Sustainability **2014**, *6*, 8029-8055; doi:10.3390/su6118029

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

Competitiveness *vs.* Sustainability: An Assessment of Profitability as a Component of an Approach on "Sustainable Competitiveness" in Extensive Farming Systems of Central Spain

Andrea Baudoin Farah [1,†] and Almudena Gómez-Ramos [2,†,*]

[1] Agricultural Engineer, Rural Development Consultant, La Paz, Bolivia;
E-Mail: andrea.baudoin@gmail.com

[2] Area of Economics, Sociology and Rural Policies, Department of Agriculture and Forestry Engineering, University of Valladolid, Palencia 34004, Spain

† These authors contributed equally to this work.

***** Author to whom correspondence should be addressed; E-Mail: almgomez@iaf.uva.es;
Tel.: +34-979-108-444; Fax: +34-979-108-303.

External Editor: Marc A. Rosen

Received: 30 August 2014; in revised form: 31 October 2014 / Accepted: 3 November 2014 / Published: 14 November 2014

Abstract: The "Europe 2020 Strategy" launched by European Institutions is a commitment to increase growth based on the coexistence of both competitiveness and sustainable development. This paper analyzes the competitiveness of production systems in the cereal steppes of Castile, Spain. An indicator based on each production system's profitability threshold was built. The diagnostic analysis methodology allowed the identification of 20 production system models related to agrarian, livestock and mixed farming systems. The results show very different levels of competitiveness which are not necessarily related to the farms' sizes or capitalization levels but mostly to production costs and the farmers' ages. The response of these models to future input and output price scenarios shows that mixed farms are less dependent on external production factors.

Keywords: competitiveness; extensive production systems; cost structure; price scenario; profitability

---

1. Introduction

The European agricultural sector, just as the rest of the economy, is facing the challenges of this decade's market globalization and new trends in economic movements. Spain, as well as some other Mediterranean countries, is suffering the consequences of a deep economic recession which affects every sector of the economy, including agriculture. Many authors point out that the lack of competitiveness of the Spanish economy—including the agricultural sector—is one of the causes that explains the intensity of the crisis when compared to other countries of the region. It is in this adaptation process to the new economic context that the Common Agricultural Policy (CAP from now on*)* is being reviewed [1]. One of the principal objectives of the new CAP is to integrate Europe's agricultural activity into the global market, consequently attributing most of the CAP's budget to subsidies decoupled from production for them not to interfere in the functioning of markets ("green box" aids in the World Trade Organization's terminology). In short, what is expected of the new CAP is the persistence of a sustainable agriculture that is viable in an eminently competitive environment [2,3]. Under this premise, subsidies are presented as a payment per hectare provided that certain environmental requirements are met, recognizing the sustainability of agriculture [2]. This is why the reform's debate revolves around identifying which agricultural sectors are the least competitive (and as a result the most vulnerable to subsidies' decoupling) and trying to prevent them from being penalized in the future distribution of aids [4,5].

Nevertheless, in the authors' opinion, it is in every way short-sided to focus the debate of competitiveness in agriculture exclusively as a sector issue (following the traditional scheme of all Common Market Organizations), especially when analyzing Mediterranean agrarian systems [6,7]. Most of these studies have been done at a macro scale evaluating the effects of the new aid model on the basis of sector stereotypes: rain fed cereal production [8], intensive and extensive irrigation [9,10], cattle breeding [11,12] or hill farming [13].

The different production systems—understood as management and decision units which compose a determined agrarian system—should be considered in the analysis as they have intrinsic differentiating factors which partially determine production levels and, as a result, their adaptation to more competitive markets [7,14].

This study tries to deepen these issues at a very precise work scale in a limited territory. In essence, the objective of this paper is to evaluate and explain the competitiveness of different production systems with different levels of sustainability belonging to the same agrarian system on the basis of technical, economic or sociological factors which reflect differences between farms (data compiled during field work). Furthermore, the competitiveness results were attributed to different output and input price scenarios in order to identify the systems that are most resistant to price fluctuation. Given these results, it is possible to detect if there are endogenous and structural factors in the farm which could induce a better adaptation to agricultural markets in a medium and long term scale [7,15]. In others words, we try to answer the question of why two very similar farms can show such different levels of competitiveness [4].

