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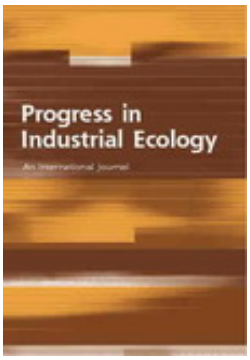

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Contributions to a more sustainable model of food production and consumption in Portugal: an opportunity to reduce the ecological footprint of food

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Contributions to a more sustainable model of food production and consumption in Portugal: an opportunity to reduce the ecological footprint of food

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Abstract: This article evaluates the possibility of resolving three imbalances in Portugal in a single equation: reducing the food footprint, improving the trade balance, and increasing human consumption of vegetables, contributing to a healthier diet. According to our results, a reduction in the consumption of beef, achieved mainly by reducing imports, combined with an increase in the production of vegetables and cereals for baking, reduces the trade deficit by around 460 million euros per year and improves the Food Footprint by 20% in average. These goals, along with the increased consumption of vegetables, also have a positive effect on the health of Portuguese families. To achieve these objectives, it is necessary to establish new rules for the application of the common agricultural policy in Portugal.

Keywords: food footprint; agri-food trade balance; sustainable agriculture; common agricultural policy; strategic plan; Portugal.

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1 Introduction

Food demand has become infinitely more complex in recent years. It goes far beyond simple nutritional concerns. It is also a response to social, public health and environmental factors. The world population is still growing and the demand for food grows every year. In 2050, the world population is expected to reach 9 billion people. The Food and Agriculture Organization of the United Nations (FAO) estimates that food production needs to increase 70% by 2050 to feed the 2.3 billion extra people estimated by then. However, this increase must consider, on one hand, the limits of existing resources and the environmental and social impacts of any increase of food production, and on the other, the deep inequalities across the planet. Climate change caused in part by the intensive production models of developed countries is compromising the ability of poor countries to produce food for their population (Alam et al., 2018). Thus, the FAO

argues that this increase in food supply must be based on the development and growth of family farming in developing countries (FAO and IFAD, 2019).

Food demand is therefore differentiated according to economic and social contexts. In developed countries, factors related to food quality and safety, animal welfare or environmental sustainability of the food chain become essential in determining food consumption. It is important to bear in mind that food consumption in Portugal represents around 19% of total household expenditure, while in other countries this percentage can reach 80% (PORDATA, 2021). The crucial issue facing governments around the world and particularly in the most prosperous countries is the need to feed the population within the limits of our ecosystems and respecting a set of social, labour and human rights, and environmental standards.

Portugal has a chronic deficit in its agri-food balance. This balance has worsened with the entry into the European Union in 1986. This deficit weighs negatively on the macroeconomic stability of Portuguese economy. It implies the outflow of financial resources which could be used to respond to the many needs of the population. On the other hand, this deficit simultaneously worsens the Ecological Footprint of food (from here we will use the expression 'Food Footprint') of the Portuguese population, especially with regard to the emissions associated to the transport of these goods, many of which come from other continents. With a large area of abandoned territory, Portugal has a negative agri-food trade balance of around 3 billion euros per year. In areas where agricultural goods were previously produced, the population left in search for higher incomes and better job opportunities, fuelling a rural exodus that urgently needs to be reversed. No country can be self-sufficient in all the goods it needs, and international trade can generate mutual benefits. Nevertheless, it can also often generate harmful effects for the population and the environment, especially when there are external factors which are not incorporated into the pricing system.

According to the Ecological Footprint of Portuguese Municipalities project, the Ecological Footprint of each Portuguese citizen in 2016 greatly exceeded national biocapacity (Galli et al., 2020b). The Ecological Footprint Accounting (EFA) concept, created by Mathis Wackernagel and William Rees in the 1990s, compares the amount of resources needed to sustain the socioeconomic development of our society with the capacity of the ecological assets available on the planet (Borucke et al., 2013; Wackernagel et al., 2002, 2004). The ecological assets that determine the biocapacity of the country or region are composed of arable land, pastures, aquatic environments associated with fishing and aquaculture (marine and freshwater) and forest and constructive support areas for infrastructure (Galli et al., 2014). Consumption needs in Portugal have already exceeded its biocapacity since the 1960s. This deficit worsened with its entry into the European Union. In 2014, the per capita equivalent consumption of Portuguese citizens (3.69 gha) required an area equivalent to more than three times the global biocapacity per capita in Portugal (1.28 gha) (Galli et al., 2020b). According to these authors, 29% of the Ecological Footprint derives from food. Thus, the food sector represents the one with the greatest weight in the Ecological Footprint, followed by transports (20%) and housing (10%). Food Footprint alone (associated with the food and beverage sector) almost exceeds the country's total biocapacity and in 2020, the Portuguese situation worsened (Global Footprint Network, 2021). The per capita Ecological Footprint was estimated at 4.4 gha, compared to the per capita biocapacity of 1.3 gha.

According to the cited authors (Galli et al., 2020a), this is mainly due to three reasons. First, as in most developed countries, there is an excessive consumption of food that goes beyond the 2,500 daily calories per person (on average) recommended by the FAO (*FAOSTAT*, n.d.). Secondly, there is a significant food waste estimated at around one million tons, corresponding to 17% of processed foods annually (Baptista et al., 2012). Finally, the diet of Portuguese families contains large amounts of foods that are very harmful to the environment, including excessive consumption of animal protein, such as certain types of fish (tuna or cod) or meat (beef) (Galli et al., 2020a).

The General Directorate of Health (DGS) has published several surveys on the nutrition of Portuguese families. Despite Portugal being considered a developed country, a DGS report (PNPAS, 2021) stated that a third of Portuguese families were at risk of food insecurity during COVID-19 lockdown, with a value well above the pre-pandemic percentage of 10%. The risk of food insecurity occurs when there is difficulty in providing food for the whole family due to lack of financial resources. Considering the global consumption of Portuguese families (which obviously differs significantly), the latest National Food and Physical Activity Survey (IAN-AF) confirms the food imbalances mentioned above and gives some clues about what needs to be corrected (Lopes et al., 2018). According to the survey, Portuguese families exceed the recommended consumption of red meat and remain well below the minimum values recommended for fresh vegetable foods.

