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Diverging and Converging Pathways

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Workshop 5.3: Rural development policies in the peripheral Southern and Eastern European regions

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European agricultural and rural development policies are changing. Nowadays, the CAP's primary principles and objectives are adjusted to a new reality according to globalisation, climate change, employment and growth, environmental protection, food security and the need to avoid global hunger. The new PAC is much more environmentalist but conflicts with the economic and social issues and the outcomes of rural development need to be different to previous years. The world's citizens, including farmers, are increasingly more concerned to ensure that production respects the environment, and are changing some of their ways. A friendly agricultural production system seems to be achieved by some European farmers. However, the particular geographic and economic resource characteristics of many peripheral regions enforce the adjustment of European rural policies to match these realities. Understanding how to provide better outcomes could be an example to other regions and plans, regarding agricultural and rural policy and rural economy issues.

The Workshop provided a forum for discussion around how rural development policies constrain farming systems and the farm sustainability, in particular addressing the following issues:

- What are the rural development policies conducted by European countries?
- What are their results in terms of the productive and environmental logic of rural farms?
- What is the farmer behaviour towards rural development policies?
- Which model of farming system will be suitable to be pursued by the next European rural policies?
- What strategies can be found to adjust rural policies to the new world?

Global overview of the Rural Development Programme: the mainland Portugal case-study

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Abstract: This paper provides a global overview of the implementation of the Rural Development Programmes (RDP) in mainland Portugal, based on the collected and analysed information concerning the rural programmes and some local parameters. These RDPs have been focused in the agriculture sector because the main Portuguese figures indicate that its rural territory is dominated by the agroforestry complex and about one third of the population lives in rural areas. The agriculture is very diverse, with a prevalence of small-scale farms. Large farms account for only 9% of the total, but represent 67% of the utilised agriculture area (UAA) and 77% of the total standard output value. The implemented RDPs show a positive impact in Portuguese economy due to the increasing of agricultural products, mechanisation and buildings. Also, the decreasing agricultural population has been balanced by the improved living standard level of farmers (the increasing income). The recent RDP (2014-2020) follows the previous programmes and is centred on five priorities, with the main emphasis being given to enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and sustainable management of forests.

Keywords: Agroforestry, Portugal, rural development, socio-economic and environmental indicators.

Introduction

The environment, local culture and heritage are three key factors in rural areas, with the local population being the main generator and defender of these elements (Cardoso, 2011). Their absence or reduction imposed by the set of economic, social and demographic changes in recent decades has resulted in a growing devitalised economic and social decline, through a spiral process. The rural depopulation is very intense, the population that remains is ageing and the economic sources of income are scarce, with negative consequences for the territory cohesion and the overall country development.

Rural Portugal, with an economic history and a structure resulting from the use of land by agriculture, forestry and industrial activities that used the rural labour force and/or rural natural resources, has been subject to major changes in terms of their economic functioning. Farming has lost importance, worsening the agrifood supply problems. However there is an increased interest by the pluri-activity and pluri-income, industry, the development of residential and recreational activities, as well as the growth of social interest by rural and nature goods (Cardoso, 2011). Indeed, the countryside no longer has the exclusive function of agro-forestry-

pastoral production, but acquired a symbolic and recreational representation imposed by urban dwellers (Cardoso, 2011), giving new social and environmental functions (or alternatives) to agriculture, besides the economic (Lima, 2008). This means that farms are not only production units but they become consumer spaces embedded in the rural landscape (Pinto-Correia, 2007).

This view of the countryside marked by the multifunctionality of rural areas, in general, and of agriculture, in particular (Melides et al., 2010), especially since the reform of the Common Agricultural Policy (CAP) in 1992, aims not only to develop agriculture and forestry, but also the diversification of economies. The creation of new activities is focused on the natural resources and biodiversity protection, the landscape valuation, the space management and the preservation of cultural and heritage values (Carneiro, 2010).

However, this change of paradigm alerts us, according to various authors (e.g. Cardoso, 2011; Marta-Costa, 2008), to the need for greater concern about the economic, social and environmental development of these areas. Fernandes (2003) refers to it as a movement, a dynamic that is reflected in the passage from one stage to another, or a process that combines the construction, destruction, reconstruction and reintegration of ideas (Fernandes, 2003). The emergence of these new concerns regarding the rural areas has given rise to a new concept - rural development - which the European Union has been keen to promote, establishing goals to achieve in this field (as in the case all over the world) mainly in the last two decades. Rural development is also one of the strategies defined for Portugal. In a recent document from the Ministry of Agriculture and Sea (MAM, 2014a), the creation of conditions for the promotion of rural areas emerges as one of the three strategic objectives to achieve in the period 2014-2020.

This rural development concept is multidimensional because it integrates issues since the economic growth until the improvement of the living conditions of the residents. This is a social process based on the respect and articulation of the principles of: economic efficiency, social and territorial equity, heritage and environmental quality, sustainability, democratic participation and civic responsibility (Cardoso, 2011). The decline of agriculture in rural areas imposes the need to search for alternatives in other economic activities, bearing in mind the need to potentiate agriculture by the implementation of measures which promote a sustainable local development. It was in this context that the rural, local and regional development policies were elaborated and implemented through the RDPs, among other programmes with similar goals.

In fact, as indicated by Baptista (1999), rural development is mainly a density problem: density of population, actors, (institutional and private) initiatives, organisational capacity; economic activities, skilled labour, job creation and infrastructure. In this sense, the various programmes that have been implemented aim to reverse, as far as possible, the demographic and economic decline of rural areas, and to introduce new forms of sustainable development, only possible through the preservation of the territories, the unique cultural heritage and maintaining populations (Cavaco, 2005).

The translation of the assumptions on which the rural development is based in terms of indicators, and the analysis of its evolution through cross-referencing with the global overview of the various RDPs for mainland Portugal is the main purpose of this work.

This analysis will be developed based on the data published in the official statistics. The agroforestry activities will have particular relevance, because they still occupy a key place given the economic weight of the sector, the performance in terms of natural resources and also the ability to boost the development providing better quality of life and promoting social cohesion. These are also the arguments used to give priority to activities covered by this sector on the RPDs, because a competitive agriculture dominant in rural areas will promote a sustainable countryside (MAM, 2014b).

In this sense, the work starts with a brief statement of the implemented RDPs and their priorities on the Portuguese mainland. Then we show the evolution of the agroforestry sector, based on information published by the Statistical Office of Portugal (INE). After that we analyse some agricultural ratios regarding structural, economic, labour and environmental issues to assess the impact of these programmes on the rural economy and development of mainland Portugal.

Rural Development Programmes of Portugal

Despite some previous regional development initiatives that were targeted at rural areas, only following European integration did Portugal commit seriously to rural development (Carneiro, 2004).

The European Union (EU) is the institution that promotes the development, decreeing goals to achieve in this field (Cardoso, 2011). Their concerns with the rural world are relatively new and for many years focused on the problems of agriculture (DGDR, 1997). In Portugal it is still the same. Despite the discourse changing, the political guidelines continue to emphasise the role of agriculture and to focus on this sector the investment efforts for rural areas (Silva & Figueiredo, 2013). Maybe because the main Portuguese figures show that its rural territory is dominated by the agroforestry complex and about one third of the population lives in rural areas (MAM, 2014b).

It was following the Future of the Rural World, published by the European Commission in 1988, that rural development gained prominence (CCE, 1988). In this document, rural development should stimulate local agents and project promoters to acquire necessary skills to become agents involved in the development of their territory (Carneiro, 2010). The "bottom-up" or upward approach was encouraged contrary to what was done until then (“top-down” actions) (Cristóvão & Miranda, 2005; Dinis, 2010; Ferreira, 2012).

In fact, the specific policies and measures created by the Community for rural areas try to be part of an integrated and grounded perspective on local realities (Cardoso, 2011). Since the first Integrated Programmes of Rural Development that accompanied the reform of the Structural Funds in 1988, it continued its preparation in close cooperation with national, regional and local authorities (CCE, 1988). Each Member State should draw up a development plan, on which would be established the development priorities for each country and for each region (Carneiro, 2004). From the document Major Options of the Plan for the period 1989-1992, the Regional Development Plan (PDR, 1989-1993) was developed in Portugal, a document that would serve as a basis for the negotiation of the Structural Funds to be granted to Portugal (I Community Support Framework, CSF).

The reform of the Structural Funds was, according to Carneiro (2004), the greatest impetus for solving the problems of the European rural areas. Linked to the CAP reforms, (the first in 1992), through the Agro-Environmental Programme (Reg. 2087/1992) (and the next CAP reforms in 1999), through the Rural Development Regulation (Reg. 1257/1999), and to the Commission reflections, the theme of rural development begins to gain importance in the EU (Galvão, 2010).

Also as part of a necessary reflection about the CAP future, the Cork Conference of 1996, mobilised independent experts and the Member States to reflect on this reality. It was noticed, then, that the integrated development of Europe's rural areas could not be based on a pricing and markets' policy and on a somewhat lacking structural policy (Carneiro, 2004; Galvão, 2010; Ferreira, 2012). It was necessary to reverse the rural exodus process and rehabilitate the economy of rural areas, particularly in the agricultural sector, by stimulating job creation and equal opportunities that would be reflected in improved living conditions for rural populations (Cardoso, 2011). As indicated by Ferreira (2012), rural development in Portugal was highly dependent on and conditioned by the evolution and fluctuations of this issue at Community level.

Regarding the 1994-1999 RDP, from which emerges the CSF II, Carneiro (2004) points out that their funds are directly related to rural development through the Operational Programme of Strengthening Regional Development Potentials. However, the structural and administrative difficulties found with the programme produced an undervaluation of the funds. Like its predecessor, this PDR was dedicated to the approximation of the average living standards of Portugal to the Community and to the correction of internal regional imbalances.

Along with the LEADER and INTERREG, this plan announced a speech change and, from 1999, rural development was included in the strategic axes of the III CSF, as well as on the government's strategy for Portugal. This is witnessed by the Axis 2 (AGRO programme) and Axis 4 (AGRIS Measure). These two instruments were accompanied, for the 2000-2006 period, by the Rural Development Plan, known for RURIS, and the Community Initiative for Rural Development - LEADER + (Carneiro, 2004; Cristóvão & Miranda, 2005; Fonseca & Ramos, 2008; Carneiro, 2010; Galvão, 2010).

The rural development support was the interventions core of the Guidance section of the European Agricultural Guidance and Guarantee Fund (EAGGF-O) in the 1989-2006 period, whose main fields of intervention are shown in Table 1. In the following years it was replaced by the European Agricultural Fund for Rural Development (EAFRD) which provides the framework for the National Strategic Reference Framework (NSRF 2007-2013) and the current RDP 2020 for Portugal mainland Rural, since 2014.

Table 1. Intervention areas and potential funding of EAGGF-O in 1989-2006 period

1989-1993	1994-1999	2000-2006
• Structural adjustment of farms: balance between production and the market, viable agricultural communities, young farmers establishment, efficiency in farming, processing and marketing of agricultural and forestry products, associations of producers		• Competitiveness of agroforestry sector • Multifunctionality of farms
• Environmental protection and landscape • Rural infrastructure development • Land consolidation • Irrigation • Tourism and handicraft • Forest • Processing and marketing of products • Technical assistance	• Sustainable development of the rural environment • Rural infrastructure development • Land consolidation • Irrigation • Tourism and handicraft • Technical assistance	• Quality and innovation of production • Specific potential of rural territories • Conditions of life and work of farmers and rural populations • Farmers organisation, association and initiatives • Technical assistance

Source Mateus (2013)

For the 2007-2013 period three RDPs were created to implement the National Strategic Plan for Rural Development (PEN), prepared by the Ministry of Agriculture, Rural Development and Fisheries of Portugal (MADRP) for:

(1) The mainland (PRODER);

(2) Azores (PRORURAL);

(3) Madeira (PRODEAM) (MAMAOT, 2012).

More recently, the RDP 2020 (2014-2020) started for the Portuguese mainland and pursues the previous programmes. Taking into account the objectives of the CAP, it is centred on five priorities with the main emphasis given to enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and the sustainable management of forests. In this programme support concentrates on the industry and the production of tradable goods (MAM, 2014b).

The main objectives and measures of the RDPs after 2006 are shown in Table 2.

Table 2. Objectives and measures of the RDPs of Portugal for 2007/2013 and 2014/2020

Period	2007-2013	2014-2020
Objectives	• Increase the competitiveness of the agricultural and forestry sectors • Promote the sustainability of rural areas and natural resources • Social and economic revitalisation in rural areas • Promotion of competitiveness	• Value added growth of the agroforestry sector and economic viability of agriculture • Promotion of efficient management and resources protection • Ensure conditions for economic and social dynamism of the countryside • Innovation &
Actions/ Measures	• Sustainable management of rural areas • Rural areas dynamisation • Knowledge promotion and skills development	• Knowledge • Add value for the agriculture production • Add value for the forest resources • Production organisation • Risk management and restoration of productive potential • Agriculture and natural resources • Protection and rehabilitation of forest • Maintenance of agricultural activity in disadvantaged areas • LEADER

Source Carneiro (2004); MAMAOT (2012)

Next, a brief statement about the application of funds for the Portuguese rural development is exposed, through the study coordinated by Mateus (2013):

- Between 1989 and 2011 Portugal received about 21 billion Euros for rural development (2011 constant prices), with just over half (52%) coming from the EU funding. The remaining financial contribution was from national public entities (17%) and private agents (31%);
- The annual average amount of total investment was higher (at 2011 constant prices) in the period of the I and III CSF (1989-1993 and 2000-2006);
- The Northern (24-32%), Alentejo (20-29%) and Central (18-19%) regions of Portugal have earned higher amounts to the other regions of the country, regarding the distribution of funds for rural development during the period 1989 to 2011. Lisbon and Vale do Tejo (16 to 8%) and the Algarve (7 to 2%) have received a decreasing proportion of funds over time;
- The funds distribution for rural development by policy area in each of the four programming periods highlights the importance of the support given to farms. It was aimed at farm modernisation, conversion and diversification and adding value to agricultural production. This intervention has represented, on average, about 45% of the total funds received for rural development. The support infrastructures to agriculture utilised about one-fifth of the received amount of structural funding, including the construction and improvement of irrigation, rehabilitation of agricultural and rural tracks, soil drainage and conservation, and land consolidation. Also it is possible to see the growing importance of support to the

forestry sector for promoting sustainable development and forests' competitiveness as well as landscape management. Finally, the processing and marketing of agricultural products had been one of the privileged areas of intervention, absorbing about 12% of the total funds received through the various CSF;

- The physical achievements financed by the EAGGF-O and EAFRD were, in general, aimed at farms, initially through infrastructure improvements and, in later years, through a more targeted support for the modernisation and establishment of young farmers. The programmes had also prioritised the forest sector, although there was a downward trend on the figures along the timeframe of the funding. Other types of intervention were also highlighted through the cross-services establishment for the sector, and, in the last period, the compensation payments for natural or economic disadvantages were also evident.