The chosen area to do this analysis is the steppe of the Iberian Peninsula's central plateau, more specifically the "Tierra de Campos" region of the Castile and Leon Community [16]. The methodology used to build the models is the diagnostic analysis. Twenty production system models were built. They represent different production strategies associated with the same agrarian system. The most interesting component of this methodology is the use of a rigorous protocol to understand the local agrarian reality which is achieved by means of a comprehensive, systemic and detailed approach. The study is based on physical, landscape, historical, agronomic, economic and sociological data collected directly in the field. This information is essential to the construction of a competitiveness index (CI from now on) that takes into account the profitability of the production systems given the unstable context of the current global markets. This index was used to identify the determining elements of competitiveness and to establish a ranking among the different production systems. In addition, two different output and input price scenarios for 2010–2020 were explored to analyze the production systems' reaction to them. This is a case study which can be used as a reference to think about the different factors that can determine the solidity and competitiveness of an agrarian system's production systems in a context of great price volatility, international competition, uncertainty, rural depopulation and an aging population [17,18]. The purpose is to try to explain, in a specific climatic, geographic and socio-economic context, the causes of unequal economic performances and to suggest developmental ideas to improve the producer's situation and protectagro-ecosystems. Beyond the case study, it is important to understand the difficulty in conciliating competitiveness and sustainability, specifically from the subsidies' impacts point of view [14].

This paper is organized as follows: in the next section, the concept of competitiveness in agriculture and its components are analyzed. The third section is dedicated to the presentation of the study zone. The fourth section presents the methods of diagnostic analysis and those used to build the CI. The fifth section is dedicated to the presentation of the main results, the sixth is devoted to discussion of results and the last section draws the resulting conclusions.

2. Competitiveness and Agriculture

The concept of competitiveness refers to the capacity of offering goods and services where and how buyers demand it, at a better price than potential direct competitors, maximizing the profit by reducing the cost of the used resources [2]. Two different approaches lie within this concept:

The first approach refers to competition in national or international markets and pertains to the capacity to sustain a determined market share [19]. This mainly pertains to countries which predominantly produce industrial and raw material.

The second approach refers to the competition among production factors in order to make a profit at the minimum opportunity cost. In a free market context, being competitive means that in a medium and long term scale, companies must make significant profit to be able to remunerate the invested capital of their resources at their real opportunity cost.

Both of these approaches define competitiveness as relative in the sense that it cannot be determined in absolute terms but rather by comparison to other companies, sectors or countries. If we focus on the agricultural sector, most of the outputs and inputs are commodities. Therefore, the price is the variable that has the most bearing on their competitiveness. Of course, the price is directly related to production costs, which depend on input prices and the efficiency of production factors. The competitiveness level of a company is ultimately determined by its product's market price. This price is established more by the profitability threshold (break-even point from which the company starts to make a profit) than by the prices offered by competitors. In a global market sector level analysis, the sector for which domestic prices are below international prices is considered competitive. In this context, market prices depend on many factors often uncontrollable by the producer. However, there are controllable factors which would lead to two fictitious identical farms having different levels of competitiveness. At a company level, admitting that the objective is to enhance its wealth assets, the concept to be considered is profitability. Profitability reflects the link between profit and the resources used to generate it. In short, enhancing the farm's profitability would also enhance its competitiveness.

It is becoming more difficult to support farms through subsidies in global markets, so it is fundamental to focus these efforts on the use of productive factors. This would mean that taking into account factors that are intrinsic to the farm and controllable by the producer, would decrease the uncertainty of future profitability. This study focuses on production systems, not on countries or sectors. This analysis is done at farm scale, considering the fact that production units often have several different outputs. In [20], taken as a reference for this paper (and often used as a reference in Spain), the analysis is done at an agrarian system scale. They consider that producers of the same sector or territory are not natural competitors but that they compete with producers in other agricultural sub-sectors, economic sectors, territories and even other countries. Nevertheless, the approach used for this paper focuses on production systems which belong to a unique agrarian system. Competition established in the global market is equal to survival, in a long term scale, within the agrarian system. In a global scenario, ruled by price volatility, the idea of making a CI is to reflect the different production systems' capacity to maintain profitability when prices diminish. This analysis is enshrined in the post 2013 CAP which has the specific objectives of increasing competitiveness and enhancing the part of agriculture within the agri-food industry, while at the same time preserving production sustainability. Both of these objectives may seem contradictory. Competitiveness analysis at a production system level is in this way interesting since it could identify the possibility of achieving both objectives within a determined agrarian system [4,6,11,15,21].