The food system is heavily influenced by public policies, which have a local, national, and international dimension. Food should therefore be a priority target in policies which combat climate change, since it represents a significant part of green gases emissions (Collins and Fairchild, 2007). To reduce the food footprint and increase the sustainability of food systems, public policies need to align consumer eating behaviour with seasonal production cycles and shorten the distance between production and consumption as much as possible (Döner et al., 2020). The promotion of sustainable consumption has been the subject of several studies (Gómez et al., 2022). Portugal had its Strategic Plan for the Common Agricultural Policy (PEPAC) of the European Union (EU), which establishes the rules for the application of the Common Agricultural Policy (CAP) in Portugal between 2023 and 2027, approved by the European Commission. The latest reforms approved by the European Parliament and the European Council give greater decision-making freedom to Member States in applying CAP rules in their territories (Matthews, 2020). The conditions enable adjustments to agricultural policy, aligning Portuguese agriculture with the challenges of climate change whilst at the same time improving the health of Portuguese families. By analysing and comparing the elements that weigh most negatively on our trade balance and on the environment with the nutritional needs of Portuguese families, it is possible to identify what needs to be done to improve the current situation.

This article starts by analysing the Portuguese food balance, first at the aggregate level and then by identifying the products that most negatively impact the trade balance. The objective of the second part of this article is to ascertain whether the three main problems can be solved in a single equation: the trade balance deficit, the high Food Footprint, and the imbalance in the diet of Portuguese families. However, to achieve this, it is necessary to adjust the rules of agricultural policy and break with the current model, which focuses more on intensive production and excludes a large part of the Portuguese territory and most farmers. This reform is possible and necessary, and the decision is in

the hands of policy makers. It is hoped that this article will contribute to the debate and create a foundation for those decisions.

2 Data and methods

Combating climate change requires profound changes in food systems. This article shows that it is possible to allocate resources to more sustainable agricultural production which promotes healthier eating and at the same time reduces the agri-food deficit in the Portuguese trade balance. To do that, we used data pertaining to the Portuguese agricultural sector. We used international trade statistics and consulted the statistical databases for the food consumption of Portuguese families. The vast majority of statistics used were taken from the National Statistics Institute of Portugal (http://www.ine.pt). All data referring to the Ecological Footprint were taken from the Global Footprint Network (http://www.footprintnetwork.org).

To assess the evolution of Portuguese agricultural production, we used data on utilised agricultural area (UAA), measured in hectares in the various regions. We studied the UAA composition and the various crops on arable land (ha). We also studied the evolution of animal production and collected statistics available at the National Institute of Statistics (INE) on the trade balance between Portugal and the rest of the world. Agricultural and animal productions are treated differently depending on the various aggregation methods used. The results are not entirely consistent due to the different methodologies used in each case. However, all indicators agree that there is a persistent external deficit. Food and energy deficits are the two most important structural imbalances in the Portuguese economy. To study the Portuguese trade balance, we used three different aggregated indicators: the 8-digit combined nomenclature (NC8), the Statistical Classification of Products by Activities (CPA) and the major economic categories classification (CGCE).

The trade balance (8-digit combined nomenclature, NC8) considers various groups of goods. The first group brings together live animals and animal products. The second group is made up of vegetable products. In a third group are animal or vegetable fats and oils. Finally, in the fourth group, we have the products of the food industries, alcoholic beverages and liquids and vinegars, tobacco, and its manufactured substitutes.

In another aggregate, INE separates traded goods according to major economic categories (CGCE). The broad categories are food and beverage products, industrial supplies, fuels and lubricants, machinery, and other capital goods (except transport equipment) and their accessories, transport equipment and accessories. Food and beverage products are, in turn, separated into primary products and processed products.

The INE also describes the trade balance using the Statistical Classification of Products by Activities (CPA). We used the 2002 CPA statistic to get the longest series. From this classification, we used data relating to the headings ‘agriculture, animal production, hunting and related services’ and ‘forestry products, forestry and related services’. We also used the data from the manufacturing industries from where we took the ‘food products and drinks’ category.

To calculate the impacts on the Ecological Footprint, we used the values in gha per kilo of product published in Galli et al. (2020a). In the case of wheat, we used the primary footprint (before processing) of bread, which is largely composed of wheat. Regarding the environmental costs associated with imports, we used the total and import

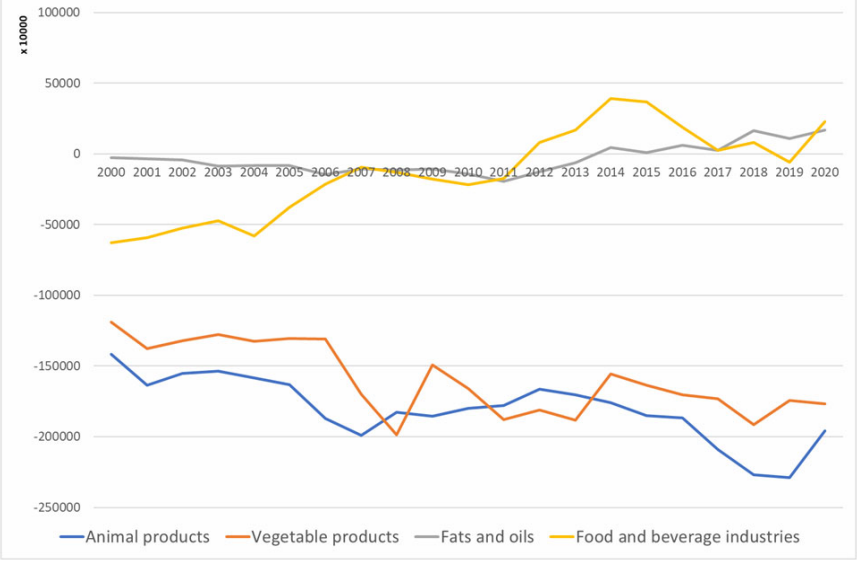
Food Footprint by product for 2014 published in Galli et al. (2020b). To obtain the value per kg of product, we used international trade statistics for 2016 published by the INE of Portugal.