Briefly Portuguese agriculture dynamic: the impact of their RDP's

Indicators that reveal the evolution of agriculture and the Portuguese countryside as a result, in part, of the Portuguese RDP's are evidenced in this section. Obviously, other factors influence the observed numbers because the rural area benefits from other policy measures (from European, national or local ambits), besides the global economic conjuncture and the adverse environmental factors. However, it should also be noted that the evolution of the RDP's, implemented since 1989, was carried out (or should have been) in response to the various constraints to the development of rural areas.

The indicators were measured using the available population figures (from 1981, 2001 and 2011 years) and agricultural census data (from 1989, 1999 and 2009 years) provided by the Portuguese official statistics office (INE, 1984, 2001, 2002, 2011, 2012) for mainland Portugal. The autonomous regions of the Azores and Madeira were not included because they benefit from RDPs more adapted to their context. The available databases do not match with the RDPs' periods but they are the most credible and quantitative information for the dates under analysis. However, in this work, and according to what was said above, we try to expose the readings of the gathered indicators based on the established goals of the RDPs. In fact, we intend to check for direct answers to the evidenced problems in rural areas of the Portuguese mainland. These are essentially located at two levels: in the population dynamics, whose balance is critical to the maintenance of rural areas; and in the evolution of the agriculture structural and competitive features, the main target of several Portuguese RDPs, in order to reflect the economic, social and environmental dimensions of the sector and surrounding territory.

Population dynamics

The Portuguese mainland has a population of 10,028 thousand inhabitants, an average of 113 inhabitants per km^2 for an area of 89,089 km^2, of which 70% corresponds to agriculture and forestry (MAM, 2014b).

Approximately 81.4% of its territory is rural (MAM, 2014b), and the produced statistics for the Portuguese mainland reflect, in general, the rural area dynamics (Table 3). An exception is the data regarding the resident population evolution, where the coast and the large urban centres have a strong impact and have led to slight increases between 1981 and 2011, which is reflected in the increasing population densities. For rural areas, for the 2000 to 2012 period, the population fell by 1.7%, in contrast to the urban areas, which increased by 5.3%. At present,

the rural areas of the Portuguese mainland represent about 33% of its population, corresponding to a density of 46.1 inhabitants/km^2 (MAM, 2014b).

The ageing index for the Portuguese mainland shows a marked deterioration for the dates under analysis, with a value of 112.7 by 2011. This is more accentuated for the rural areas reaching 141.8 and 177.2, in 2001 and 2011 respectively (MAM, 2014b). The negative trend is accompanied by the potential sustainability index, with the reduction of one individual at working age per elderly between each evaluated period.

Table 3. Population indicators from 1981, 2001 and 2011 for the Portuguese Mainland

INDICATORS		1981	2001	2011
Population Census	Population density (Nr. inhabitants/km²)	104.8	110.9	112.7
	Ageing index	45.4	104.5	130.6
	Potential sustainability index	5.5	4.1	3.4
	Longevity index	34.2	41.4	47.9

Source INE (1984, 2002, 2012).

On the other hand, the longevity index shows a growing trend which reflects the improvement of quality of life of the population. It should be also noted that this progression is accompanied by the educational level. By 2011, almost 55.9% of the population of rural areas had basic education and 9.7% had higher education (MAM, 2014b).

Structural and competitive features of agriculture

According to the last agricultural census from 2009 (INE, 2011), there are on the Portuguese mainland 278,114 farms covering 3,542,305 hectares of Utilised Agricultural Area (UAA). The number of farms in the country has declined about 30% per decade since 1989, but their size has been growing, reaching 12.7 ha per holding on the mainland in 2009 (INE, 2001; 2011) (Table 4). This evolution allows a productive fabric restructuration on the larger farms embodied by the transference of arable crops to pasture; towards a more extensive agriculture (MAM, 2014b).

However, according to data for 2009, there is a high proportion (roughly 90%) of small and very small farms in this country. These farms are mostly family businesses with a low hiring rate and small amounts of land. On the other hand, medium and large farms (9% of the total) employ more hired labour and represent 67% of the UAA (GPP, 2012; INE, 2011).

The use of the UAA has shown a positive trend only for permanent grassland since 1989 (INE, 2001; 2011). In the last decades, a significant transfer of the arable land use for pasture and meadow was observed, with particular emphasis for the poor spontaneous (MAM, 2014b). Between the considered dates (1989-2009), temporary cultures have regressed in general and in permanent crops growth stands out only for nuts (INE, 2001; 2011).

In terms of livestock species in Portugal, statistics show regression in all of them, except for cattle where it denotes a stabilisation or small growth in the last two decades (INE, 2001; 2011). The animal effective consists of approximately two million Normal Heads (NH) (MAM, 2014b), corresponding to an average of seven NH per farm.

Table 4. Agricultural indicators from 1989, 1999 and 2009 in Portuguese Mainland

INDICATORS		1989	1999	2009
Farm structure	Number of farms	550,879	382,163	278,114
	Average size of farms (Ha)	7.0	9.8	12.7
	Livestock density/farm (NH)	4.10	6.10	7.14
Production and profitability	Output of the Agricultural Industry (Basic prices)/UAA (10^3 €/Ha)	n.a.	1.59	1.62
	Output of the Agricultural Industry (Basic prices)/UAA (10^3 €/Ha)	n.a.	1.59	1.62
	Output of the Agricultural Industry (Basic prices)/Intermediate Consumption	n.a.	1.97	1.66
	Gross Value Added/AWU (€)	n.a.	5,873.53	6,653.84
	Operating Surplus/Mixed Income/farm (10^6 €)	n.a.	5,464.87	4,928.27
	Farms with profitable but not agricultural activities (%)	n.a.	8.6	5.4
Population and farm labour	Labour input/farm (AWU)	1.5	1.3	1.2
	Labour input/SAU (AWU/Ha)	20.9	13.3	9.6
	Importance of family farming in total labour (% AWU)	84.9	82.0	79.9
	Importance of family farming population in the resident population (%)	18.9	11.6	7.0
	Family farming population with more than 64 years (%)	17.0	24.8	34.60
	Family farming population with paid work from the outside of the farm (%)	28.9	29.3	29.1
Environmental indicators	Livestock density/UAA (NH/Ha)	0.58	0.62	0.56
	Irrigated surface (% UAA)	n.a.	16.1	13.0
	Tractors per 100 ha of UAA	3.4	4.4	5.1

Note: n.a. = not available; Source INE (2001, 2011); GPP (2000, 2012)

At the agriculture production level the uncovered values are generally decreasing on the dates under consideration. Variations of production are predominantly negative in the diverse components of vegetal production, highlighted by the sharp drop in cereal production, while livestock production has lower amplitudes (GPP, 2012). However, the observed decreases are offset by the decrease of UAA and used hand labour, resulting in increased productivities per unit of used area and by Annual Work Unit (AWU). This is mainly due to technological improvements and changes in cultural occupation and also to the sharp decrease in the number and relative weight of the smaller farms (GPP, 2012). Nonetheless, the sector still shows very low productivity levels (GPP, 2012).

When vegetable and animal productions are compared, the first showed a greater contribution, with 57.6% against 37.1% for the second, according to 2009 data (GPP, 2012). Still, deepening the perception of each subsector, it is noted that the livestock production has more dependency on intermediate consumption (Sousa, 2015). According to Eurostat (2012), in Portugal and for 2011, the share of the total value of the product affects to the inputs cost is 88.6% in animal production and only 13.8% in vegetal production (GPP, 2012). It should be noted that in the period under analysis, there was a sharp increase in inputs prices and the prices stabilisation of agricultural products (GPP, 2012). In this sense, the evolutionary analysis in the last decade reveals a smaller efficiency of the sector, expressed by the ratio of output/input through the intermediate consumption. This is also confirmed by the decrease of gathered operating surplus/mixed income by farm (Table 4).

The decreasing Gross Value Added (GVA) and subsequent evolution of agricultural production in value have affected the importance of agriculture in total Gross National Product (GDP). Agriculture had a weight in the national economy of 2.5% in 2000, 1.7% in 2007 and 1.4% (estimate) in 2011 (GPP, 2012). This decreasing weight of the agricultural GVA in the country GVA follows the general trend in the EU27. However, some of the improvements realised in 2012, and especially in 2013, are a result of further improvement in the agricultural products' prices and an increase less marked in the intermediate consumption prices accompanied by a decrease in the use of them (Sousa, 2015).

Also, it is worth noting the decrease of farms with profitable but not agricultural activities of from 8.6 to 5.4% (Table 4), which may be due to the decline of the available labour force for such activities.

Regarding population and farm labour (Table 4), with the exception of the last two indicators, decreases are observed on the used labour per farm and per unit area, in the periods under review. Also the importance of family farming population in total labour and in resident population shows a declining trend. For 2011, the labour input was 341,502 AWU, of which 272,273 was family AWU.

Table 4 shows further the worsening of the age of the family farming population, revealing the need for its rejuvenation. The family farming population with paid work from the outside of the farm already remains at constant levels, not reaching one third of this population.

The measurable parameters regarding environmental effects of the agricultural sector on the Portuguese mainland are at the end of Table 4. Its observation allows us to show a small fluctuation in the livestock density by unit of UAA, with about 0.6 NH/Ha, and therefore not exceeding the header limits allowed by the soil ability. Already the irrigated land has decreased between 1999 and 2009, with a water consumption of 2,139 m^3/ha of watered UAA in the last year. The indicator related to the number of tractors was an attempt to be a measure of used mechanical traction, with negative effects on physical soil degradation. This parameter has a growing trend and may be due to several factors. Besides the UAA decrease, there are continuous supports for machinery and equipment acquisition. Also, the tractors are a compensation factor for the reduction in hand labour in the sector and, also, a display factor of the activity.

Final considerations

The characteristics of the Portuguese countryside are a result of numerous factors, and the various RDPs have an increased responsibility for the dynamics of these territories. In the EU, especially in Portugal, those plans have been highly targeted to the agricultural sector, since it dominates the occupation of the country. This is a subject of extreme criticism in the scientific literature, because rural areas are not only agricultural. New development models should be followed based on an integral and holistic approach to the territory, in which several dimensions converge to contribute to its development.

Given the different dimensions in this space, it is difficult to directly assess the real effects of the several programmes. Regarding population, there is a general worsening of the indicators that characterise it. The quality of life, demonstrated by the longevity index, is the parameter with the better progress. The analysis at the agricultural sector level allows us to acknowledge the land restructuring of farms, with an increasing of its average size and a productivity and profitability growth. Concerns over the environment are beginning to take shape and the quality of life requires still other requisites. However, rural depopulation continues to occur, accentuating imbalances between the coast and inland, and between the rural and urban of the Portuguese mainland.

Nevertheless, the main effect of the several measures supported by the RDPs may be their contribution to avoid the worsening of the indicators shown in this work.

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A model for agricultural planning at farm level for the European Union countries

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Abstract: The agricultural sector, considering its specificities, needs good strategic plans from production through to commercialisation. However, planning for agriculture is not easy, because it depends on several factors: climatic conditions; the biologic vulnerabilities (pests and diseases); the socioeconomic conjuncture; and changes in the legislation and the farming markets. Linear programming models, as optimisation techniques, are usually adjusted methodologies to help in the construction of these agricultural plans. Within this framework, this investigation aims to be a stimulating contribution for the scientific community and for the various agricultural operators (farmers, policymakers, etc.), by building an accessible (namely for the farmers) and simple planning model, based on the linear programming methodologies and using the data available from the Farm Accountancy Data Network (FADN, 2014), across the period 2007-2011, for the former twenty-seven European Union countries. These models are flexible and easily adaptable to new circumstances, helping, in this way, in the prevision of the respective implications. This study is a first approach using these methodologies and this kind of data.

Keywords: Agricultural planning, European Union, Farm Accountancy Data Network, linear programming models

Introduction

A good agricultural planning presupposes several steps until it is ready to be implemented in the farms, namely when the intention is to start from the beginning and do it all again. As a first step it is important to collect information about the soil and climate conditions about the locality where the farm is located. Nowadays, there is lots of information about the soil and climate, sometimes georeferenced, in public platforms that can help the agricultural operators in the systematisation of this information. A second step concerns the collection of information related to the current legislation, the associated farming markets and the various financial supports. After the systematisation of this information it is important to identify agricultural productions adjusted to the conditions observed in the information collected and analysed. The next step is to obtain information about the costs and revenues associated with the agricultural activities identified. With this information it is possible to select the productions best adjusted to the conditions to optimise results. This agricultural activities selection can be done by various management methodologies, such as budget methods (total or partial), the cash flows (total or partial) and the mixed and linear programming models, among others.