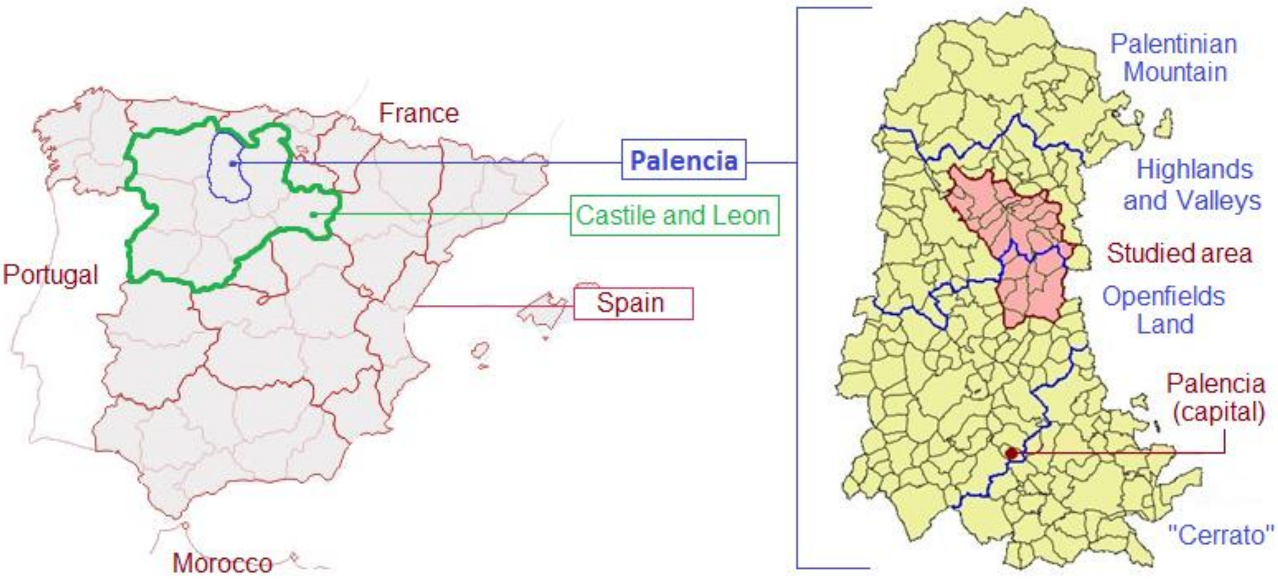
3. Case Study

The Studied Area and Previous Results

As field work is very precise and detailed, the size of the geographic area that can be studied applying the diagnostic analysis methodology is restricted; therefore, this study is solely focused on Palencia, a province in the Castile region of Spain. The first step was to establish partial limits to the area of study. Palencia has four agricultural districts from which two were retained ("Tierra de Campos"—open field land and "Páramos y Valles"—highlands and valleys) and two excluded (the "Cerrato" for its different soils—calcareous, landscape, topography and productions and the "Palentinian Mountain" for its particularities and difficult access).

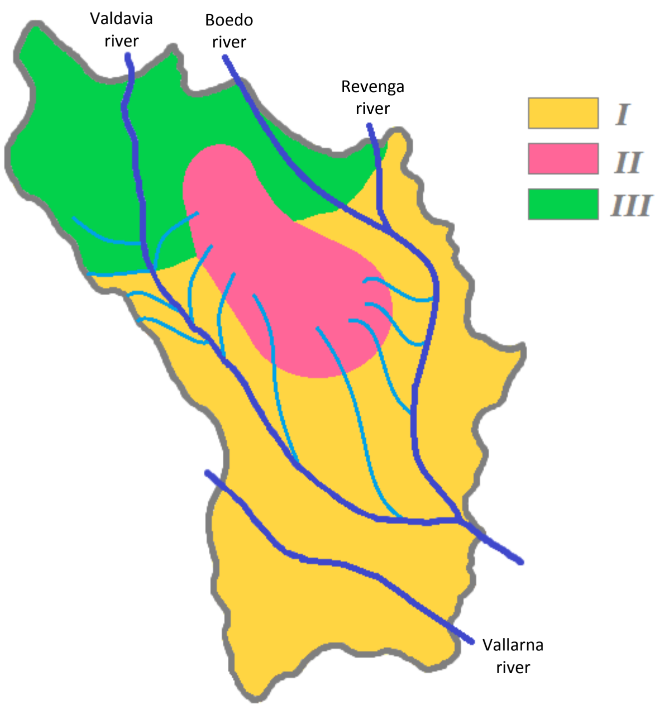
To increase the diversity of the studied farms, and to avoid areas where urbanization has created speculation about land prices, the studied area was defined as presented in Figure 1. The chosen zone was 720 km^2 comprising of 45 villages distributed among 24 municipalities.