3 The vulnerability of the Portuguese agri-food balance

In this section, we analyse the main aggregates used by the INE to characterise the evolution of the Portuguese agri-food balance. Firstly, we look at the trade balance broken down by products according to the C8 nomenclature. Secondly, we will see the evolution of the balance of the food balance according to major economic categories (CGCE). Lastly, we will explore the Portuguese classification of products by activities. All data were taken from the Portugal's National Statistics Institute.

The evolution of the trade balance over the last decades for four food groups is illustrated in Figure 1. The balance of vegetable and animal products has been worsening since 2000. This deficit has been partially offset by the fats and oils sector, where olive oil plays a major role. The Food and Beverage industry also went from a deficit to a surplus, with an important contribution from the wine sector. The overall balance of these four aggregate groups from 2000 to 2020 results in a persistent deficit that fluctuates between 3 and 4 billion euros per year.

Figure 1 Goods trade balance (NC8) (see online version for colours)



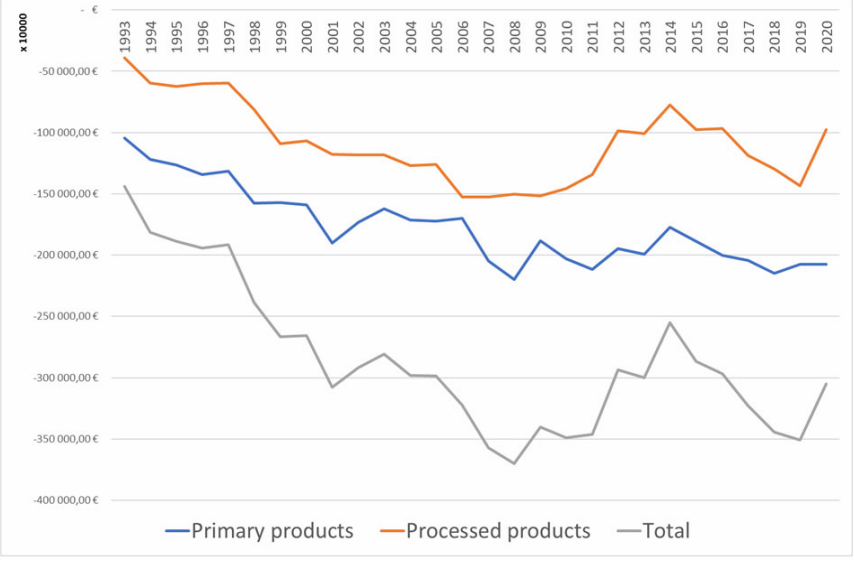
Source: Portugal's National Statistics Institute

The food balance according to major economic categories (CGCE) specifies two main aggregates: primary and processed food products. Figure 2 shows the evolution of the trade balance of primary and processed products between 1993 and 2020. The total balance (primary and processed products) worsened significantly in the 1990s. From 2007 onwards, the deficit stabilised at around 3.5 billion euros per year, with a slight

recovery between 2008 and 2014, followed by a further decline from that point onwards. The recovery period between 2008–2014 is mainly due to a decrease in demand due to the strong reduction in household income caused by the readjustment program between 2011 and 2014. The data which show improvement in the balance in 2020 still require some analysis and it is not possible to conclude whether we are in the presence of a new trend of a structural nature or whether it is just a cyclical effect related to the COVID-19 pandemic.

As for the external balance using the classification of products by activity, Figure 3 shows the evolution of three main aggregates: animal and vegetable production, Forestry products, and Food and beverage products. The graph highlights different trends, with the balance of Forestry products showing a fairly stable and balanced trajectory. As for the other two aggregates, a worsening trend between 1993 and 2010 is confirmed, followed by a slight recovery, coinciding with the Troika's intervention program between 2011 and 2014. A small recovery can also be seen in 2020.

Figure 2 Evolution of the balance of the food balance according to major economic categories (CGCE) (see online version for colours)

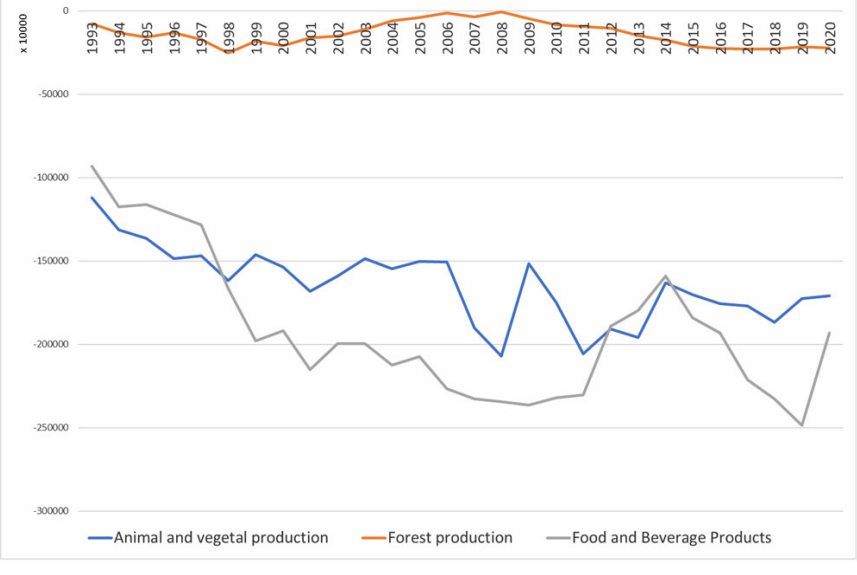


Source: Portugal's National Statistics Institute

The analysis so far confirms Portugal's agri-food dependence on foreign countries. We continue with the study of the products that weigh most in the trade balance, in both imports and exports. The disaggregation of the trade balance, shown in Figure 4, identifies some of the most significant products. On the side of surplus products, wines and olive oil stand out (GPP, 2021). Beef, pork and poultry, wheat, and fresh products (fruits and vegetables) represent the products that most negatively impact the trade balance. The huge deficit in meat is paradoxical in that it is supported by a demand that far exceeds the limits prescribed by the World Health Organization (WHO) in terms of daily consumption. Regarding cereals, and in particular wheat, the self-sufficiency rate is only 5%. As such, considering the central role of wheat in human nutrition, it is