In this work, the objective is to centre the research in the economic and management part, namely in the procedures related with the selection of farming activities and with the adjustment of the farms' structures, dimension and daily functioning to optimised frameworks. For that, a simple model was built, based on linear programming, for the European farms, using statistical information available in the FADN (2014) database for the European Union countries over the years (on average) from 2007 to 2011.

The linear programming models, in comparison to other methods, have the advantage of obtaining optimised solutions and allowing the interrelation of different activities, which is what happens in reality; between, for example, animal and vegetal production, where some profitable vegetal productions are interrelated with animal activities.

This is an interesting contribution, considering our knowledge, to the scientific community and to the agricultural operators, from the policymakers to the farmers, and may be one more support to the design of new strategies for the improvement of agricultural performance.

Related literature

Agricultural planning is crucial for all economic performance (Paster, 2004). Recently the geographic information systems have been used as support methodology for agricultural planning, through the construction of land maps that allow elaborate plans based on the visualisation of georeferenced information (Saroinsong et al., 2007; Bryan et al., 2011; Rosa & Privitera, 2013; Russo et al., 2014). The geospatial tools are interesting supports for the plans construct in agriculture, taking advantage of significant improvements verified in the new technologies (Erickson et al., 2013; Bruin et al., 2014).

In certain cases, namely in zones of difficult access, it is already possible to collect information for farming planning, namely that related to the soil conditions, through algorithms using data available in public databases (Coopersmith et al., 2014).

Another question about farm planning is related to the irregularity of the parcels of land on the farms, which can cause some complications concerning the introduction of machines and in the displacements. In these cases the challenge is to reduce the distances and minimise the costs associated with various practices (Zhou et al., 2014), as for example those related with the diverse operations that involve the harvesting and distribution of agricultural productions (Ahumada & Villalobos, 2011; Bakhtiari et al., 2013).

Independently of these several advances in the tools for agricultural planning, there are different concerns about the farming growth and development process that must be taken into account in each plan, namely those related to the social and environmental aspects which may be so key factors influencing the optimisation of returns. The sustainability cannot be forgotten in the agricultural plans (Pearson, 2013).

The uncertainty verified in the agricultural activities related with the production of fresh products calls for efficient plans to reduce the risks associated with the several activities involved from the production to the final consumer. The complications appear around supply, related to the characteristics of the productions in agriculture (perishable products and atomized farms - in general small and in great number - which brings various complications) and also around demand, associated with the specificities of the goods produced in the farms (in general these are products of first need with low price and income elasticities). Ahumada et al. (2012) developed a stochastic model to deal with these uncertainties, more robust than the deterministic models. The ways of dealing with the questions related to the risks verified in the agricultural markets were also approached by Tan and Comden (2012).

On the other hand, Cardín-Pedrosa and Alvarez-López (2012) developed a model to support the decisions of the several agricultural operators based in numerous socioeconomic and environmental indicators, constructing a matrix of adequacy among the farming productions

and the indicators. Moulogianni et al. (2011) generated a programming model with more than one decision operator, allowing for the possibility of contradictory criteria, as an alternative to the models built based on linear and nonlinear programming models.

In farming plans it is important to prioritise the various steps and options. For this, there are some methodologies such as those developed by Thompson (2011) for the conservation and restoration of biodiversity. Concerning planning for the restoration of farming landscapes, Moreno-Mateos and Comin (2010) proposed an approach with four steps to support the decisions of the related operators.

The identification and characterisation of the farms, as referred to before, is an important step for agricultural planning. Álvarez-López et al. (2008) characterised the agricultural systems based on the farm dimension, land utilisations and type of production.

Crop succession is another important factor that must be considered in farm planning. The crop successions are technical, agronomic requirements. Haneveld and Stegeman (2005) proposed a linear programming model to take these aspects into account in the agricultural planning.

Agricultural planning, considering the particularities of the sector, is indispensable to minimise some adverse characteristics such as the farming structures, the organisational debilities and the mismatches between the demand and the supply in the agricultural markets. However, constructing plans for agriculture is not easy, because there are several factors that can influence the dynamics and performance of the farming activities. In any case, planning in agricultural has advantages at a micro level, because it supports the farmers in their daily decision making, other operators related to distribution and commercialisation, and the policymakers. Considering this, these plans allow conclusions to be reached that may help the public institutions in the design of the policies and strategies for the sector. There are many methodologies and many tools to support the elaboration of these agricultural plans, but the linear programming models continue to be interesting bases. These models have the advantage of being easy tools that permit optimised and interrelated solutions to be obtained. The utility of the solutions depends on the information utilised and the structure of the model.

The model used

The model considered in this work has linear programming as its base, however it considers statistical information at the farm level, available in the FADN (2014) database, and is an extended model that aims to consider the majority of the variables and factors that may influence farming growth and development in the farms of the European Union countries. The model was run with data, an average for the period 2007-2011, relative to a representative farm built for the all European countries by the FADN (2014) for each year.

Below we develop a generic model that can be adjusted to any context and will be applied in the fifth section with the typical structure divided into two parts (Dantzig, 2002): the ***objective function*** and the ***restrictions***:

- ***Objective function*** (euro): Max Z=r11x11+…+r1nx1n+r21x21+…+r2nx2n-c11x11-…-c1nx1n--c21x21-…-c2nx2n-cc11x11-…-cc1nx1n-cc21x21-…-cc2nx2n+s11x11+…+s1nx1n+s21x21+…+s2nx2n-ic11x11-…-ic1nx1n-ic21x21-…-ic2nx2n-x31-…-x3n

Where:

r11,…,r1n, are crop returns per ha (cereals, protein crops, energy crops, potatoes, sugar beet, oil-seed crops, industrial crops, vegetables & flowers, fruit, citrus fruit, wine and grapes, olives & olive oil, forage crops and other crop output);

r12,…,r2n, are livestock returns per LU (cows' milk & milk products, beef and veal, pig meat, sheep and goats, poultry meat, eggs, ewes' and goats' milk and other livestock & products);

c11,…,c1n, are crop specific costs per ha (seeds and plants, fertilisers, crop protection and other crop specific costs);

c12,…,c2n, are livestock specific costs per LU (feed for grazing livestock, feed for pigs & poultry and other livestock specific costs);

cc11,…,cc1n, are common costs per ha (total farming overheads, machinery & building current costs, energy, contract work, other direct inputs, depreciation, total external factors, wages paid, rent paid, interest paid, taxes, vat balance excluding on investments and vat on investments);

cc12,…,cc2n, are common costs per LU;

s11,…,s1n, are common subsidies per ha (compensatory payments/area payments, set aside premiums, other crops subsidies, environmental subsidies, lfa subsidies, total support for rural development, other rural development payments, other subsidies, subsidies on intermediate consumption, subsidies on external factors and decoupled payments);

s12,…,s2n, are common subsidies per LU (subsidies dairying, subsidies other cattle, subsidies sheep & goats and other livestock subsidies);

ic11,…,ic1n, are common investment costs per ha;

ic12,…,ic2n, are common investment costs per LU;

x11,…,x1n, are vegetal productions expressed in ha (cereals, other field crops, energy crops, vegetables and flowers, vineyards, permanent crops, olive groves, orchards, other permanent crops, forage crops, agricultural fallows, set aside, total agricultural area out of production and woodland area);

x21,…,x2n, are livestock activities expressed in LU (dairy cows, other cattle, sheep and goats, pigs and poultry);

x31,…,x3n, are several buying activities (buying of labour, etc).

Subject to

Restrictions:

- All vegetal activities (ha): x11+…+x1n<=b1 (where b1 is the availability of ha);
- All livestock productions (LU): x21+…+x2n<=b2 (b2 is the availability of LU);
- Labour needs (hours): a11x11+…+a1nx1n+…<=b3+x31 (a11,…,a1n are matrix designations and are needs per unit of labour, b3 is the total labour existent in the farm and x31 is a labour buying activity);

- Total fixed assets constraint (euro): a21x11+…+a2nx1n+…<=b4 (a21,…,a2n are matrix designations and are request per unit of total fixed assets, and b4 is the total fixed assets of the farm)
- The following equations that may be constructed can be similar to the last two restrictions and in this work are relative to issues such as: gross investment, subsidies on investments, total subsidies on crops, total subsidies on livestock, environmental subsidies, lfa subsidies, total support for rural development, other rural development payments, other subsidies, subsidies on intermediate consumption, subsidies on external factors, decoupled payments, machinery & building current costs, energy, depreciation, wages paid, rent paid, interest paid and taxes.

Data analysis

Table 1 has the values relative to a typical European Union farm built using averages, in this work, for the years 2007-2011, from the statistical information available in the Farm Accountancy Data Network, where a typical farm for each country was built, covering all countries over the last decades.

The values in Table 1 reveal that a typical European Union farm uses 3584.3 hours a year of labour (the majority unpaid) in 31.2 ha of utilised agricultural area and with 25.2 livestock units. The majority of this area is occupied by cereals and forage crops and the most important livestock productions are the dairy cows and other cattle and the pigs.

This farm has a total output of 59551.4 euro, where the majority is obtained with crop productions (31287.8 euro). The crop activities with more total output are the cereals, the vegetables & flowers and the wine and grapes. In the livestock production, the total output comes from the cows' milk & milk products, pig meat and beef and veal.

The farming system considered here, needs inputs in a total of 53156.4 euro, where the majority are intermediate consumption (31287.8 euro). In the crop productions are the fertilisers (3280.8 euro), the seeds and plants (2496.4 euro) and the crop protection products (2142.8 euro) that consume relevant inputs. In the livestock productions a significant part of the inputs come from the feed for grazing livestock (6031.0 euro) and the feed for pigs & poultry (4898.6 euro). The depreciation (8081.2 euro), the wages paid (4969.8 euro) and the energy (4232.8 euro) represent a relevant part of the common costs.

The farm taken into account in this work has a net income of 16780.0 euro and a total fixed assets of 231906.4 euro, where the largest part is for the land, permanent crops and quota (154809.8 euro) followed by the buildings (38924.4 euro). These farmers invest 8395.4 euro per year, on average.

Table 1. Characteristics of the typical European Union farm

Labour (hours), Area (ha) and livestock (LU)		Total, crops and livestock outputs (euro)		Specific and common crops and livestock inputs (euro)		Economic results, fixed assets and subsidies (euro)	
Labour input	3584.3	Total output	59551.4	Total Inputs	53156.4	Farm Net Income	16780.0
Unpaid labour input	2780.1	Total output crops & crop production	31287.8	Total intermediate consumption	35831.4	Total fixed assets	231906.4
Paid labour Input	804.2	Total crops output / ha	1041.2	Total specific costs	21851.4	Land. permanent crops & quotas	154809.8
Total Utilised Agricultural Area	31.2	Cereals	9639.6	Specific crop costs / ha	288.4	Buildings	38924.4
Cereals	11.8	Protein crops	184.4	Seeds and plants	2496.4	Machinery	28603.4
Other field crops	3.5	Energy crops	182.8	Seeds and plants home-grown	205.0	Breeding livestock	9569.0
Energy crops	0.2	Potatoes	1302.4	Fertilisers	3280.8	Gross Investment	8395.4
Vegetables and flowers	0.3	Sugar beet	788.6	Crop protection	2142.8	Total subsidies - excluding on investments	10591.0
Vineyards	0.6	Oil-seed crops	1934.2	Other crop specific costs	1139.8	Total subsidies on crops	567.8
Permanent crops	1.4	Industrial crops	346.0	Specific livestock output / LU	503.8	Compensatory payments/area payments	181.2
Olive groves	0.7	Vegetables & flowers	6158.2	Feed for grazing livestock	6031.0	Set aside premiums	4.6
Orchards	0.7	Fruit	2113.6	Feed for grazing livestock home-grown	2187.2	Other crops subsidies	367.4

Other permanent crops	0.0	Citrus fruit	465.0	Feed for pigs & poultry	4898.6	Total subsidies on livestock	612.6
Forage crops	12.4	Wine and grapes	3599.0	Other livestock specific costs	1844.8	Subsidies dairying	68.8
Agricultural fallows	0.7	Olives & olive oil	1340.8	Forestry specific costs	16.6	Subsidies other cattle	339.6
Set aside	0.5	Forage crops	2120.0	Total farming overheads	13980.2	Subsidies sheep & goats	70.8
Total agricultural area out of production	1.2	Other crop output	1295.6	Machinery & building current costs	3221.0	Other livestock subsidies	133.4
Woodland area	1.2	Total output livestock & livestock products	25167.2	Energy	4232.8	Environmental subsidies	983.0
Total livestock units	25.2	Total livestock output / LU	987.8	Contract work	2548.4	LFA subsidies	671.8
Dairy cows	4.8	Change in value of livestock	56.6	Other direct inputs	3978.2	Total support for rural development	1833.4
Other cattle	7.8	Cows' milk & milk products	9877.0	Depreciation	8081.2	Other rural development payments	178.4
Sheep and goats	2.7	Beef and veal	4405.2	Total external factors	9243.8	Other subsidies	650.8
Pigs	6.9	Pigmeat	5373.6	Wages paid	4969.8	Subsidies on intermediate consumption	195.2
Poultry	2.9	Sheep and goats	1069.6	Rent paid	2538.0	Subsidies on external factors	55.4
		Poultrymeat	1446.4	Interest paid	1735.8	Decoupled payments	6672.4
		Eggs	856.8	Taxes	651.8		

Ewes' and goats' milk	982.8	VAT balance excluding on investments	290.4
Other livestock & products	1155.8	Subsidies on investments	434.0
Other output	3096.4	VAT on investments	281.0

The total subsidies, excluding on investments, represent 10591.0 euro, where the majority are decoupled payments (6672.4 euro). The total subsidies for the crops represent 567.8 euro and for the livestock productions 612.6 euro. The environmental subsidies are 983.0 euro and the total support for rural development is 1833.4 euro.