Figure 1. Localization of Palencia, its agricultural districts and the limits of the studied area.



The climate in Palencia fluctuates between continental and semi-arid [8] as the Cantabrian Mountains located in the north of the province isolate Castile from the oceanic influence. There are just two seasons: a long, cold and humid winter (average temperatures are approximately 2–3 °C) and a short, warm and dry summer (with average temperatures from approximately 18–20 °C). Daily temperature ranges are generally very wide. Rainfall is irregular and scarce (from 500 mm/year in the southern part of the studied zone up to 630 mm/year in the north). Autumn rains are fundamental for agricultural activities in the region and constitute a limiting element since they determine the number of days available for plowing and sowing.

Figure 2. Sub-areas location and distribution.



Three sub-areas were identified using geological, soil, topographic, and land use criteria as well as climatologic data analysis and data collected from interviews with active and retired producers (see Figure 2). The biggest sub-area was given the name of "Open fields and Valleys" (I). The sub-area located between the Valdavia and Boedo rivers (characterized by its lack of access to recent fertile alluvial deposits) was given the name of "Interfluve" (II) and the sub-area located in the north was given the name of "Highlands" (III). Each production system pertains to one of the aforementioned sub-areas presenting specific characteristics.

Distinguishing the sub-areas is the first step of the landscape modeling process. There are some limitations in this procedure since more precise soil analyses would have been required (the scale used in local soil maps made the whole area appear as homogeneous). Table 1 recapitulates the most relevant characteristics of each sub-area.

Table 1. Principal characteristics of the studied area's sub-areas.

	Relief	Soil distribution			Temperature, risk of frost, parcel size	Humidity, wooded areas	Yields (kg/ha)		
		Recent alluvial deposits	Clayey (sometimes hydromorphic)	Acid, stony and light			wheat	Barley	Vetches (fodder)
I	Little relief, virtually flat	5%–25%	30%–80%	15%–60%	+++	+	2800	2675	2400
II	Plateau with some hills	0%	30%–50%	50%–70%	++	++	2750	2650	2430
III	Wavy relief with steep slopes	5%–10%	10%-30%	70%–80%	+	+++	3670	3025	2875

4. Methodology

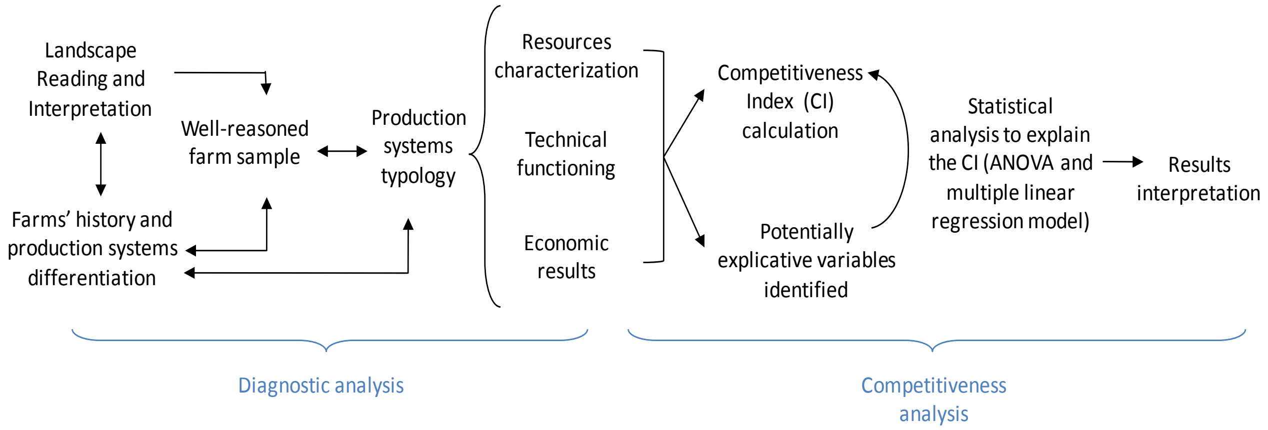
An overall diagram that lays out the methodology is presented at the end of this section (Figure 3).