legitimate to question whether it is safe for any country to have this degree of dependence on external supply (Shewry, 2009). Fresh products weigh negatively on the Portuguese trade balance. However, unlike meat, Portuguese families consume few fresh vegetables compared to recommended levels (Lopes et al., 2018). Portugal has a favourable climate for fruit and vegetable production. Producing more fresh products would enable a response not only to the problem of external imbalance, but also to the nutritional imbalance of the population and especially of young people. Indeed, it is among young people that the low consumption of fresh produce is most worrying (Lopes et al., 2018).

Figure 3 Evolution of the food products balance using the classification of products by activity (CPA 2002) (see online version for colours)



Source: Portugal's National Statistics Institute

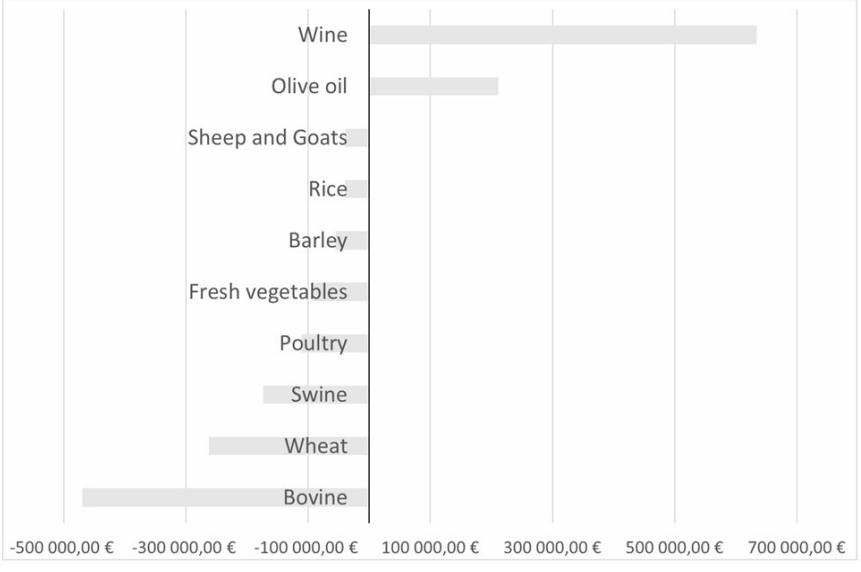
4 The evolution of Portuguese agriculture in the last three decades

Portugal has lost almost 60% of its farms since joining the European Union. This trend affected all regions of mainland Portugal, but there are three that stand out: Entre Douro e Minho, Beira Litoral and Ribatejo Oeste, where the fall ranges between 64 and 68%. The regions that gave most resistance were Alentejo and Trás-os-Montes with losses of 39% and 30% respectively. Regarding the disappearance of farms by class, it is possible to see that most losses come from small farms and of all the farms that have disappeared in the country since the 1980s, almost 63% had less than 5 hectares.

Since Portugal entered in the European Union, the Utilized Agricultural Area (UAA) decreased by around 10% until 2009, having recovered its initial values over the last decade (Cunha, 2004). However, this dynamic varied widely from region to region. As we can see in Table 1, there was a slight decrease of 1% in the continent's total UAA. However, in the same period, there was a significant increase in Alentejo, which gained

around 300 thousand hectares (an increase of 15.27%). In stark opposition, the North and Center of the country lost 14.84% and 23.44% respectively. Altogether, the two regions lost nearly 310 thousand hectares. As for the Algarve (South of Portugal), it lost almost 37 thousand hectares of UAA (26.45% less). This dynamic heightened the concentration of UAA in Alentejo at the expense of other regions, where most farms have disappeared.

Figure 4 Trade balance of various products (average 2015–2019) (see online version for colours)



Source: GPP (2021)

Table 1 Evolution of UAA (hectares) by region

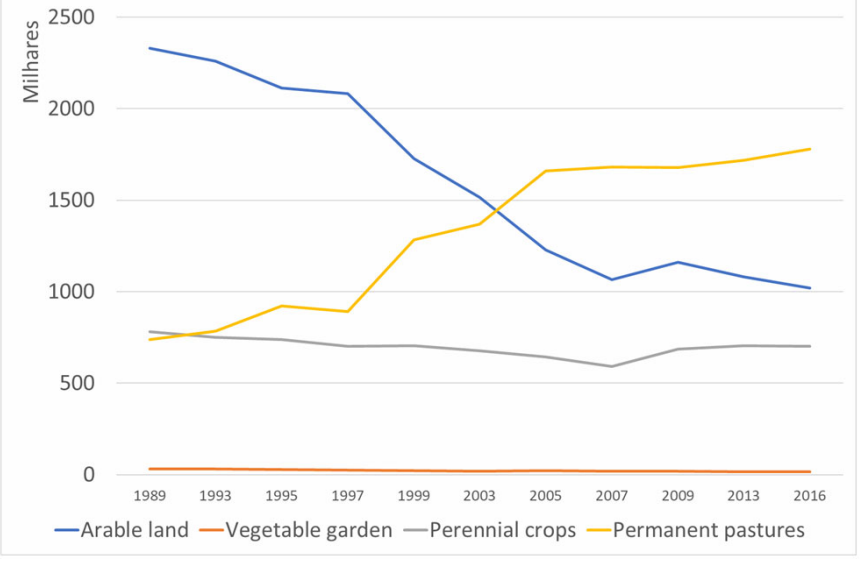
	2019	*1989*	*Dif. (%)*
Continental Portugal	3,838,708	3,879,579	–1.05%
North	663,341	778,953	–14.84%
Center	633,297	827,240	–23.44%
Lisbon Metropolitan Area	90,733	97,243	–6.69%
Alentejo	2,350,732	2,039,364	15.27%
Algarve	100,605	136,779	–26.45%

