D., Sutton, M.A., de Vries, W., Weiss, F., Westhoek, H., 2015. Impacts of European livestock production: nitrogen, sulphur, phosphorus and greenhouse gas emissions, land use, water eutrophication and biodiversity. Environmental Resource Letters 10 115004.

Lesschen, J.-P., van den Berg, M., Westhoek, H.J., Witzke, H.P., Oenema, O., 2011. Greenhouse gas emission profiles of European livestock sectors. Animal Feed Science Technology 166-167, 16-28.

Martin, G., Durand, J-L., Duru, M., Gastal, F., Julier, B., Litrico, I., Louarn, G., Médiène, S., Moreau, D., Valentin-Morison, M., Novak, S., Parnaudeau, V., Vertès, F., Voisin, A.-S., Cellier, P., Jeuffroy, M.-H., 2020. Role of ley pastures in tomorrow's cropping systems. A review. Agronomy for Sustainable Development 40:17.

Mohr, A., Raman, S., 2013 Lessons from first generation biofuels and implications for the sustainable appraisal of second generation biofuels. Energy Policy 63, 114-122.

Mora, O., de Lattre-Gasquet M., Le Mouël C., 2018. Land Use and Food Security in 2050: A Narrow Road - Agrimonde-Terra. Editions Quæ, Collection Matière à débattre, Versailles, France, 400 p.

Mormède, P., Boisseau-Sowinski, L., Chiron, J., Diedrich, C., Eddison, J., Guichet, J.-L., Le Neindre, P., Meunier-Salaun, M.-C., 2018. Bien-être animal : contexte, définition, évaluation. INRA Productions Animales 31 (2), 145-162.

Mottet, A., de Haan, C., Flacucci, A., Tempio, G., Opio, C., Gerber, P., 2017. Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. Global Food Security 14, 1-8.

Oates, W.E., 1972. Fiscal Federalism. Harcourt, New York, United States, 256 p.

Pe'er, G., Zinngrebe, Y., Moreira, F., Sirami, C., Schindler, S., Müller, R., Bontzorlos, V., Clough, D., Bezák, P., Bonn, A., Hansjürgens, B., Lomba, A., Möckel, S., Passoni, G., Schleyer, C., Schmidt, J., Lakner, S., 2019. A greener path for the EU Common Agricultural Policy: It's time for sustainable, environmental performance. Science 365 (6452), 449 - 451.

Pierre F., 2016. Produits carnés et risques de cancer : rôle du fer héminique et de la peroxydation lipidique. Viandes & Produits Carnés, November 2016, 7 p.

Poore, J., Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. Science 360, 987-992.

Rizov, M., Pokrivcak, J., Ciaian, P., 2013. CAP subsidies and productivity of the EU farms. Journal of Agricultural Economics 64 (3), 537-557.

Salanié, B., 2000. Microeconomics of market failures. MIT Press, Cambridge, Massachusetts, 240 p.

Smith, P., 2014. Do grasslands act as a perpetual sink for carbon? Global Change Biology 20(9), //doi.org/10.1111/gcb.12561.

Springmann, M., Spajic, L., Clark, M.A., Poore, J., Herforth, A., Webb, P., Rayner, M., Scarborough, P., 2020. The healthiness and sustainability of national and global food based dietary guidelines: modelling study. British Medical Journal, 370:m2322.

Treich, N., 2018. Veganomics: vers une approche économique du véganisme. Revue française d'économie XXXIII (4), 3-48.

WHO, 2011. Tackling antibiotic resistance from a food safety perspective in Europe. World Health Organization (WHO), Regional Office for Europe, Copenhagen, Denmark, 88 p.