4.1. The Diagnostic Analysis

Data collection was completed between March and August 2011 using diagnostic analysis. The diagnostic analysis is a systemic and multidisciplinary methodology which focuses on understanding the causes within the constructive process of an agrarian system (whether the causes are physical, environmental, historical, technical, socio-economic or political) [22]. The main techniques used are direct observation and interpretation and first hand quantitative and qualitative data collecting through interviews with key actors. Data collected and processed includes landscape modeling, production systems' historical differentiation process analysis and technical-economic functioning modeling (a more detailed explanation of this methodology can be found in [23–25].

The information collected comes from semi-directive interviews with producers from the studied area (Section 3) which were complemented with official data (such as market prices). Forty-six "historical interviews" (with retired producers) and 51 technical-economic interviews (with active producers) were completed during field work. The interviews were set up with specific producers in order to obtain the greatest possible variety of production systems. Throughout the interviews, producers' resources (labor force, quantity and quality of land, equipment, buildings, *etc.*), practices (cropping techniques, herd management, crop rotations, *etc.*) and strategies (product commercialization, investment projects, *etc.*) were evaluated. With that data, a detailed description of technical functioning and economic performance of each farm was made and subsequently, after data aggregation, the production systems' models were built [7].

Figure 3. Overall methodology diagram.



4.2. The Production Systems Models

It is in this geographic context that the different production systems were modeled as part of a previous study using the diagnostic analysis methodology [26]. Each production system model is the result of the aggregation of data concerning technical functioning, economic performances and resources (labor forces, land, equipment, buildings, *etc.*) of similar farms [3,23]. Often, farms similar enough to be representative of a production system are the result of a similar historical differentiation process but these details cannot be presented in this paper (see [26] for details). The idea is to take into account all the different types of farming still present in the landscape, even if they are not statistically representative.

Twenty production systems were modeled, revealing the immense diversity that hides beneath the apparent homogeneity of Castile's steppes, as presented in Table 2.

Table 2. Production factors and principal characteristics of the production system models.

Shorten Name	Production system name	Labor force	Area (ha)	% owned	Sub-area	Years (average)	Other income	Rain-fed or irrigation	Animals
I.R1	Medium farm of rain-fed agriculture and other sources of income	1–2 FM	160	15%	I	45	Yes	RF	No
I.R2	Small farm of rain-fed agriculture with predominance of barley growing	1 FM	70	80%	I	50	Yes	RF	No
I.I1	Small farm of rain-fed agriculture and watered alfalfa	1–2 FM	97	31%	I	40	No	RF + I	No
I.I2	Medium farm of rain-fed agriculture with watered alfalfa and cereals	1–2 FM	153	79%	I	35	No	RF + I	No
I.I3	Big farm of rain-fed agriculture with watered potatoes and sugar beets	1 FM	370	30%	I	40	Yes	RF + I	No
I.Org	Small farm of rain-fed organic agriculture	2 FM	100	70%	I	40	No	RF	No
I.II.OM1	Small farm of rain-fed agriculture and Assaf sheep breeding for milk production	1 FM	40	65%	I + II	35	No	RF	400 Assaf sheep
I.OM2	Medium farm of rain-fed agriculture and Assaf sheep breeding for milk production	2 FM	200	35%	I	35	No	RF	800 Assaf sheep
I.DC	Medium farm of rain-fed agriculture, watered alfalfa, dairy cows and veal calves	2 FM	60	29%	I	45	No	RF + I	70 cows (Prim'Holstein)
I.R2	Big farm of rain-fed agriculture and other sources of income	2 FM	440	38%	II	40	Yes	RF	No
II.R2	Small farm of rain-fed agriculture with predominance of wheat growing	1 FM	100	50%	II	50	Yes	RF	No
II.I1	Big farm of rain-fed agriculture and watered crops (potatoes, sugar beet, alfalfa, sunflower and cereals)	2 FM	443	35%	II	50	No	RF + I	No
III.R1	Medium farm of rain-fed agriculture	1 FM	160	32,5%	III	55	Yes	RF	No
III.R2	Small farm of rain-fed agriculture with predominance of rye growing	1 FM	49	31%	III	68	Yes	RF	No
III.I1	Medium farm of rain-fed agriculture with watered cereals	1–2 FM	142	35%	III	55	No	RF	No
III.I2	Medium farm of rain-fed agriculture with watered potatoes and sugar beet	2 FM	289	48%	III	50	No	RF + I	No