From this data analysis the cereals and the bovine productions are the more highlighted productions in the European Union farms. The fertilisers, the crop protection, and seeds and plants are the determinant specific costs in the crop productions and the feed the input that consumes a significant part of the specific costs in the livestock activities. The wages, the depreciation and the energy are relevant common costs and the decoupled payments the relevant subsidies, excluding on investments. The subsidies on the investments represent in these farms 434.0 euro per year, which seems to be of little relevance compared with the values of the investment and with the dimension of the total output and the farm net income referred to before and presented in Table 1.

Results

The results presented in the following tables were obtained through the Lingo (2015) optimisation software, based on the linear programming model presented above and pretend to be a simulation, among many others.

In these tables:

- X11, x12, x13, x4, x15, x16, x17 and x18 represents, respectively in ha, the cereals, energy crops, vegetables and flowers, vineyards, olive groves, orchards, forage crops and other field crops.

- x21, x22, x23 and x24 are, respectively in LU, the cows, sheep and goats, pigs and poultry and other livestock products.

- The rows represent, respectively, the objective function and the following restrictions: total area, total livestock, unpaid labour, paid labour, total fixed assets, gross investment, subsidies on investments, total subsidies on crops, total subsidies on livestock, environmental subsidies, lfa subsidies, total support for rural development, other rural development payments, other subsidies, subsidies on intermediate consumption, subsidies on external factors, decoupled payments, machinery & building current costs, energy, depreciation, wages paid, rent paid, interest paid and taxes.

In the tables the value is the solution for each variable, the reduced cost is the reduction per

unit in the optimised value if the correspondent variable was used, slack or surplus is the difference among the availabilities in each constraint and that used by the model for the solution presented, and the dual prices or shadow prices are the gain in the optimised value per any unit more of the correspondent factor.

Table 2 shows that the most profitable agricultural activity in the European Union countries is the vegetables and flowers, that in an optimised solution will occupy 30.8 ha. The productions which did not select with more reduced costs are, respectively, the other livestock products (33344.48 euro) followed by the other animal productions and by the forage crops and the cereals. The more limiting factor is the subsidies on external factors and the factor where the slack or surplus have a higher value are the total fixed assets. In the global the model was optimised with 694602.1 euro for the objective function.

In Table 3, with the same model but without the subsidies in the objective function, the results are very similar, the only difference is in the value of the objective function that decreases slightly and in this case is 682962.0 euro.

Tables 4 and 5 present results for models similar to those used, respectively, for the results shown in Tables 2 and 3. In these cases the models were extended with more than twelve restrictions to limit, respectively, each activity considered to the dimension of the actual context in the European Union.

The results in Table 4 presents that was chosen the vegetables and flowers (0.3 ha), vineyards (0.6 ha) and the orchards (0.7 ha). In this case the limiting factor is the area of these three crop productions. The value maximised of the objective function for these conditions is 10784.21 euro.

The values showed in Table 5, with limits for the dimension of each production and without subsidies in the objective function, are very similar with those presented in Table 4, including the value for the objective function that in this case is 10179.09 euro.

Table 2. Optimised results based on the linear programming model

Variable	Value	Reduced Cost
X11	0.000000	23721.80
X12	0.000000	23608.70
X13	30.77778	0.000000
X14	0.000000	18205.10
X15	0.000000	22647.60
X16	0.000000	20574.30
X17	0.000000	24370.00
X18	0.000000	23573.60
X21	0.000000	28764.88
X22	0.000000	29128.48
X23	0.000000	29614.48
X24	0.000000	33344.48
X3	0.000000	6.200000
Row	**Slack or Surplus**	**Dual Price**
1	694602.1	1.000000

2	0.4222222	0.000000
3	25.20000	0.000000
4	40.87778	0.000000
5	10.13333	0.000000
6	3329.078	0.000000
7	119.2556	0.000000
8	6.188889	0.000000
9	7.644444	0.000000
10	612.6000	0.000000
11	13.50000	0.000000
12	10.07778	0.000000
13	26.74444	0.000000
14	2.966667	0.000000
15	10.62222	0.000000
16	1.300000	0.000000
17	0.000000	12537.94
18	95.18889	0.000000
19	44.73333	0.000000
20	59.33333	0.000000
21	115.9111	0.000000
22	69.97778	0.000000
23	35.76667	0.000000
24	24.55556	0.000000
25	8.544444	0.000000

Table 3. Optimised results based on the linear programming model (without subsidies in the objective function)

Variable	Value	Reduced Cost
X11	0.000000	23721.80
X12	0.000000	23608.70
X13	30.77778	0.000000
X14	0.000000	18205.10
X15	0.000000	22647.60
X16	0.000000	20574.30
X17	0.000000	24370.00
X18	0.000000	23573.60
X21	0.000000	28773.33
X22	0.000000	29136.93
X23	0.000000	29622.93
X24	0.000000	33352.93
X3	0.000000	6.200000
Row	**Slack or Surplus**	**Dual Price**
1	682962.0	1.000000
2	0.4222222	0.000000
3	25.20000	0.000000
4	40.87778	0.000000
5	10.13333	0.000000

6	3329.078	0.000000
7	119.2556	0.000000
8	6.188889	0.000000
9	7.644444	0.000000
10	612.6000	0.000000
11	13.50000	0.000000
12	10.07778	0.000000
13	26.74444	0.000000
14	2.966667	0.000000
15	10.62222	0.000000
16	1.300000	0.000000
17	0.000000	12327.83
18	95.18889	0.000000
19	44.73333	0.000000
20	59.33333	0.000000
21	115.9111	0.000000
22	69.97778	0.000000
23	35.76667	0.000000
24	24.55556	0.000000
25	8.544444	0.000000

Table 4. Optimised results based on the linear programming model, with limits for the dimension of the crop and livestock productions based on the European reality

Variable	Value	Reduced Cost
X11	0.000000	1153.500
X12	0.000000	1040.400
X13	0.3000000	0.000000
X14	0.6000000	0.000000
X15	0.000000	79.30000
X16	0.7000000	0.000000
X17	0.000000	1801.700
X18	0.000000	1005.300
X21	0.000000	1181.400
X22	0.000000	1545.000
X23	0.000000	2031.000
X24	0.000000	5761.000
X3	0.000000	6.200000
Row	**Slack or Surplus**	**Dual Price**
1	10784.21	1.000000
2	29.60000	0.000000
3	25.20000	0.000000
4	2637.700	0.000000
5	762.9200	0.000000
6	220023.7	0.000000
7	7965.160	0.000000
8	411.7600	0.000000
9	538.6800	0.000000
10	612.6000	0.000000
11	932.6000	0.000000

12	637.4000	0.000000
13	1739.480	0.000000
14	169.2800	0.000000
15	617.5200	0.000000
16	185.1200	0.000000
17	52.52000	0.000000
18	6330.480	0.000000
19	3055.880	0.000000
20	4015.840	0.000000
21	7667.120	0.000000
22	4715.080	0.000000
23	2407.920	0.000000
24	1646.840	0.000000
25	618.3600	0.000000
26	11.80000	0.000000
27	0.2000000	0.000000
28	0.000000	22568.30
29	0.000000	4363.200
30	0.7000000	0.000000
31	0.000000	1994.000
32	12.40000	0.000000
33	4.700000	0.000000
34	12.60000	0.000000
35	2.700000	0.000000
36	9.800000	0.000000
37	0.2000000	0.000000

Table 5. Optimised results based on the linear programming model, with limits for the dimension of the crop and livestock productions based on the European reality (without subsidies in the objective function)

Variable	Value	Reduced Cost
X11	0.000000	1531.700
X12	0.000000	1418.600
X13	0.3000000	0.000000
X14	0.6000000	0.000000
X15	0.000000	457.5000
X16	0.7000000	0.000000
X17	0.000000	2179.900
X18	0.000000	1383.500
X21	0.000000	1652.100
X22	0.000000	2015.700
X23	0.000000	2501.700
X24	0.000000	6231.700
X3	0.000000	6.200000
Row	**Slack or Surplus**	**Dual Price**
1	10179.09	1.000000
2	29.60000	0.000000
3	25.20000	0.000000
4	2637.700	0.000000

5	762.9200	0.000000
6	220023.7	0.000000
7	7965.160	0.000000
8	411.7600	0.000000
9	538.6800	0.000000
10	612.6000	0.000000
11	932.6000	0.000000
12	637.4000	0.000000
13	1739.480	0.000000
14	169.2800	0.000000
15	617.5200	0.000000
16	185.1200	0.000000
17	52.52000	0.000000
18	6330.480	0.000000
19	3055.880	0.000000
20	4015.840	0.000000
21	7667.120	0.000000
22	4715.080	0.000000
23	2407.920	0.000000
24	1646.840	0.000000
25	618.3600	0.000000
26	11.80000	0.000000
27	0.2000000	0.000000
28	0.000000	22190.10
29	0.000000	3985.000
30	0.7000000	0.000000
31	0.000000	1615.800
32	12.40000	0.000000
33	4.700000	0.000000
34	12.60000	0.000000
35	2.700000	0.000000
36	9.800000	0.000000
37	0.2000000	0.000000

Conclusions

The literature review showed that the new technologies, namely those related to the geographic informatics systems, are interesting supports, considered by many authors for agricultural planning. However, there are many other methodologies referred to in the literature e.g. the mathematical models based on several frameworks and the linear programming models, which are used as supports for the farmers' decisions.

This literature review also reveals the importance of farm planning for the agricultural performance in the economic growth and development processes, considering the specificities of this economic sector.

The data description shows that typical farms in the European Union countries, over the period 2007-2011, have 31.2 ha and 25.2 livestock units. The cereals and the forage crops are the relevant vegetal productions and the dairy cows, other cattle and pigs are the determinant livestock activities. The fertilisers, crop protection products and seeds and plants represent a great part of the crop specific costs and the feed an important portion of the livestock specific

costs. The depreciations, energy and the wage paid represent significant common costs in the European Union farms. A great portion of the subsidies, excluding on investments, come from the decoupled payments, the single area and the single farm payments created after the Common Agricultural Policy reform of 2003.

The simple model constructed can be used by the farmers, is based on linear programming methodologies and is an interesting support for the farmers' decisions and farm management, as well as for the public institutions and other operators that work with the agricultural sector. This model uses data at farm level for all European Union countries and considers, in a disaggregated way, the majority of the factors and variables that can influence the evolution and organisation of the agricultural sector in Europe.

The results, obtained with a simulation of the model among many others that be realised, show that vegetables and flowers are the most profitable agricultural activities in the European Union countries followed by the vineyards and orchards. The maximised value of the objective function when the model is optimised only with vegetables and flowers is 694602.1 euro, very different to the actual economic results verified in the European farms. Of course, this is a theoretical scenario, but could be a base for the design of strategies. On the other hand, the subsidies do not influence the optimisation process and few influence the maximised value of the objective function. It will be important for future research to complement these results with those obtained with a different methodology.

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The impact of subsidies on the agricultural sector: a linear programming approach to Portuguese farming

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Abstract: Since joining the European Economic Community (EEC) in 1986, Portugal has benefited from several forms of financial support, in the context of the Common Agricultural Policy (CAP), towards the farmers' income and the farms' structure. The framework for these income subsidies has changed from that time until now, due to the CAP reforms in 1992, 2000, 2003 (with its application since 2005), 2007 (less importantly) and 2013, and the structural subsidies transformations in 1994, 2000, 2007 and 2014. In this context, the principal objective of this study is to analyse the implications of the various subsidies, within the Portuguese agricultural sector, that came as a consequence of joining the ECC and of several farming policy reforms after that date, with data obtained from the FADN (2014) and through a model of linear programming solved with the LINGO (2015) optimisation software. This study is an interesting contribution to scientific literature and for the agricultural policy makers and designers. There are no existing studies in the literature consulted which cover these subjects for Portugal using the linear programming with this statistical information. The linear programming has some advantages, because it allows for optimal analysis and obtains exact results. This is a first approach with these methodologies and data.

Keywords: Portuguese agricultural sector, agricultural policies, subsidies; linear programming.

Introduction

In the mid-eighties (1986) Portugal joined the European Economic Community with great implications for the Portuguese across several economic sectors. The agricultural sector benefited, more or less, from a transitional period for adaptation to the EEC rules and dynamics and to consider the implications of joining, namely those related with the free trade among the Member States. In this context, Portugal did not benefit from some Common Agricultural Policy instruments applied to the European farming sectors, namely those related to the markets and prices, until the first great CAP reform of 1992.

With the first reform of 1992 there were significant changes, namely the de-coupling of the CAP income subsidies from production (Martinho, 2015a). The reform of 1999 reinforced the tendencies of the first reform and the reform of 2003 brought new significant changes with the total de-coupling of the CAP income subsidies from production and from farming activities. In 2007 the unique Common Market Organisation for agricultural products was created.

The structural policies for agriculture changed, after Portugal joined; in 1994 (first Common Support Framework), in 2000 (second Common Support Framework), in 2007 (National Strategic Reference Framework) and in 2014 (Portugal 2020).

In this context it seems interesting to analyse the implications of these several transformations in the Portuguese farming sector, not only as an important contribution to scientific literature, considering the adequacy of the study, but also for the Portuguese and European Union policy makers and designers. Agriculture is an important economic sector with significant direct and indirect impacts on the socioeconomic framework (Martinho, 2015b).