Source: Portugal's National Statistics Institute

Without going into detail, it is still worth analysing how the UAA in Portugal has evolved qualitatively across the same period. The composition of the UAA experienced profound changes after entrance Portugal joined the EU (see Figure 5). Between 1989 and 2016, arable land lost more than half of its area, going from 2.3 million to just over 1 million hectares. Two main factors contributed to this sharp reduction. The first was the disappearance of thousands of small farms. The second factor was more complex and resulted from the dismantling of production support systems that began with the 1992 CAP reform (Cunha and Swinbank, 2011). From the 1990s onwards, payments were

decoupled from production to make farms more market-oriented and to reduce distortions in agricultural markets. Decoupled payments were replaced in 2003 by the 'single farm payment', also based on guaranteeing income stability. With the conversion of guaranteed prices to the single farm payment scheme, plus premiums for suckler cows and incentives for extensification, much of the arable land was converted to permanent pasture. It was in the Alentejo region, where rainfed arable crops with low yields predominated, that this phenomenon became more prevalent. Between 1989 and 2016, the area occupied by permanent pastures more than doubled, going from 736,000 to 1.8 million hectares. This trend was confirmed in the latest 2019 agricultural census data published in 2021 (INE, 2021).

Figure 5 Evolution of UAA composition (ha) (see online version for colours)



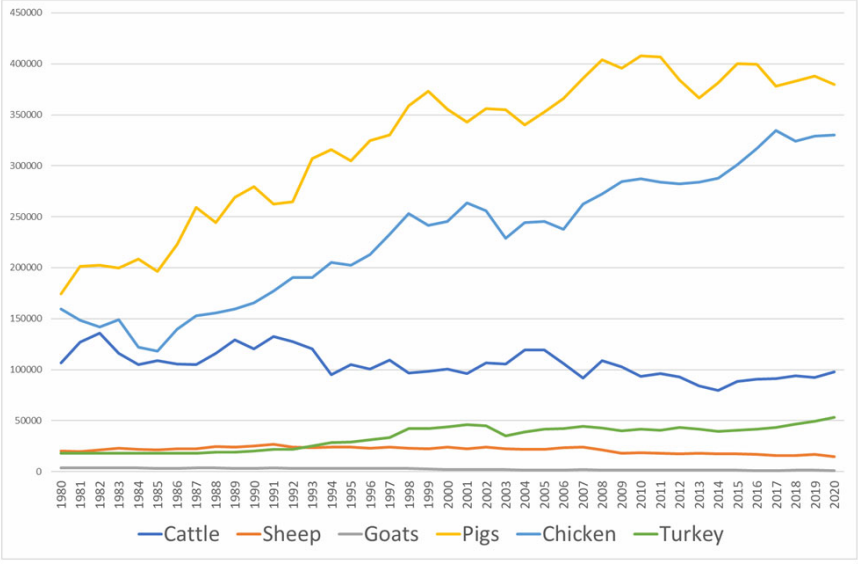
Source: Portugal's National Statistics Institute

Regarding arable land, during the period between 1986 and 2018, there was a sharp decrease in cereal crops, dried pulses, potatoes, fruit, and vineyards but the area occupied by olive groves and nuts increased (Avillez, 2016). Planted areas of vineyards and olive groves were significantly renewed. In the case of vineyards, the quantitative balance is negative insofar as the new planting areas did not make up for the abandoned areas, unlike the olive groves. In the case of nuts, the increase resulted mainly from the doubling of the chestnut area. The production of almonds, which represented in 1986 an annual production of 35 thousand tons, declined until 2013. Since then, it has recovered, going from 4 thousand to 21,000 tons in 2018, an increase of more than 400% in 5 years, based mainly on the intensive almond groves recently planted in the Alqueva (in Alentejo) irrigation perimeter (Cordovil, 2021).

Figure 6 and Table 2 show the evolution of animal production. They indicate a trend that began in the 1960s with the emergence of industrial farming, namely in poultry and swine. As for ruminants, whether cattle or sheep, Portugal showed a downward trend, which was more pronounced in small ruminants. This development in meat production

can be explained by two factors. The first stems from the development trajectory of the Portuguese economy, with a growing demand for animal protein by the population. This demand remained largely confined to white meat (pork and poultry), due to its low price. The second concerns EU subsidies??? which were strongly oriented towards the extensive breeding of cattle and the promotion of native species. The effect of these subsidies is still uncertain because they discouraged intensive cattle production and represented fundamental support in disadvantaged areas. We believe that the premium paid for suckler cows and steers was crucial in preventing the closure of a large part of the cattle farms in Portugal (Cunha and Swinbank, 2011).

Figure 6 Meat production (t) (see online version for colours)



Source: Portugal's National Statistics Institute

The data presented demonstrate that there is a productive capacity in Portugal that is not being exploited. With the great reform of 1992, a process of reformulation of the CAP support system began. With the other reforms that followed, payments until then linked to production (cereals, sugar beet and tobacco, among others) were completely decoupled and transformed first into the single payment system and then into the basic payment system. This new support system greatly benefited the Alentejo region, where the largest properties are located, at the cost of the remaining regions where smallholdings predominate. In Alentejo, with the end of direct support, many crops ceased to be profitable and were transformed into pastures. In the central and northern regions, arable areas were progressively abandoned (Cunha and Swinbank, 2011). Exceptionally, some support linked to ruminants and to extensive beef cattle raising were maintained and even reinforced. These changes explain the profound alteration in the UAA explained above. They also explain the paradox of having declined production precisely in one of the sectors most supported by the CAP (Rolo and Cordovil, 2014).