Table 2. *Cont.*

Shorten Name	**Production system name**	**Labor force**	**Area (ha)**	**% owned**	**Sub-area**	**Years (average)**	**Other income**	**Rain-fed or irrigation**	**Animals**
III.OB	Medium farm of rain-fed agriculture with watered alfalfa, "churras" sheep and Limousine cows	2–3 FM	177	58%	III	52	No	RF + I	500 "churras" sheep 70 Limousine cows
III.OM	Big farm of rain-fed agriculture and Assaf sheep breeding for milk production	2 FM and 2 workers	196	50%	III	40	No	RF	1700 Assaf sheep
III.Om1	Very small farm of rain-fed agriculture and "churras" sheep breeding for meat production	1 FM	10	0%	III	45	No	RF	500 churras sheep
III.Om2	Small farm of rain-fed agriculture and "churras" sheep breeding for meat production	1 FM	80	20%	III	45	No	RF	232 churras sheep

Notes: FM: Family members, RF: Rain-fed, RF + I: Rain-fed + irrigation; Production systems' names: I, II, III are the sub-areas and R = rain-fed, I = irrigation, OM = ovine cattle for milk, Om = ovine cattle for meat, OB = ovine and bovine, DC = dairy cows, Org = organic.

Economic indexes were calculated for each production system on the basis of the information gathered during the interviews and official data collected from 2010. Each production system has a different technical functioning which implies unequal economic performances. The calculations were made to evaluate these results in the most precise and realistic possible way. The first stage was modeling economic results such as added value (gross and net) and family income. The second step was to use these results to evaluate each production system's competitiveness through the Competitiveness Index (a table of the inputs and products for which values were established can be found at the beginning of Section 4.3).

4.3. The Production Systems' Economic Indicators

All of the equations are presented in Appendix.

First of all, it is necessary to calculate the Gross Added Value (GAV) of each production system. For this, it is first required to evaluate the Gross Product (GP, Equations (A1)–(A5)) which depends on the different products and their average market prices, their average yield, the area dedicated to each crop or the number of animals when relevant. For each crop and for each soil type an average yield was evaluated in every production system based on information provided by the farmers and considering variation between dry and wet years and their occurrence. In semi-arid rain fed systems, the impact of year-to-year variability of rainfall is an important factor to be taken into account since farmers often try to maximize profitability in wet years and reduce costs in dry years. This issue is a limitation to the present analysis made with average production amounts and values.

The concept of GAV is related to the production activity so subsidies are not included in the calculation of GP.

Then, the Intermediate Consumptions (ICO) were calculated for every production system. The ICO are defined as goods and services consumed during the production process which can be variable (seeds, fertilizers, pesticides, *etc.*) or fixed (insurances, management expenses, *etc.*) and depend on each producer's practices and strategies. They do not include fixed capital such as land, buildings and wells, amongst others. The attribution of ICO to each crop (fallow land included) is detailed in the paragraph about agriculture in Section 4.4.1 Interaction between crops and grazing animals are an important determinant of the functioning of these production systems. In the study region, farmers that breed animals use mainly stubbles, fodder and pasture for feeding their herds. The model deals with this interaction by subtracting the VGP that corresponds to crops used to feed the animals from the production system GAV. Stubbles are considered to have an opportunity cost of zero since there is no demand for hay in the region due to the abundance of cereal growing.

It is important to point out that family or contracted labor force costs are not considered Intermediate Consumptions [23]. Labor force is a contribution to the production process (as well as capital or land) and it is taken into account when redistributing the wealth generated during the production process between stakeholders (Equation (A12)).

With these economic figures the Gross Added Value (GAV) can be calculated by subtracting the ICO from the GP (Equation (A9)).

Subsequently, the Net Added Value (NAV) was calculated by deducting the real depreciations of fixed capital (equipment, irrigation material, buildings, *etc.*) from the GAV (Equation (A11)). The idea is not to use book-values (understood as an accounting tool) but to make an evaluation of the real value loss of production means which depends on the number of years of actual use (Equation (A10)). In order to be as realistic as possible in these calculations, information concerning the year and price of purchase, the actual years of use and an estimate of the selling price (planned) were gathered during the interviews (for each piece of equipment). Every price used needs to be converted to 2013 Euros. For that, a table was built using the official consumption indices of the Spanish National Statistics Institute (INE locally).