This study is also of interest due to the consideration of linear programming as a method of analysis. The linear programming models have the advantage of allowing for optimal and exact results.

Thus, the objective of this study is to analyse, through models of linear programming, the consequences for agriculture of the income and structural subsidies which came to Portugal after joining what was once referred to as the EEC, and after the several changes in the income and structural agricultural policies. The study makes use of statistical information available from 1989 until 2009 (the largest time series accessible) in the FADN (2014) and using the optimisation software LINGO (2015).

Background literature

Sometimes the agricultural subsidies, namely those related with international trade practiced in the United States and in the European Union, can cause economic distortions in international relationships (Bruno et al., 2012). In fact, these two economies are those which suffer more pressures in the context of the World Trade Organisation, from subsidies on agriculture (Bruno et al., 2014).

The agricultural subsidies aim to stabilise the relationship between the demand and the supply in food markets, ensuring prices are accessible to consumers and incomes are reasonable for farmers, whilst aiming to improve the structure of farms. However, these financial supports can have various adverse consequences (depending on the context), such as health, environment and food security; as happened in China after 1997 with the agricultural subsidies being introduced to reduce the problems related to the lack of food in the agricultural markets (Zhao et al., 2014).

In a different context, farming subsidies have also had negative consequences upon the health of the United States' population, increasing the problem of obesity (Franck et al., 2013). The adverse impacts of subsidies on local biodiversity, in some regions, is real and significant, calling for more adjusted policies, oriented towards the local realities, rather than to the national or regional conditions (Gottschalk et al., 2007).

On the other hand, in certain circumstances, the subsidies can be economically inefficient, because they induce the farmers to opt for production which may be less profitable, stimulating productions which were previously not considered (Střeleček et al., 2009). In the South of Portugal, along with the crop prices, availability of water, farmers' vocational training and the market structures, the subsidies influence the farms' performance (Silva et al., 2001). In other cases they promote structural changes such as those seen in Slovenia, where the number of medium-size farms has been decreasing because they are too big to receive sufficient subsidies and too small to be economically efficient (Bojnec & Latruffe, 2013). In Northeast Portugal, over the last three decades, the annual crop productions have decreased. This is

as a consequence of various factors, but partly because of the farming policies designed into the framework of the Common Agricultural Policy (Pôças et al, 2011). Structural changes were also observed in the last decade for the Southern region of Portugal, with several structural changes partly due to decoupled subsidies (Ribeiro et al., 2014). Similar structural transformations have been witnessed over the last 20 years for the Central and Alentejo regions of Portugal, where there has been some transition to livestock production (Jones et al., 2014).

Another important question is the relationship between subsidies and employment. The impact on the labour market, considering the existing literature, are not consensual (Pandit et al., 2013). The subsidies for agriculture may also be socially unjust, because they favour the larger farmers to the detriment of smaller ones; hence some efficient redistribution is needed (Cong & Brady, 2012). The farming policies, in some contexts, have significant implications for farmers' debts. For example, Ciaian et al. (2012) found that the subsidies increase the long-term credits in the larger farms and the short-term credits in smaller farms.

However, the farming sector has many particularities and requires planned interventions at the structural and farmers' income level. For example, the prices in the farming sector are often subject to some volatility during the year and between different years, which can bring about some undesirable implications for the consumers and the farmers, but frequently the main negative consequences are for the agricultural producers. Hence, there are several farming strategies in different countries to deal with these situations, such as price subsidies and product purchases (Severová et al., 2012; Chen et al., 2014).

The need for planned interventions by public institutions and the implementation of adjusted policies is higher in disadvantaged or mountain zones, where problems with the food markets' supply are far greater and the implications for the local population without the necessary support can be serious (Dame & Nüsser, 2011). The importance of the agricultural subsidies is also referred to by Czech farmers who indicate positive improvements after joining the European Union in 2004, with the adoption of the Common Agricultural Policy (Špička et al., 2009; Lapka et al., 2011). In a similar way, the strategies and the subsidies associated with crop insurance help the farmers in their decisions and can improve agricultural output growth and the profitability of the farmers (Jing-feng & Pu, 2014). Nowadays, a growing problem is the asymmetry between the rural and the urban, between the peripheral and the core zones and between the coastal and the interior regions. A big challenge has been to counteract this tendency, namely for public policies. Some studies show that, indeed, the recent subsidies for agriculture reduced the agglomeration of economic activity in the more populated cities (Daniel & Kilkenny, 2009). The majority of olive-growing farms in the south of Spain are not viable without the national and European subsidies, which clearly explains the importance of agricultural subsidies for the continuation of farms in some countries and in certain regions (Amores & Contreras, 2009). The olive production was also studied by Graaff et al. (2008) and Stroosnijder et al. (2008), in the context of the European Union, who highlight some scenarios for the future of these activities in Mediterranean countries, and by Fleskens and Graaff (2010) in the Portuguese context. Gomez et al. (2008) found that organic olive production, namely in mountain zones, has low profitability in Mediterranean countries and its sustainability depends on substantial levels of financial support.

The farming policies implementation and subsidies management are not easy tasks for the different governments and public institutions. To diminish these difficulties several software

tools have been developed, some based on the recent evolution within the framework of the information communication technologies (Zadravec & Zalik, 2009).

The perception of the farmers about the level of subsidies that they receive is not always correct, namely concerned with indirect financial support (Daugbjerg et al., 2005), which can bias the decisions and options of farmers. Indeed, these questions related to the agricultural sector are complex and need resilient approaches.

Legg (2003) presented in these fields an interesting address and some ideas for international debate about the farming policies and concerning the interrelated and derived subsidies for agriculture.

Data used

In the following tables the statistical information obtained from the FADN (2014) for the Portuguese context is presented for the period 1989-2009 (the largest period available in the database considered).

Table 1. Economic size and labour (AWU and hours)

Year	Economic size (ESU)	Total labour input (AWU)	Labour input (hours)	Unpaid labour input (AWU)	Paid labour input (AWU)	Paid labour Input (hours)	Unpaid labour input (hours)
1989-1993	6.0	1.6	3866.2	1.3	0.3	679.0	3187.3
1994-1999	7.2	1.4	3393.9	1.2	0.2	501.6	2892.3
2000-2007	11.0	1.5	3302.4	1.2	0.2	543.2	2759.3
2007-2009	12.7	1.6	2992.4	1.3	0.3	478.7	2513.7

The period considered was divided into four sub-periods (considering the dates related to the most determinant CAP reforms and with the structural subsidy changes) and averages for each sub-period were calculated. In 1992 the first CAP reform occurred; in 1994 an important change to the structural funds after Portugal joined the European Economic Community/European Union also occurred; another transformation was verified in 2002; with a further one in 2007.

Table 1 shows that the economic size of farms in Portugal increased during the sub-periods considered, from 6.0 ESU (European Size Units) in the first sub-period to 12.7 in 2007-2009. Both paid and unpaid labour, expressed in hours, decreased significantly across the period, which is not verified by the labour expressed in AWU because of the changes verified in the form of calculation for this unit from 1989 until 2009. Paid labour is around 20% of the total labour, which is demonstrative of the unpaid, or family labour on farms.

Table 2 proves the farms' specialisation in livestock production, namely after the year 2000, changing from 5.6 LU in the first sub-period to 12.9 in the last. This specialisation is evidenced not only by the number of LU (that indeed increased), but also by the stocking density (that is unchangeable over the period), which means that some farms changed their structure from crop to livestock production. The other livestock production that increased the most was that for cows, from 1.8 in 1989-1993 to 5.3 in 2007-2009.

Table 2. Livestock production (LU)

Year	Total livestock units	Dairy cows	Other cattle	Sheep and goats	Pigs	Poultry	Stocking density (LU/ha)	Milk yield (Kg/cow)
1989-1993	5.6	1.0	1.8	1.1	1.0	0.4	0.6	4086.8
1994-1999	5.7	1.0	2.0	1.1	1.1	0.4	0.6	4979.9
2000-2007	9.8	1.6	3.7	2.0	1.9	0.3	0.7	6007.1
2007-2009	12.9	2.0	5.3	2.6	1.9	0.8	0.6	6761.5

Some agricultural economic results have increased significantly from 1989 until 2009, e.g. the gross farm income (increased about 3.1 times), the farm net value added (augmented around 3.3 times) and the farm net income (about 3.6 times more). Work productivity also increased considerably (Table 3).

Table 3. Farm economic results (euro)

Year	Gross Farm Income	Farm Net Value Added	Farm Net Income	Farm Net Value Added / AWU	Farm Net Income / FWU
1989-1993	5043.4	3674.8	2773.4	2262.8	2071.6
1994-1999	6154.5	4262.2	3174.7	3034.0	2650.8
2000-2007	11384.9	8276.7	6463.6	5577.1	5230.0
2007-2009	15751.0	12269.0	9914.3	7883.0	7582.0

The average capital increase from the eighties until 2009 was around 100%, the gross investment was augmented by about 50% and the cash flows improved significantly. However, the net investment decreased drastically, signaling that the investment was made with capital subject to a rapid and vast depreciation (Table 4).

Table 4. Investments and cash flows (euro)

Year	Average farm capital	Gross Investment	Net Investment	Cash Flow *	Cash Flow **
1989-1993	25745.6	2250.0	881.4	3115.6	859.2
1994-1999	25947.5	2180.0	287.3	4095.2	2063.5
2000-2007	40775.1	2719.4	-388.6	8897.7	6235.9
2007-2009	50433.7	3492.7	10.7	12970.7	9052.0

**Not taking into account operations on capital; ** Taking into account all operations in farms.*

The total utilised agricultural area (Table 5) increased significantly from 11.9 to 26.1 ha. as did the rented area (from 4.1 to 8.2 ha.), mainly because of the increase in the area used for forage crops (from 3.3 to 11.8 ha). This confirms the conversion of farms from crop production to livestock activities.

Table 6 confirms this tendency (forage crops production increased from 480.6 euro in the first sub-period to 1618.7 in the last sub-period). However, this table also shows other tendencies, such as the increase in production (in euros) of industrial crops, vegetables and flowers and fruits. Maybe the total decoupling of the subsidies implemented after the CAP reform of 2003 has had some influence here, correcting some problems related to some CAP technical inefficiency.

Indeed, the total livestock output doubled from the second to the third sub-period, with increases in almost all livestock production (Table 7). However, the livestock value changed negatively over the last two sub-periods, maybe due to some rises verified in supply.

Table 8 shows that the costs for the inputs increased significantly after the year 2000, representing 7633.2 euro in 1989-1993, 15293.1 in 2000-2006 and 19675.3 in 2007-2009. The large part of these costs is represented by intermediate consumption and about half is due to specific costs. In stressing the increases in the costs for fertilisers (481.4 in the first sub-period to 1285.7 euro in the last period) and crop protection (from 242.4 to 816.3 euro), the specific costs for forestry augmented significantly in the last period.

Table 9 corroborates the tendency shown in Table 8, referring to the significant rises, over the whole period, in energy consumption and in depreciation (increased about 2.5 times and the gross investment around 1.6 times-Table 4). On the other hand, the interest paid decreases.

Over the last two decades Portuguese farms have invested in land, permanent crops, buildings, machinery and breeding livestock, but mainly in the first two fixed assets (Table 10). Farms increased their liabilities, through greater increases in short-term loans, but the net worth was also augmented, which means that the increase in total assets exceeded the rise in liabilities.

The total subsidies, excluding investment, rise dramatically after the third sub-period, from 415.4 euro in 1989-1993 to 3871.1 in the third sub-period and 5659.7 euro in 2007-2009 (Table 11), mainly because of the significant rise in the total of subsidies for livestock (cattle), environmental subsidies, LFA subsidies, total support for rural development and decoupled subsidies (Tables 11 and 12).

The subsidies on investments changed from 574.8 euro in the first sub-period, to 391.7 in 1994-1999, to 501.1 in 2000-2006 and to 295.7 in the last sub-period. In fact, the changes in the subsidies are significant, but show a tendency to decline (Table 12).

The total decoupling of subsidies introduced with the CAP reform of 2003, seems to have brought significant structural change to Portuguese farms, specifically with transitions from crop productions to livestock activities, and to Mediterranean crop productions that traditionally were not chosen because they did not receive subsidies (namely after the CAP reform of 1992), such as fruit, vegetables and flowers.

Another important finding is that the agricultural output appears to increase in Portugal, with relevant rises in the utilisation of fertilisers and crop protection products. This may be an unexpected practice with less desirable implications for the environment and farming sustainability.