Table 2 Variation of the main meat productions (t)

Year	*1980*	*2020*	*Dif (%)*
Cattle	123,344.3	94,603.67	–23.30
Sheep	20,456.67	15,690.33	–23.30
Goats	3,757.667	1,150	–69.40
Swine	192,719.7	383,655.7	99.07
Chickens	150,104.7	327,678.3	118.30
Turquey	18,000	49,602.33	175.57

Source: Portugal's National Statistics Institute

5 Opportunities for a more sustainable agricultural production model

Portugal must reduce its excessive consumption of meat (especially beef), which is harmful to health. This reduction in consumption can be done in favour of sustainable production, with local breeds raised in low density areas and without competing with arable land. Moreover, the reduction in beef consumption reduces imports, with macroeconomic and environmental gains. The external dependence on cereals, namely on wheat for human consumption, constitutes a weakening of the Portuguese external balance which, due to its magnitude, could compromise its food sovereignty. The Portuguese Government has announced a plan that aims to reduce this dependency in the coming years. Unlike red meat, the Portuguese population should consume more fresh vegetables. This raises the need to increase the production of fresh products, where Portugal currently has a strong deficit.

According to data from the INE, the consumption of beef has been increasing in Portugal. Between 2012 and 2019, the annual consumption increased from 164 thousand tons to 199 thousand tons (an increase of 20%). Production remained stable at around 90 thousand tons. In the same period, imports rose from 80 to 121 thousand tons. As confirmed by the DGS (PNPAS, 2021), there is an excess of meat consumption in Portugal, and in particular red meat (beef, pork, sheep, and goats). Recommendations from the WHO confirm that the consumption of more than 100 grams per day is associated with several pathologies, including colon cancer. Moreover, beef is one of the products that weigh most negatively in the trade balance and simultaneously has the largest Ecological Footprint relative to other food products. According to data from the Global Footprint Network (Global Footprint Network, 2021), the Ecological Footprint of beef is almost 13 times greater than that of pork and 16 times greater than that of poultry (Lin et al., 2018).

There are discrepancies in meat consumption data between the values presented by the INE and the data presented in nutritional surveys. Data from the INE point to total meat consumption of about 320 grams per day. This daily consumption can be broken down into poultry (130 grams), pork (130 grams) and beef (55 grams). However, the surveys that measure direct ingestion by families (Lopes et al., 2018) point to a less dramatic reality, with a total meat consumption of around 160 grams a day. The difference is related to the various losses that food suffers along the production and processing chain, in addition to the food waste in Portugal, which is about one million tons annually (Baptista et al., 2012).

According to the IAN-AF, household consumption of meat exceeds three times the one recommended by the food wheel, which recommends a proportion of 5% in weight of the daily amount of food consumed (Lopes et al., 2018). For the purpose of this paper, we consider the reduction of a daily intake to 100 grams of animal protein as a target. This desirable average level of consumption implies a reduction of around 37.5%, which will be applied only to beef, considering everything else constant.

Cereal production plummeted with the decoupling of payment from production, creating a strong external dependence on essential goods such as wheat. Wheat is the staple food for over a third of the world's population. It is responsible for about 20% of the caloric intake of food, in addition to a set of vitamins and minerals which are essential for health (Shewry, 2009). The Portuguese level of self-sufficiency ratio of wheat was 60% in 1990, which declined until it reached 4% in 2018. In 1990, the area sown with cereals was around 900,000 hectares. Today it is no more than 250,000 hectares (INE, 2021). To reverse this situation, the Portuguese Government approved a National Strategy for the Promotion of Cereal Production in 2018 (Bagulho et al., 2019). Within a period of ten years, in other words until 2028, the government intends to double the level of self-sufficiency ratio of cereals from 20% to 40%, taking advantage of the productive potential arising from the National Irrigation Program. Specific targets are 80% for rice, 50% for maize and 20% for other cereals (wheat, rye, barley, oats, and triticale). In this paper, we simulated the substitution of imports for domestic production until 20% of supply was reached, in line with the government's strategy. We assumed the same direct cost matrix. Environmental benefits in the Ecological Footprint resulted from the reduction in transport costs linked to imports (transport, storage, packaging, etc.), considering that production modes remained equivalent.

Table 3 Global results with impacts on the balance of goods and on the ecological footprint

	Beef	*Vegetables*	*Wheat*	*Total*
Initial balance (euros)	–469,662,576.25 €	–90,687,176.33 €	–262,145,975.33 €	–822,495,727.92 €
Final balance (euros)	–140,149,193.22 €	–6,544,429.43 €	–213,476,113.07 €	–360,169,735.72 €
Difference (euros)	329,513,383.03 €	84,142,746.90 €	48,669,862.27 €	462 325 992.19 €
Initial ecological footprint	0.5715	0.0504	0.1648	0.7868
(gha-per capita)				
Final ecological footprint	0.3002	0.0639	0.1567	0.5209
(gha-per capita)				
Difference (gha-per capita)	–0.2713	0.0135	–0.0081	–0.2659

Source: INE and authors' calculations

The food wheel recommends a 23% proportion of vegetables in our daily diet.[1] According to the IAN-AF, half of the Portuguese population ingests below this limit (Lopes et al., 2018). In children and young people, the situation is even worse. According to the survey, vegetables represent only 14% of food consumed. In line with the WHO

recommendations, which prescribe a daily consumption of 400 grams of fresh vegetables, we are going to simulate a 60% increase in national consumption along with an increase in national production, assuming the maintenance of current modes of production.

Table 3 presents the partial and global effects of the proposed changes in the three directions: a reduction in the consumption of beef (37.5%) and an increase in the consumption of vegetables (60%) in line with the recommendations of the WHO and the DGS, together with an increase in wheat production (20%) recommended by the government strategy.

Globally, these changes could alleviate the Portuguese trade balance by 462 million euros. This represents a 15% reduction in the agri-food deficit of the country. From an environmental perspective, this strategy could lead to a decrease of 0.2659 gha per capita. This decrease corresponds to a reduction of 6% in the global Ecological Footprint and a reduction of 20% in the Food Footprint.