The NAV represents the wealth created during the production process (deducting the destroyed wealth either counted as ICO or production means value loss). That wealth has to be distributed between the stakeholders who took part in the production process either by their work or their capital investment. It is important to mention that farmers in this zone have insurance to help deal with uncertainty over climate. In this sense, insurance companies are also considered as stakeholders who take part in the production process. The family income (FI, Equation (A12)) provides the results of that distribution. To calculate the FI, subsidies are added to the NAV (wealth transfer from society—through taxes—to producers). Capital remuneration (land leasing and financial expenses), work remuneration, collective resources remuneration (irrigation and common pastures taxes) and risk remuneration (crop insurance) are on the other hand deducted from the NAV. Subsidies in this paper have been considered for classifying farms according to their economics dependence on them. So in Table 3 in the last column, the weight of subsidies in the family income of the farm concerned is presented. Equation (A12) shows a form of wealth distribution between the State and producers, and from this the percentage of revenue as a potentially explanatory variable (which turned out not to be explanatory) was calculated. However, it should be noted that this is not a variable involved in the calculation of the index competitiveness since the aim of the paper is to analyze the exposure of farm to market in the absence of agricultural subsidies, what we could call the intrinsic competitive of production systems

According to the diagnostic analysis methodology, the FI needs to be compared to the opportunity cost of family labor force [23]. In Europe, the minimum salary is usually used as reference for this comparison (Table 3). However, it is important to consider that in the present financial and economic crisis context, the extremely high unemployment rates in Spain diminish the opportunity cost of labor force.

Table 3 presents the main agro-environmental and economic indicators resulting from this data treatment.

Table 3. Agro-environmental data and main economic results of the production system models.

Shorten Name	Production system name	% of fallow land	% of area in AE	ICO/ha (€)	FC/ha (€)	Non proportional depreciations (€/year)	Family Income (€/year)	Opportunity cost of family labor * (€/year)	Subsidies (% of Family Income)
I.R1	Medium farm of rain-fed agriculture and other sources of income	10%	40%	243	91	11,348	11,088	13,299	230%
I.R2	Small farm of rain-fed agriculture with predominance of barley growing	7.1%	0%	317	118	2385	7452	8866	140%
I.I1	Small farm of rain-fed agriculture and watered alfalfa	8.2%	51%	245	94	9828	17,894	13,299	106%
I.I2	Medium farm of rain-fed agriculture with watered alfalfa and cereals	0%	78%	316	67	6808	51,190	13,299	74%
I.I3	Big farm of rain-fed agriculture with watered potatoes and sugar beets	9.5%	27%	410	148	27,568	97,719	8866	62%
I.Org	Small farm of rain-fed organic agriculture	2%	90%	292	120	5454	36,225	17,732	92%
I.II.OM1	Small farm of rain-fed agriculture and Assaf sheep breeding for milk production	12.5%	0%	928	92	3067	31,281	8866	42%
I.OM2	Medium farm of rain-fed agriculture and Assaf sheep breeding for milk production	6%	0%	421	97	8034	54,598	17,732	75%
I.DC	Medium farm of rain-fed agriculture, watered alfalfa, dairy cows and veal calves	7.3%	0%	690	104	19,000	52,977	17732	92%
I.R2	Big farm of rain-fed agriculture and other sources of income	5.7%	66%	236	98	16,826	79,862	17,732	84%

Table 3. *Cont.*

Shorten Name	Production system name	% of fallow land	% of area in AE	ICO/ha (€)	FC/ha (€)	Non proportional depreciations (€/year)	Family Income (€/year)	Opportunity cost of family labor * (€/year)	Subsidies (% of Family Income)
II.R2	Small farm of rain-fed agriculture with predominance of wheat growing	15%	0%	251	103	4480	13,830	8866	102%
II.I1	Big farm of rain-fed agriculture and watered crops (potatoes, sugar beet, alfalfa, sunflower and cereals)	5.6%	68%	361	89	19,970	112,793	17,732	74%
III.R1	Medium farm of rain-fed agriculture	10%	31%	284	113	6420	18,475	8866	136%
III.R2	Small farm of rain-fed agriculture with predominance of rye growing	28.6%	0%	249	84	2335	4044	8866	197%
III.I1	Medium farm of rain-fed agriculture with watered cereals	23.2%	0%	240	110	7211	19,328	13,299	107%
III.I2	Medium farm of rain-fed agriculture with watered potatoes and sugar beet	3.5%	0%	373	126	16,188	53,748	17,732	70%
III.OB	Medium farm of rain-fed agriculture with watered alfalfa, "churras" sheep and Limousine cows	8.5%	0%	369	86	879	80,410	22,165	80%
III.OM	Big farm of rain-fed agriculture and Assaf sheep breeding for milk production	7.7%	64%	738	111	13,464	113,648	17,732	75%
III.Om1	Very small farm of rain-fed agriculture and "churras" sheep breeding for meat production	0%	0%	4440	90	100	15,631	8866	52%
III.Om2	Small farm of rain-fed agriculture and "churras" sheep breeding for meat production	20%	0%	96	307	3184	11,970	8866	151%