Table 5. Crop productions (ha)

Year	Total Utilised Agri-cultural Area	Rent-ed U.A.A.	Cereals	Other field crops	Energy crops	Vege-tables and flowers	Vine-yards	Perm-anent crops	Olive groves	Orchards	Other perm-anent crops	Forage crops	Agri-cultural fallows	Set aside	Total agricultural area out of production	Wood-land area
1989-1993	11.9	4.1	2.1	0.4	0.0	0.1	0.7	1.4	0.9	0.5	0.0	3.3	4.0	0.0	4.0	4.1
1994-1999	12.3	3.8	1.8	0.5	0.0	0.1	1.0	1.3	0.8	0.5	0.0	4.0	3.5	0.1	3.6	4.0
2000-2007	19.4	6.3	2.3	0.5	0.0	0.3	1.1	2.1	1.4	0.7	0.0	7.2	5.8	0.2	6.0	4.1
2007-2009	26.1	8.2	2.3	0.5	0.0	0.4	1.2	2.9	2.0	0.9	0.0	11.8	6.8	0.0	7.0	3.3

Table 6. Crop productions (euro)

Year	Total out-put	Total output crops & crop production	Total crops output / ha	Cereals	Protein crops	En-ergy crops	Pot-atoes	Sugar beet	Oil-seed crops	Indus-trial crops	Vege-tables & flowers	Fruit	Cit-rus fruit	Wine and grapes	Olives & olive oil	Forage crops	Other crop output
1989-1993	9572.4	5490.0	692.8	1254.2	31.6	0.0	363.4	0.0	37.6	64.0	599.0	487.0	118.4	1371.0	300.6	480.6	381.0
1994-1999	10226.3	6124.8	708.0	875.7	30.5	0.0	491.2	18.7	22.5	30.5	959.5	498.0	107.8	1868.0	322.8	597.5	302.7
2000-2007	17643.0	9725.9	732.6	878.4	24.0	0.0	624.0	133.3	12.6	87.3	1966.1	814.7	269.3	2966.6	576.0	1018.1	355.0
2007-2009	23951.0	13203.0	692.3	1218.3	20.7	9.0	727.7	38.7	38.0	210.3	3357.7	1539.0	392.7	2841.7	996.3	1618.7	204.0

Table 7. Livestock productions (euro)

Year	Total output livestock & livestock products	Total livestock output / LU	Change in value of livestock	Cows' milk & milk products	Beef and veal	Pig-meat	Sheep and goats	Poultry-meat	Eggs	Ewes' and goats' milk	Other livestock & products
1989-1993	3769.0	668.8	76.4	1220.6	912.2	793.6	261.4	280.2	89.0	118.8	93.4
1994-1999	3450.5	600.7	82.3	1327.2	761.2	661.3	240.2	143.2	58.0	139.7	120.5
2000-2007	6961.4	702.3	-85.1	2834.0	1369.7	1639.7	516.3	157.3	5.0	338.7	100.7
2007-2009	9606.0	741.3	-162.7	4304.0	1841.0	1651.7	682.7	162.3	256.7	491.0	217.3

Table 8. Crop, livestock and forestry productions inputs (euro)

Year	Total Inputs	Total inter-mediate con-sumption	Total specific costs	Specific crop costs / ha	Seeds and plants	Seeds and plants home-grown	Fert-ilisers	Crop pro-tection	Other crop specific costs	Specific live-stock costs / LU	Feed for grazing live-stock	Feed for grazing live-stock home-grown	Feed for pigs & poultry	Feed for pigs & poultry home-grown	Other live-stock specific costs	Fores-try spec-ific costs
1989-1993	7633.2	4854.0	3440.8	100.4	376.0	93.6	481.4	242.4	101.4	400.6	1310.6	547.4	803.2	27.8	122.4	3.4
1994-1999	9001.8	5656.0	3741.2	119.2	412.3	88.8	509.3	359.2	185.8	394.5	1413.8	604.0	628.2	19.2	211.8	20.2
2000-2007	15293.1	9912.6	6699.6	129.3	656.1	105.4	833.0	576.9	453.3	420.9	2566.7	1009.3	1052.9	26.3	536.0	25.6
2007-2009	19675.3	13582.3	9615.3	147.0	984.0	185.3	1285.7	816.3	743.3	440.7	3649.0	1267.0	1313.7	16.0	729.7	93.7

Table 9. Other inputs (euro)

Year	Total farming overheads	Machinery & building current costs	Energy	Contract work	Other direct inputs	Depreciation	Total external factors	Wages paid	Rent paid	Interest paid	Taxes
1989-1993	1413.2	346.4	560.4	244.4	262.2	1368.6	1410.8	989.6	214.8	206.6	19.0
1994-1999	1915.0	496.0	700.5	262.2	456.3	1892.5	1453.3	1085.5	223.0	144.8	23.2
2000-2007	3213.0	857.9	1132.9	470.3	752.0	3108.0	2272.6	1775.1	369.9	127.7	71.0
2007-2009	3967.3	972.3	1711.0	542.7	742.0	3481.7	2611.0	1894.3	540.7	176.0	109.3

Table 10. Some accounting indicators (euro)

Year	Total assets	Total fixed assets	Land, perm-anent crops & quotas	Build-ings	Machinery	Breeding livestock	Total current assets	Non-breeding livestock	Stock of agri-cultural products	Other circu-lating capital	Total liabilities	Long & medium-term loans	Short-term loans	Net worth
1989-1993	52154.2	46730.4	30672.4	6577.6	7115.8	2364.4	5424.0	1629.8	1350.6	2443.6	1479.4	1091.0	388.2	50674.8
1994-1999	49146.8	43364.3	27524.8	6214.7	7414.3	2210.3	5782.7	1406.5	1642.3	2733.5	1543.7	958.3	585.0	47603.2
2000-2007	68011.9	58089.6	34765.9	8348.0	11074.1	3902.0	9922.1	2137.6	1985.7	5799.0	2469.0	1301.0	1168.1	65542.9
2007-2009	87975.3	75045.0	46601.7	10738.7	12012.7	5691.3	12930.3	2820.0	2695.3	7415.7	3075.3	1752.7	1323.0	84900.3

Table 11. Crop and livestock productions subsidies (euro)

Year	Total subsidies - excluding on invest-ments	Total subsidies on crops	Compen-satory payments /area payments	Set aside prem-iums	Other crops subsidies	Total sub-sidies on live-stock	Sub-sidies dairying	Subsidies other cattle	Subsidies sheep & goats	Other livestock subsidies	Environ-mental subsidies	LFA subsidies	Total support for rural devel-opment	Other rural devel-opment pay-ments
1989-1993	415.4	121.4	0.0	0.0	121.4	183.6	9.8	58.4	110.8	4.2	0.0	0.0	0.0	0.0
1994-1999	1694.2	742.0	385.8	28.8	327.0	473.3	73.3	201.0	148.8	49.8	208.3	0.0	208.3	0.0
2000-2007	3871.1	1185.6	497.7	27.4	660.4	1064.3	160.0	656.4	246.9	0.6	505.0	499.4	1024.6	19.7
2007-2009	5659.7	513.7	15.3	0.0	498.3	1186.0	210.3	758.7	215.7	1.3	487.7	785.7	1405.3	132.3

Table 12. Other subsidies (euro)

Year	Subsidies on intermediate consumption	Subsidies on external factors	Decoupled payments	Single Farm payment	Additional aid	Balance subsidies & taxes on investments	Subsidies on investments	Payments to dairy outgoers
1989-1993	110.2	0.2	0.0	0.0	0.0	509.6	574.8	0.0
1994-1999	10.8	2.3	0.0	0.0	0.0	365.8	391.7	8.0
2000-2007	33.7	3.0	525.1	510.6	14.6	459.6	501.1	11.6
2007-2009	1.0	0.0	2544.7	2490.3	54.0	255.7	295.7	0.0

The model considered

The results presented in Table 13 (below) were obtained for each sub-period considered over the period 1989-2009, through the optimisation software LINGO (2015), considering a model of linear programming. This methodology was used in some recent analysis such as those presented in Dantzig (2002). These models of linear programming have two parts, the objective function that aims to be optimised (maximised in this study) and a set of constraints to adjust the models to each context. The model used may be described as follows:

Max Z=o1x1-c1x1+o2x2-c2x2 (Objective function)

Subject to

a11x1<=b1 (Constraint to crop subsidies)

a21x2<=b2 (Constraint to livestock subsidies)

a31x1+a32x2<=b3 (Constraint to total subsidies excluding investments)

a41x1+a42x2<=b4 (Constraint to total subsidies on investments)

x1<=b5 (Constraint to the area)

x2<=b6 (Constraint for the livestock units)

Where the x1 represents crop production in ha, the x2 the livestock activities in LU, the o1 crop output per ha, o2 livestock output per ha, c1 crop specific costs per ha and c2 livestock specific costs per LU. The letters ‘a’ represent the needs per respective unit in each constraint for the crop and livestock activities, and the letters ‘b’ are the availabilities.

The results obtained

Table 13 demonstrates that the gross margin increased from the first sub-period (7055.1 euro) to the last sub-period (14215.7 euro) and that the crop productions are more profitable than livestock activities. Only in the third sub-period (2000-2006) were the livestock productions considered with some dimension (3.7 LU).

Table 13. Results obtained with the linear programming models

	Sub-period 1989-1993	
Variable	Value	Reduced Cost
X1	11,9	0,0
X2	0,0	0,0
Row	Slack or Surplus	Dual Price
1	7055,1	1,0
2	0,0	45,8
3	183,1	0,0
4	0,0	3,6
5	0,6	0,0
6	0,1	0,0
7	5,6	0,0
	Sub-period 1994-1999	
Variable	Value	Reduced Cost
X1	12,3	0,0
X2	0,0	0,0
Row	Slack or Surplus	Dual Price
1	7243,9	1,0
2	1,5	0,0
3	472,6	0,0
4	0,5	0,0
5	0,0	3,0
6	0,0	493,5
7	5,7	0,0
	Sub-period 2000-2006	
Variable	Value	Reduced Cost
X1	12,2	0,0
X2	3,7	0,0
Row	Slack or Surplus	Dual Price
1	8365,8	1,0
2	0,0	7,6
3	788,1	0,0
4	2,1	0,0
5	0,0	5,5
6	7,2	0,0
7	6,1	0,0
	Sub-period 2007-2009	
Variable	Value	Reduced Cost
X1	26,1	0,0
X2	0,0	800,5
Row	Slack or Surplus	Dual Price
1	14215,7	1,0
2	0,1	0,0
3	1186,0	0,0
4	0,0	2,5
5	1,1	0,0
6	0,0	0,0
7	12,9	0,0

From 2007 to 2009 the marginal costs for livestock production were about 800.5 euro, the worst period in terms of reduced costs for animal activities.

In the first sub-period (1989-1993) the Portuguese farms could have increased the gross margin in 45.8 euro per each additional euro in crop subsidies and 3.6 euro in any extra euro in the total subsidies excluding investments.

In the years 1994-1999 the increases in the gross margin for any additional euro could have been of 3.0 euro for the subsidies on investments and 493.5 euro for any extra ha.

In the third sub-period any extra euro in crop production subsidies and subsidies on investments could have improved the Portuguese farms gross margins by 7.6 and 5.5 euro, respectively.. In the last period, the total subsidies were excluding the investments that could have provided some improvements in the gross margin per additional euro (2.5 euro).

This is an approach for these issues, considering the data available in the FADN (2014), that could be improved in the future with more disaggregation in the statistical information.

Conclusion

The study presented here, for the period 1989-2009, is intended to be an interesting contribution to the international scientific community and more of a base or study to support the policymakers in designing adjusted agricultural policies for the objectives of each country and region.

The literature review reveals that the several concerns related to farming policies are not unanimous and generate some controversy. Considering the particularities of agriculture, the various public interventions in the sector (in terms of market and price and in terms of structures) are needed, but sometimes there are undesirable implications (e.g. in the environment, sustainability, markets and structures), namely when the policies are implemented in a similar way in all situation, as happened with the Common Agricultural Policy where the rules governing application are the same for all countries in the European Union.

With the data analysis it was possible to observe that there were significant structural transformations in Portuguese farms, namely after the years 2000-2006, with some transitions to livestock production and Mediterranean crop production, such as vegetables, flowers and fruit. These evolutions from 1989 until 2009 were accompanied by improvements in the farming economic results, in total assets and in the net worth. However, there are other consequences, such as the increase in the use of fertilisers and crop protection products, as a reduction in the net investment.

The results confirm, in an optimised way, improvements in farming economic results from 1989 until 2009, but show that crop production continues to be the most profitable agricultural activity in the Portuguese context, where the farms are, on average, of a small size. On the other hand, all the subsidies are an important complement to the income of Portuguese farmers.

The recent agricultural policies in Portugal, i.e. those related to the total decoupling of subsidies (single farm payment) that come from the Common Agricultural Policy and which have been implemented since 2005 (following the CAP reform of 2003) seem to promote increases in agricultural output (in line with the findings of Martinho, 2015a), specifically through livestock activities and Mediterranean crop production, increasing the use of fertilisers

and crop protection. However, in Portugal crop production continues to be the most profitable activity.

In future research it will be important to analyse the implications of these subsidies on the environment and on Portuguese agricultural sustainability. It will be important to analyse the questions related to the reduction in net investment.

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The Efficiency of POSEI and PRORURAL programmes in Azores Islands' development

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Abstract: Azores is one of the outermost regions (ORs) in the European Union (EU). Isolation of the islands raises issues involving socio-economic difficulties, remoteness, small size and the competitiveness of agriculture, which makes the region one of the poorest in the EU. As a consequence of this the government has introduced a number of programmes: Programme d'Options Specifique à l'Éloignement et l'Insularité (POSEI), Rural Development Plan (RuDP), Azores Rural Development Programme (PRORURAL) and PRORURAL +. The objective of this project is to analyse the efficiency of these programmes in Azores agricultural development. Firstly, the main feature of the Azorean economy is agriculture. This economy represents 2.1% of the Portuguese Gross value added. Azores Gross domestic product per capita in 2013 is 14,900€ and the contribution of the agricultural sector is 9.6% (2012). Secondly, POSEI aims to compensate for the additional costs of transporting certain agricultural products to the ORs. RuDP was the first rural development programme applied to Azores. PRORURAL + is the successor of PRORURAL. It has six priority measures: 1. measures for the transfer of knowledge and innovation; 2. enhancing the viability and competitiveness of farms and agro-industry; 3. chain improvement; 4. preserving agricultural and forestry ecosystems; 5. energy and climate change; and 6. local development. After, the brief analysis of the information available in the Azorean, the agricultural ratios are: economic, agricultural, market, agricultural labour market and financial market. This paper evaluates the impact of these programmes on the rural economy and development. Finally, it shows a positive impact of European programmes on the economy of the Azores.