Each of the products contributes in a different way to improving imbalances. The reduction in beef consumption by 37.5% is the one that weighs most, both on the trade balance and on the Ecological Footprint. Results stem from the high environmental cost of this source of animal protein, but also from the fact that Portugal imports huge quantities of this meat, which burdens external accounts. Indeed, imports represented an average yearly value of more than half a million euros in the last three years. On the other hand, decreasing consumption also reduces the Food Footprint. If this 37,5% reduction is made (as we are proposing) at the expense of a reduction in imports, the benefit is even greater. Combining the results of (Galli et al., 2020b) with the Portuguese statistics on international trade, they show that the Ecological Footprint associated with the consumption of imported meat is twice as high when compared to locally produced meat. This result stems from two factors, the first being distance. The first supplier country is Spain, but other more distant countries are also important meat suppliers, such as France, the Netherlands, Germany, and Uruguay. The second factor stems from the need for refrigeration in transport, which has a significant negative impact on the Ecological Footprint. The effect of transport on the ecological footprint is calculated from a matrix of distance weighted by the type of transport (plane, boat or road) plus the packaging costs. We do not take into account the different modes of production, assuming the same pattern inside and outside the country.

The proposed changes in vegetables are due to the urgent need to increase the consumption of fresh vegetables and to correct the deficiencies identified in families' diet, with a view to benefiting public health. We propose a 60% increase in vegetable consumption in line with the WHO recommendations together with a 30% decrease in imports. The implementation of this scenario leads to a balanced situation in the horticultural trade balance. This objective is perfectly acceptable, especially if we consider that Mediterranean countries are generally net exporters of fruit and vegetables. Spain exports nine times more than it imports (De Cicco, 2018). Portugal has the potential to increase the production of vegetables. In our exercise, the increase in consumption and production of vegetables could lead to an 84-million-euro improvement in the external deficit in relation to the rest of the world. In environmental terms, the Food Footprint is slightly worse because of the net increase in production and consumption. Nevertheless, considering that vegetable consumption can replace the consumption of other types of food with a greater Ecological Footprint (such as animal protein products) this negative effect is probably overvalued. Despite the environmental costs associated with transport (because of refrigeration), the decrease in imports does not

directly cancel the increase in the Ecological Footprint caused by the rise in domestic production. Thus, the overall effect may be negative, but not at a very significant rate (increase of 0.0135 gha per person).

As for wheat, the goal is to quadruple wheat production, with a consequent reduction in imports. This increase in production predicted by the Portuguese Government represents a relief of almost 50 million euros in the external balance. From an environmental point of view, we have a slight reduction in the Ecological Footprint, resulting from the substitution of imports (mainly from France) for local production. It should be noted that, unlike meat and vegetables, the environmental cost of transporting of cereals is lower. According to Galli et al. (2020b), the Footprint of imported cereals grows 37.5% in relation to domestic cereals. The goal of increasing production from 77,000 to 383,000 tons of wheat production may seem unrealistic because it implies the allocation of 153,000 additional hectares compared to what currently exists (for an average productivity of 2000 kg per hectare). However, in the 1980s, Portugal produced more than 500,000 tons of wheat annually.

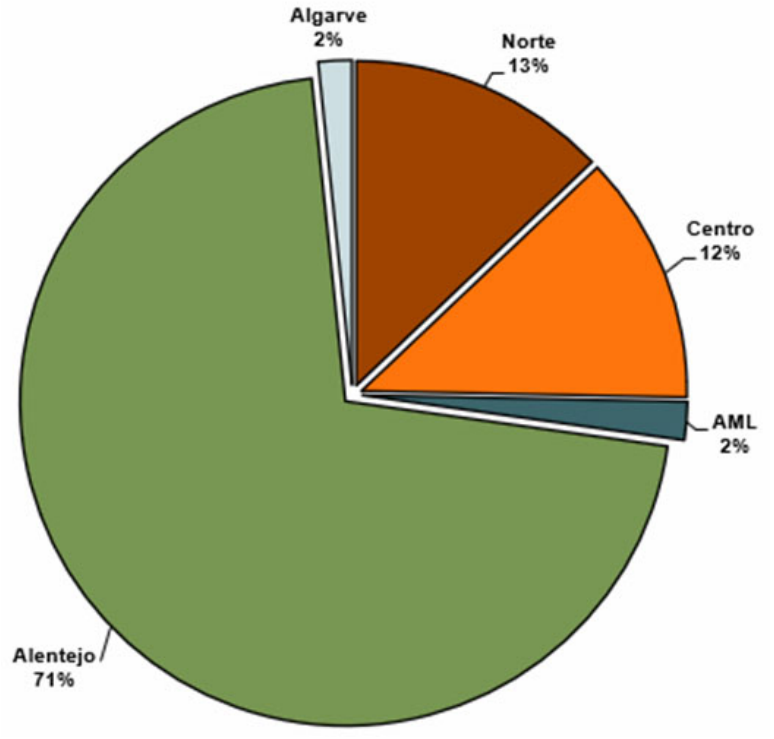
6 Policy implications

With the new Multiannual Financial Framework (MFF 2021-2027) the CAP rules were revised to take into account new political priorities. Compared to the 2014–2020 MFF, the new CAP rules give Member States more flexibility to manage and apply the different financial envelopes of the European Union (Matthews, 2020). Portugal will benefit from a global envelope of 7 billion euros to apply until 2027. The government has the opportunity with the PEPAC (CAP Strategic Plan for Portugal) to correct long-identified imbalances in its agriculture sector and the CAP aims to mobilise the productive potential of European farmers. However, like any public support system, it must do so according to criteria of additionality, efficiency, and equity. The CAP should support value-added projects with difficulties in finding sources of funding. It should avoid granting subsidies to profitable activities that would still exist without subsidies. Public support also serves to correct market failures, which occur when the benefits or losses associated with a particular economic activity are not captured by the price system. Many farmers contribute to the maintenance of the rural landscape and the preservation of biodiversity with their activity. The logic of the CAP is based on the attribution of support aimed at remunerating environmental services provided by farmers (Poppe and Koutstaal, 2020). These services are essential for improving land use and increasing its biocapacity.