Keywords: Agricultural European programmes, rural development, socio-economic and environmental indicators.

Introduction

The Azores is a remote region of the European Union with development problems, caused by the geographic isolation of the European and American continents and the lack of resources. The Azores is a Portuguese archipelago located in the middle of the North Atlantic with a surface area of 2322 km^2, equivalent to 2.6% of the Portuguese territory. It is 800 km from Madeira, 1500 km from the European mainland, 1450 km from Africa, 3900 km from North America and 6400 km from the north of Brazil. The archipelago has been subdivided into three groups that consist of nine islands: the Western group (with two islands - Flores and Corvo);

the Central group (with five islands - Faial, Pico, São Jorge, Graciosa, and Terceira) and the Eastern group (comprising the islands of São Miguel and Santa Maria, and the Formigas islets) (Massot, 2015). The largest islands are São Miguel (759 km²), Pico (446 km²) and Terceira (403 km²). Even though being a part of the Portuguese republic the archipelago has its own political and administrative statue with its own government, forming the Autonomous Region of the Azores (ARA) (Massot, 2015). The economy of the Azores represents 2.1% of the Portuguese economy, measured by its contribution to the GVA (Gross value added). Azores GDP (Gross domestic product) per capita (€) in 2013 is 14,900 and the contribution of the agricultural sector to GDP is 9.6% (2012) (Massot, 2015).

The objective of this paper is to compare Agricultural Census data from 1989, 1999 and 2009, as well as social, environmental and economic indicators from these three periods to observe the impact of the European funds on the rural development of the Azores.

In this paper, a summary of Azores' characterisation is made, as well as the evolution of rural development in the European Union, policy and the POSEI and PRORURAL programmes (the main measures, the budget over time and the main differences made to Portuguese rural development). Following this an analysis of Agricultural Census data is made and social, economic and environmental indicators are built.

The European agricultural programmes

The Common Agricultural Policy (CAP) is organised into two pillars: (i) market policy; and (ii) the sustainable development of rural policy. The first pillar includes the common market organisation (direct payments) and the second pillar, rural development regulation (national or regional development plans) (Silva & Marta-Costa, 2013). The CAP primary principles and objectives have evolved over time (greatly concerned with agricultural production) and other factors such as environmental policies and the role of rural development are increasing its importance.

Although the rural development was a concern in CAP, the peak importance appears with the MacSharry reform (1992). This reform was important to promote a modernised CAP, recognising the role of agriculture expected by society and simultaneously involving the environmental protection and rural development (Silva & Marta-Costa, 2013). Agenda 2000 strengthened the rural development, creating the second pillar of CAP (González & Gómez-Limón, 2008). A specific fund to support rural development was created in 2005, FEADER, which also strengthened rural development (Rico González & Gómez-Limón, 2008). The paradigm of rural territory had changed the previous paradigm of agricultural production, turning into a wider concept (not only the agricultural production, but also the territory and population participation) (Rico González & Gómez-Limón, 2008).

New CAP design is based on a holistic approach to policy support through the maintenance of the existing two pillar structure but in a more targeted, integrated and complementary way. Also this new design offers more responsive safety net measures and strengthens the EU's capacity for crisis management (APPB, 2013). The new rural development policy for 2014/20 is designed to improve quality of life in rural communities, and seeks to address these issues and to harness the full potential of rural areas.

The geographical isolation of the Azores along with the division of the islands makes the region one of the poorest in the European Union (EU), due to their remoteness, insularity, small size, topography and specific climate that gives rise to socio-economic difficulties (relating to the supply and the competitiveness of agriculture etc.). Due to these specific features of the regions, the EU recognised the Treaty of Maastricht in the article 299 (2) dedicated to Ultra-Peripheral Regions (UPRs), which includes the French overseas department, the Azores, Madeira and the Canary Islands (BIOA, 2008). On the basis of this acknowledgment, the POSEI programme was developed for the Portuguese archipelagos of Madeira and the Azores (POSEIMA) to make them more competitive and strengthen their regional integration.

In the Azores POSEI is the 1st pillar of CAP and PRORURAL is the 2nd pillar of CAP.

POSEI (Programme d'Options Specifique à l'Éloignement et l'Insularité)

POSEI was developed for the benefit of the agricultural sector in the EU's outermost regions (ORs). The outermost regions of the EU, identified in article 349 of the Treaty for the Functioning of the European Union (TFEU) are: France: Guadeloupe, French Guyana, Martinique, Réunion, Saint-Barthélemy and Saint-Martin; Portugal: the Azores and Madeira; Spain: the Canary Islands. POSEI has been supporting the ORs since 1991. The programme has been funded under the EU's Common Agricultural Policy (CAP), where the programme aims to compensate for the additional costs of transporting certain agricultural products to the ORs, and to nurture the development of local production. POSEI measures fall into two categories: 1) Specific supply arrangements (SSA) – which aims to offset the higher costs of raw materials for certain essential products arising from the insularity and remoteness of those regions; and 2) Measures to assist local agricultural products (MLAP) – which focuses on the production, processing and marketing of the products.

In 2001 POSEI scheme was reformed in terms of SSA, by establishing forecast supply balances, a list of products benefiting, and changing the way of calculation based on additional costs related to ORs' remoteness, insularity and small size instead of export funds. They also introduced new MLAP measures and modified existing ones and adapted the scheme to new Rural Development Regulation. In 2006 POSEI scheme reformed again, priority was given to greater regional participation, decentralisation and flexible decision-making of SSA and MLAP. The main objective of this innovation was to introduce a higher level of flexible management of SSA and MLAP and to simplify the procedures of the modification.

In 2010, The Court of Auditors noted that POSEI measures were effective but there were some weaknesses in the management of the scheme. The Court also mentioned that the national control systems didn't match the diversity of the specific measures (Library Briefing, 2013).

So, the European Committee (EC) wrote a report on the impact of the 2006 POSEI scheme with a proposal for a review of POSEI regulation, to incorporate the requirements of the Lisbon Treaty with some minor changes included: 1) Increasing by 20% the maximum ceilings set for the SSA in France and Portugal; 2) Clarifying the procedure for submitting programmes and amendments for approval by the Commission to promote flexibility and efficiency; and 3) Extending to the French overseas departments the possibility of re-dispatching products using raw materials under the SSA without the benefit being reimbursed.

POSEI's annual financial framework (2015) for the Azores region is EUR 76.78 million of which EUR 6.3 million is allocated to Specific Supply Arrangements (SSA) and EUR 70.48 million is allocated to Measures to Assist Local Agricultural Products (MLAP) (Massot, 2015).

Table 1 shows the greatest execution of the measure Specific Supply Arrangement (SSA) from 2009 to 2013, respectively 99.28% and 99.1%. In all these periods the percentage of the execution of SSA was superior to 99%.

Table 1. **Summary of the financial execution of the Specific Supply Arrangement (SSA)**

Year	Executed (1000€)	Execution (%)
2009	6 254	99.3%
2010	6 257	99,3%
2011	6 240	99.1%
2012	6 265	99.4%
2013	6 245	99.1%

In the overall MLAP program (Table 2) the financial execution increased from 83% (2007/08) to 97.5% (2013/14). The measure, Animal Production, had an execution, throughout these periods, always superior to 91% and it is the most stable measure. Plant production increases from 2007/08 (78%) to 2013/14 (99%). But the most significant increase was in the measures, Transformation (43% in 2007/08 to 87% in 2013/14) and Marketing (20% in 2007/08 to 78% in 2013/14).

Table 2. Summary of financial execution (%) of measures to assist local agricultural products (MLAP)

Year Measure	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Animal Production	92%	91%	97%	98%	99%	99%	98.5%
Plant Production	78%	82%	98%	99%	99.5%	99.5%	99%
Transformation	43%	41%	45%	61%	88%	98%	87%
Marketing	20%	38%	49%	51%	59%	76%	78%
Technical Assistance	-	-	36%	98%	99%	100%	-
Total	83%	85%	94%	96%	97%	98%	97.5%

Animal production (dairy cows) is very important in the Azores agriculture and economy. The POSEI Animal Production reflects this importance as is seen in Table 2. The breakdown of POSEI measures confirm it. POSEI measures are mainly oriented to animal production: milk production premium (49.5%), premium for dairy cows (19.5%); supplement for dairy cows (8.9%), Suckler cow premium (15.2%) etc. (Table 3). The aid for horticultural production - flowers cut and ornamental plants - is very small (3%).

Table 3. Aid of agricultural budget produced in POSEI, 2014

	Measure	Euros (10^3 €)	Percentage
1.	Milk production premium	20 216	49.5%
2.	Support for the sale of young cattle	205	0.5%
3.	Supplement for dairy cows Premium	3 645	8.9%
4.	Premium for dairy cattle	7 961	19.5%
5.	Premium for Suckler cow	6 194	15.2%
6.	Support for production traditional culture	538	1.3%
7.	Support for Horticultural Production Flowers Cut and Ornamental Plants	1 219	3.0%
8.	Row Beef - Support for the promotion and beef markets access	75	0.2%
9.	Row for Milk and Milk Products Quality - Support image reinforcement and presentation	295	0.7%
10.	Multi-sectoral actions - studies, technical assistance and implementation of actions support	150	0.4%
11.	Other Agricultural Products Produced support, in RAA	310	0.8%
	Total	40 812	100

Source: POSEI (2014)

PRORURAL (Azores Rural Development Programme)

PRORURAL is a programme, part of the 2007/13 period of the EU rural development policy, being reimbursed by the European Agricultural Fund Rural Development (FEADER). The PRORURAL was planned by the government in broad partnership with various public and private entities. It was approved by Decision C (2007) 6162 on 4th December 2007 (PRORURAL, 2011).

The programme has been based on the analysis of the previous period (2000/06) that had the drawbacks of specific geographic, economic, social and environmental issues. That characterises the region and determines specific responses from rural development policies. It has developed around four axes defined for Community policy for rural development: Axis 1. Improving competitiveness of the agricultural and forestry sectors; Axis 2. Improvement of the environment and rural landscape; Axis 3. Quality of life in rural areas and diversification of economy; and Axis 4. Operation of LAGs, acquisition of skills and entertainment in rural areas. In PRORURAL, the estimated public expenditure for seven years is EUR 322 million in which

EUR 274 million is matched by the FEADER contribution. Here, 40% of the budget is allocated to the environmental-based measures.

PRORURAL + ***(Azores Rural Development Programme)*** is one of the first programmes to be approved by the commission in February 2015 for the period of 2014/20. Due to the delay in adopting the basic regulation, delegation and implementing acts, the effective period of the Azores Programme has been reduced to a year.

The contribution to PRORURAL + is nearly EUR 295.3 million (0.3% of the total fund for the EU 28), the general rate of co-financing is 85%, in accordance with Article 59.2.a) of the Regulation (EU) No 1305/13. If the national contribution is added it is EUR 45.2 million. The total public budget of the Azores RDP amounts to nearly EUR 340.5 million (Massot, 2015).

There are some differences in the different programmes' plan during the time, as in Rural Development Plan (RuDP) (2000/06), PRORURAL (2007/13) and PRORURAL + (2014/20).

In RuDP (2000/06) there were four measures that have been considered in the plan. They are: Axis 1) Compensatory Allowances/Less favoured areas; Axis 2) Agri-environment Measures; Axis 3) Afforestation of agricultural land; and Axis 4) Early Retirement.

Table 4. Budget allocated to the measures in the period 2000/06

Measures	Average 2000/06 (10^3 €)	Increase commitments (10^3 €)	Previous Budget 2000/06 allocation (10^3 €)
Axis 1	6 672	693	50
Axis 2	5 282	1 780	719
Axis 3	2 431	1 954	920
Axis 4	6 990	4 880	5 473
Total	**21 376**	**9 308**	**7 162**

Source: SRAP (2001)

Budget that had been allocated to these measures in the period 2000/06 gives the following results: early retirement (32.7%), compensatory allowances/less favoured areas (31.2%); agri-environment measures (24.7%) and afforestation of agricultural land (11.4%). There was an increasing commitment in all measures (Table 4).

Approved and implemented measures of the PRORURAL (2007-2013) until December 31st, 2013. Here, five measures (Table 5) were considered in the programme: 1) Improving competitiveness of the agricultural and forestry sectors (51.2% of total allocation); 2) Improvement of the environment and rural landscape (38.4% of total allocation); 3) Quality of life in rural areas and diversification of economy (2.9% of total allocation); 4) LEADER approach (6.4% of total allocation); and 5) Technical assistance (1.2% of total allocation).

Table 5. Budget and execution of payments in PRORURAL, Azores (2007/13)

Measures	Allocation (2007/13) (10^3 €)	Support approved applications in total (10^3 €)	Payments (10^3 €)	Rate of commitment (%)	Rate of Execution (%)
Improving competitiveness of the agricultural and forestry sectors	176 688	171 641	127 795	97.1	72.3
Improvement of the environment and rural landscape	132 418	140 822	133 769	106.3	101.0
Quality of life in rural areas and diversification of economy	9 849	2 162	1 377	22.0	14.0
LEADER Approach	22 027	16 644	8 201	75.6	37.2
Technical assistance	4 132	1 271	555	30.8	13.4
Total	**345 114**	**332 540**	**271 697**	**96.4**	**78.7**

Source: SRRN (2014).

The overall PRORURAL program had a budget of 345114 thousand EUR, which 96% was support approved applications in total. In the Azores, the rate of commitment was 96.4% but this rate is different for each measure (Table 5). For instance, the Improvement of the environment and rural landscape had a commitment of 106.3% and the Quality of life in rural areas, 22.0%. These measures had an execution rate of 101% and 14% respectively. The Improving competitiveness of the agricultural and forestry sectors had a rate of commitment of 97.1% and a rate of execution of 72.3%

The following results (Table 6) show the budget related, approved and paid for the projects: Improving competitiveness of the agricultural and forestry sectors (53.6 % of total approved allocation), Improvement of the environment and rural landscape (40.5% of total approved allocation), Quality of life in rural areas and diversification of economy (4.1% of total approved allocation), LEADER Approach (1.4% of total approved allocation) and Technical assistance (0.4% of total approved allocation).

Table 6. Budget related, approved and paid for the projects in PRORURAL

Measures	Related Projects		Approved Projects		Paid Projects	
	No.	**(10^3 €)**	**No.**	**(10^3 €)**	**No.**	**(10^3 €)**
Improving competitiveness of the agricultural and forestry sectors	2 369	247 686	1 683	164 202 (53.6%)	1 468	120 356
Improvement of the environment and rural landscape	6 519	72 614	6 458	121 350 (40.5%)	6 451	115 664
Quality of life in rural areas and diversification of economy	562	26 684	329	12 501 (41%)	211	5 405
LEADER Approach	33	4193	33	4 144 (1.4%)	23	2 797
Technical assistance	6	1 334	5	127	4	555
Total	**9 489**	**352 511**	**8 533**	**306 141**	**8 158**	**261 252**

Source: SRRN (2014).

PRORURAL + programme (2014/20) is presently running in the rural development. It has seven measures: 1) Measures for the transfer of knowledge and innovation (budget hasn't been allocated for this axis); 2) Enhancing farm competitiveness; (42.5 % of allocated budget); 3) Chain improvement (1.8% of allocated budget); 4) Preserving agricultural and forestry ecosystems (41.5% of allocated budget); 5) Energy and climate change (3.6% of allocated budget); 6) Local development (6.6% of allocated budget); and 7) Technical and other assistance (4.0% of allocated budget) (Table 7). The most important measures for Azores are Enhancing farm competitiveness and Preserving agricultural and forestry ecosystems. Animal production and environmental concerns are always included in the Azores rural development.

Table 7. Budget allocation of PRORURAL+ in Azores

Measures	Allocated Budget (10^3 €)	Rate of commitment (%)
Measures for the transfer of knowledge and innovation.	-	-
Enhancing farm competitiveness	144 714	42.5
Chain improvement	6 118	1.8
Preserving agricultural and forestry ecosystems	141 211	41.5
Energy and climate change	12 414	3.6
Local development	22 447	6.6
Technical and other assistance	13 585	4.0
Total	**340 487**	**100**

Source: Massot (2015) according to PD B based on PRORURAL+ data (http://ec.europa.eu/agriculture/rural-development-2014-2020/country-files/pt/factsheet-azores_en.pdf).

The total allocated budget is EUR 340 487 thousands; the FEADER provides EUR 295 282 thousands (86.7%) and the Azores' Government EUR 45 205 (13.3%) (PRORURAL+, no date).

In this rural Europeans' programme, POSEI's main focus is on the EU's outermost regions. With each year's plan, the main budget has been put into measures to assist local agricultural products rather than specific supply arrangements. RuDP's budget allocation is mainly high in Compensatory Allowances/Less favoured areas and Early Retirement compared to the rest of the measures. PRORURAL has been developed on the plan of RuDP, the measures are increased here according to the year adaptableness. Budget allocation is mostly for improving competitiveness of the agricultural and forestry sectors and improvement of the environment and rural landscape. PRORURAL + is mostly similar to PRORURAL but with different axes and measures. Here, the budget allocation is mostly into Enhancing farm competitiveness and Preserving agricultural and forestry ecosystems rather than other measures.

In 2014, supposing that the PRORURAL + and POSEI annual budget is EUR 89 452 thousand and the Azores population is 246 353. Then each Azorean received EUR 6.9 a week from European agricultural programmes.

Materials and Methodology

To measure the impact of PRORURAL and POSEI in Azorean rural development two steps have been followed: 1) to analyse the database used which is the Agricultural Census data for 1989, 1999 and 2009 (Sebastião et al., 2012); and 2) to estimate economic, social and environmental indicators.

In the first step, the Agricultural Census data do not match with the PRORURAL period but it's the most credible information available. The year 1989 is the data baseline and it almost coincides with the entry of Portugal (1986) into the EU. The 1999 Agricultural Census measures the first impact of CAP (Common Agricultural Policy). The 2009 Agricultural Census shows the impact of PRORURAL 2000/07.

The criteria for selecting agricultural census information were associated with the main measures of PRORURAL and POSEI. Since POSEI is oriented mainly to dairy production, some variables chosen from the Agricultural Census were related to animal holding and agricultural population such us the number of dairy cows, the livestock density etc. The most relevant measures of PRORURAL are enhancing farm competitiveness, mainly the investment in agricultural equipment and the indicators for farm machinery (number of tractors and mobile milking machines, milking parlours).

In the second step, the economic indicators chosen are total VGA and primary sector VGA per capita. The environmental indicators are the density stock and the $CO_{2\text{-eq}}$. The social indicator is the importance of the rural population for the Azorean population.

The GVA per capita was estimated according the value of GVA in 1989, 1999 and 2009 (€) and the population living in the Azores in the same period. (Sebastião et al., 2012; SREA/INE, n.p.).

The primary sector GVA per agricultural population was estimated according to the value of the primary sector GVA in 1989, 1999 and 2009 and the agricultural population in the Azores in the same period (Sebastião et al., 2012; SREA/INE, n.p).

The $CO_{2\text{-eq}}$ was estimated by tier (level 1) (IPCC, 2007). According to this source, for Western Europe, the emission factor of methane CH_4 of dairy cows (with an average milk production of 6000 Kg/head/year) is 117 kg of CH_4/head/year and 57 kg of CH_4/head/year for other cattle (includes bulls, calves and growing heifers). To convert methane into $CO_{2\text{-eq}}$ the conversion index of 1 ton of CH_4 is equal to 25 ton of CO_{2eq} (IPCC, 2007). In the Azores' dairy farms Silva et al. (2016) found the value of 115.5 kg of CH_4 and 2.9 ton of $CO_{2\text{-eq}}$ per cow and per year. The dairy cows and other cattle data of 1989, 1999 and 2009 is provided by Sebastião et al. (2012) and methane emission is provided by IPCC (2007). The VGA and resident population were calculated with information provided by Sebastião et al. (2012) and SREA/INE (n.p.).

Results

The average size of agricultural holdings increased from 4.8 ha (1989) to 8.9 ha (2009). The holding number decreased from 24706 (1989) to 13541 (2009) and the VPPT register a value of EUR 316681 thousand (2009) (Table 8).

Table 8. Agricultural holding features in Azores, in the years 1989, 1999 and 2009

		1989	1999	2009	Variation
1.	Average size of agricultural holdings (ha)	4.8	6.3	8.9	↑
2.	Indicators for the community of typology of farms				
	i) Holdings (No.)	24 706	19 280	13 541	↓
	ii) VPPT (10^3 €) of farms specialising in livestock production.	n.a.	n.a.	316 681	-

Source: adjusted from Sebastião et al. (2012).

In the Azores, over the period 1989 to 2009, the animal density increased from 1.43 to 1.71. In addition, the cattle per farm increased from 15.8 to 32 and the dairy cows per farm from 10.3 to 28.2. (Table 9).

The farm machinery also increased markedly from 1989 to 2009 (Table 9). The number of farms with agricultural equipment had increased dramatically: from 2716 (1989) to 4893 (2009); with the number of tractors increasing from 1899 (1989) to 2630 (1999) and to 3750 (2009). This almost doubling was support by PORURAL programme. Before the entry into the EU there were no milking parlours and most farms had manual milking. No data are available (n.a.) for the years 1989 and 1999, but in 2009 there were 2166 milking machines and 37 milking parlours.

Table 9. Effective animal and machinery, in Azores, in the years 1989, 1999 and 2009

		1989	1999	2009	Variation
1.	Effective Animal				
	i) Livestock (No.) per ha of SAU in RAA	1.43	1.72	1.71	↑
	ii) Cattle (No. of animal/farm) by exploration	15.8	24.1	32.0	↑
	iii) Dairy cows (No. of animal/farm) farm in RAA	10.3	19.3	28.2	↑
2.	Indicators for farm machinery				
	i) Farms with farm equipment (No.) and type of agricultural machinery	2 716	4 490	4 893	↑
	ii) Tractors(No.) of farms and classes of SAU	1 899	2 630	3 750	↑
	iii) Milking parlours (No.) of farms and old milking parlours	n.a	n.a	373	-
	iv) Mobile milking machine (No.) of farms and age of the machines.	n.a	n.a	2 166	-

Source: adjusted from Sebastião et al. (2012).

The importance of family farming population in the resident population had decreased (1989-2009), from 38.8% to 17.2%. Farmers with agricultural training (24,205 to 13,360) also decreased by about 44.8% (Table 10). The familiar population declined by 54% between 1989 and 2009.

Table 10. Agricultural population features in the Azores in the years 1989, 1999 and 2009

		1989	1999	2009	Variation
	Population and farm labour.				
1.	i) Importance of family farming population in the resident population (%)	38.8 %	28.3 %	17.2 %	↓
	Population and agricultural labour.				
2.	i) Farmers with agricultural training (No. of individuals) and type of agricultural training	24 205	18 670	13 360	↓
	ii) Sole holders (No.) who want to maintain agricultural activity and continuity of reason.	n.a	n.a	12 829	-
3.	Family farming population (No. of individuals).	92 351	68 340	42 481	↓

Source: adjusted from Sebastião et al. (2012)

The GVA per capita increased significantly from 1641€ (1989) to 13244€ (2009), as seen in Table 11. The primary sector GVA per agricultural population also increased from 970€ per capita (1989) to 6402€/capita. Milk production almost doubles its value from 1989 (270.3 million litres) to 2009 (540.2 million litres). So for the economic indicators there is an overall positive impact (Table 11).

Table 11. Economic, social and environmental indicators from 1989 to 2009 in the Azores

	1989	1999	2009	Variation
Economic indicators:				
i. Gross Added value per capita [(1)(2)]	1 641	10 425	13 244	↑
ii. GVA of the Primary sector per agricultural population [(1)(2)]	970	3 702	6 402	↑
iii. Milk Production(10^6 litres) [(3) (4) (5)]	270.3	474.2	540.2	↑
Environmental indicators:				
i. $CO_{2\text{-eq}}$ emission Bovine (ton/year)	395	487	493	↑
ii. Density stock (animals per hectare)	407	747	058	↑
	1.43	1.72	1.71	
Social Indicators				
i. Percentage of rural population [(1)]	38.8%	28.3%	17.8%	↓
ii. Farmers >64 years old (%)[(1)]	13.6	15.2	16.0	↑
iii. Farmers <34 years old (%)[(1)]	51.7	46.4	38.5	↓

Source: [(1)] Adjusted from Sebastião et al. (2012); [(2)] SREA/INE, (n.p); [(3)] Séries Estatísticas: 1980 – 1995 (SREA, 1995); [(4)]Séries Estatísticas: 1996 – 2006 (SREA, 2009); [(5)]Açores em Números 2009 (SREA, 2010).

Looking at the environmental indicators (Table 11) the Bovine $CO_{2\text{-eq}}$ emission increases slightly from 395 407 ton/year (1989) to 493 058 ton/year (2009), as does the density stock (from 1.43 to 1.71 animals per hectare). The change in both these environmental indicators results in a negative impact.

Table 12 shows the calculation of the Tons of $CO_{2\text{-eq}}$/Year dairy cows and for other cattle.

Table 12. Emission (ton) in $CO_{2\text{-eq}}$, in the Azorean agriculture over the years 1989, 1999 and 2009

	1989	1999	2009
Number of dairy cows	78 132	98 688	92 371
Number of other cattle	117 103	139 709	156 382
Tons of $CO_{2\text{-eq}}$/Year dairy cows	228 536	288 662	270 214
Tons of $CO_{2\text{-eq}}$/Year other cattle	166 871	199 085	222 844
Total tons of $CO_{2\text{-eq}}$/Year	*395 407*	*487 747*	*493 058*

Source: Elaborated by the authors.

In 2009 the agriculture farming population was 42 481 people, which represented 17.8% of the total Azores population Sebastião et al. (2012). This percentage has decreased over the period studied from 38.8% to 17.8%. In spite of the Young Establishment measure, farmers are getting older. This is shown by the increasing percentage of farmers more than 64 years old (13.6% to 16%) and the decline in the percentage aged less than 34 years (from 51.7 to 38.5%).

Conclusions

The Azorean agriculture had changed a lot over the period 1989 to 2009 with the contribution of the European programmes support of PRORURAL and POSEI, mainly regarding their economic results (GVA) and the provision of capital (equipment and buildings) for farms. However, there are other factors which also contribute to this development which are provided by the Azores Regional Government, such as the support of SAFIAGRI - Financial Investment, providing an operating fund with a low interest rate.

The agricultural population is getting older, in spite of the good execution of the Farmers Young Establishment measure, and any growth of the population is far away from the desirable agricultural population rejuvenation.

The Professional Training measure is not enough to promote a desirable rural development and this missing professional training is recognised by farmers and other local agents (Silva & Mendes, 2012).

The dairy activity is the main measure of POSEI and the PRORURAL mainly promote investment in agricultural equipment.

The diversification of agriculture is increasing but is not enough to reach the Azorean food security; which is one of the objectives of PRORURAL.

In general, from both the economic and social contexts, the POSEI and PRORURAL programmes have increased the production of agricultural development in the Azores. However the environmental indicators show a negative trajectory and highlight an apparent conflicting impact between economic and environmental indicators, as seen with animal density stock and environmental emissions.

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