6.1 A fairer and more coherent geographic distribution

Between 1989 and 2019, most Portuguese regions lost UAA, except for Alentejo region, which reinforced its dominant position (see Table 1). At the beginning of the period in question, Alentejo comprised 52% of UAA. At the end of the period, it strengthened this position by reaching 61%. The data in Figure 7 show a strong concentration of first pillar support (income support) in Alentejo. This region concentrates 71% of the Basic payment regime, which is the most important income support of the CAP.

Figure 7 Distribution of the surface eligible for the basic payment scheme (BPS) by Nuts II (see online version for colours)



Source: Ministry of Agriculture and Fisheries (accessed 12 February 2022)

This trend of concentration of support has increased recently with the Alqueva irrigation project, which expanded the irrigation area of Alentejo by more than 110,000 hectares. Furthermore, at the moment, according to the latest agricultural census by the INE, 41% of farmers in the country do not receive any support from the CAP (Cordovil, 2021).

To meet the objectives established in this paper, with the increase in cereal and vegetable production and an increase in extensive cattle production, it is necessary to improve the distribution of EU support to have a more balanced distribution of production across all regions. For this, it is necessary to create rules so that the support reaches the most disadvantaged territories and to bet on production models adapted to the regions. It is very important to invest in public advisory services to help small and medium-sized farmers apply for CAP support. Only then will it be possible to produce more, in a more sustainable way, to create a more balanced country.

6.2 More irrigation infrastructure

Between 1989 and 2019, the regions of Entre Douro and Minho, Beira Litoral and Trás-os-Montes lost 60% of their irrigable area (from 469,000 to 190,000 hectares) (Cordovil, 2021). On the other hand, the regions of Alentejo and Ribatejo had an increase of 40% in their irrigable area. In Alentejo, this area doubled, going from 133,000 to 233,000 hectares. This increase resulted from investment in collective infrastructure

financed with public funds. In other words, the location of these investments was a political option. A better distribution of this type of investment in the territory in the future is a necessary condition to enhance the existing agricultural potential and contribute to revitalising low-density territories.

6.3 Support producer organisations

The objective of better distributing support among the different regions often collides with the land tenure regime. This regime is more fragmented in the central and northern regions compared to Alentejo (Alberto and Almeida, 2011). To develop production in those regions, strong incentives for the creation and strengthening of producer organisations must be created. Only in this way will it be possible to create collective dynamics capable of generating scale effects at the level of production, commercialisation and modernisation. It is a fact that in Portugal, fruit and vegetable producer organisations still control a low market share compared to the other states of the European Union. The Commission adopted new rules to simplify the fruit and vegetable support scheme, and in particular, rules related to activities and operational programs of producer organisations in the fruit and vegetable sector.[2] Furthermore, Regulation (EU) 2021/2115 ('Strategic Plan Regulation') allows member states to include sectors other than those currently existing in the Common Organization of Markets in their strategic plans [Regulation (EU) No. 1308/2013]. This measure aims to give more autonomy to the member states in the application of the CAP and favours the implementation of strategies such as the one we defend in this article. With the inclusion of new sectors, member states can choose several types of intervention in their CAP strategic plans such as investments in tangible and intangible assets, research and experimental and innovative production, the creation of advisory services and technical assistance, and actions to increase the sustainability and efficiency of transport and storage of products (Article 47). Member states will now be able to adjust their national strategies for the fruit and vegetable and cereal sectors to ensure a smooth transition between current and new rules once the new CAP enters into force. It is essential that the PEPAC for Portugal takes advantage of these new rules to increase incentives for the creation and strengthening of producer organisations.

7 Conclusions

Demographic evolution has created a profoundly asymmetrical world. In developing countries food needs are growing. In developed countries, the demand for food has evolved with new requirements in nutritional quality, animal welfare and environmental sustainability. Consumers are today more demanding regarding the sustainability of agricultural production methods. Furthermore, the climate crisis is increasingly present in our daily lives. Scientists call for an ecological transition, which poses new challenges to the agricultural sector in terms of sustainability.

According to the WHO and DGS recommendations, Portuguese families should rebalance their diet by decreasing meat consumption and increasing consumption of fresh fruits and vegetables. As in most developed countries, a reduction in the consumption of meat, and especially beef, could reduce the Food Footprint, saving resources and redirecting arable land to vegetable production.

The reconversion of intensive farms of ruminant species to extensive regimes can bring environmental benefits. The extensive regime normally occupies areas which are unsuitable for vegetable crops, thus contributing to a greater number of poor pastures which are able to store carbon, filter water and maintain biodiversity. Moreover, animal production makes it possible to use by-products from the vegetable or agri-food chains, thus contributing to the circular economy. The effluents can be used as fertilisers and there is also the possibility of their energy use.

In other words, a world without animal production would imply a significant increase in arable land, creating an unsustainable situation for the planet. The solution must, therefore, lie in a harmonious balance within which animal production does not come into conflict with human nutrition and the sustainability of the planet.

This article outlines a scenario for Portugal that combines a decrease in beef consumption, an increase in the consumption of vegetables and a reduction in external dependence on wheat. This scenario allows for the simultaneous resolution of three imbalances: food imbalance, environmental imbalance, and external deficit imbalance. In global terms, it is hoped that with in this scenario, Portugal can reduce its Food Footprint by 20% and reduce its agri-food deficit by 15%, with benefits for the population's health.

To make this scenario achievable, coherent, and consistent policies with the objectives outlined in this study are needed. With the new PAC rules which give member states greater flexibility, it is up to the government to use its strategic plan to make agriculture more sustainable and capable of promoting social and territorial cohesion.

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Notes

1 Vegetables - includes fresh tomatoes, lettuce, green beans, onions, carrots, peppers, peas, broad beans, melon, watermelon, strawberry, cauliflower, broccoli, cabbage, collard greens, green cabbage, greens, garlic, leek, courgette, spinach, turnip and pumpkin and other vegetables.

2 Commission Delegated Regulation (EU) 2021/652 of 10 February 2021 amending Delegated Regulation (EU) 2017/891 as regards the activities and operational programs of producer organizations in the fruit and vegetables sector.