Notes: AE: Surface registered for receiving agro-environmental subsidies; ICO/ha: Total intermediate consumption per hectare; FC/ha: Total fertilization cost per hectare; * Based on family labor and national minimum wage level in Spain for 2010 (8866 €/year).

4.4. Competitiveness Calculation for the Different Production Systems

To evaluate each production system's competitiveness a CI was created. The CI is the final output variable established in this study. The following table (Table 4) resumes the distribution of values according to two categories: inputs directly resulting from data collection (primary information) and intermediate outputs, resulting from treatment of the inputs.

Table 4. Inputs and intermediate outputs used to calculate the CI.

Primary information (inputs)	Intermediate outputs: production systems deducted indicators
Family information: number of family labor force, age. **Land tenure:** % property, % leasing. **Land use:** area for crops, grazing, fallow land, registered for receiving agro-environmental subsidies, under irrigation, *etc.* (and respective %). **Number of grown species** **Cattle information** (species, breed, number, products and sub-products, reproduction management, nutrition, *etc.*). **Prices** of every product and sub-product (eventually according to time of year, stock capacity, *etc.*). **Yields** (estimated average). **Practices** (amounts used) and supplies and services costs for cropping and breeding (seeds, fertilizers, fuel, electricity, pesticides, fodder, medicines, veterinarian services, *etc.*). **Fixed capital:** type, purchase price, selling price and years of actual use. **Distribution of income**: Subsidies, credit, contracted labor force and salaries, taxes, *etc.* **Family income:** external source of income.	**Gross Product GP** **Intermediate Consumptions ICO** **Gross Added Value GAV** **Depreciations of fixed capital D** **Net Added Value NAV** **Family Income FI** **Opportunity cost of family labor** **Profitability Thresholds PT**

The calculation of the CI will be first explained for agriculture and subsequently for livestock breeding. It is important to explain that only productive activities were taken into account to calculate the CI in order to reflect the competitiveness differences between production systems (and not between activity systems [23]). In this sense, non-agricultural activities or entrepreneurial agricultural services done outside the farm were not taken into account for the CI calculation (but they were characterized and quantified when constructing the production systems' typology).

4.4.1. Agriculture

A profitability threshold (PT) was calculated for each crop. First of all, the price ϕ under which the GAV of a certain crop becomes negative is calculated (producers are not willing to accept a lower price). These calculations were done by using the GAV and not the NAV because of the difficulty of attributing depreciations to each crop (depreciations are for the most part non-proportional to cultivated areas).

The PT corresponds to the difference between ϕ and the market price transformed into a percentage of the market price (Equation (A19)). This difference can be negative when the crop is not profitable. This sort of mediocre economic performance can persist because of the increase in the family's income generated by subsidies (not reflected in the global CI) and/or the compensation from other crops. The

PT was calculated according to the area dedicated to each crop. The weighted addition of each crop's PT represents the global CI of a production system (Equation (A13)).

To evaluate the PT of a certain product, only the ICOs corresponding to that particular product are considered. When there are fallow land areas, the corresponding ICOs are proportionally distributed amongst all the crops grown in rotation with the fallow land. For each one of these crops there will then be an "equivalent ICOs value" (ICO^{eq}; Equation (A16)). First of all, an equivalent area is calculated (S^{eq}). This equivalent area is the proportional distribution of the fallow land area among the crops grown in rotation with the fallow land (Equation (A15)). In the same way, equivalent yields (y^{eq}) are calculated (Equation (A17)). When there are no fallow lands in the considered production; $S^{eq} = S$, $ICO^{eq} = ICO$ and $y^{eq} = y$.

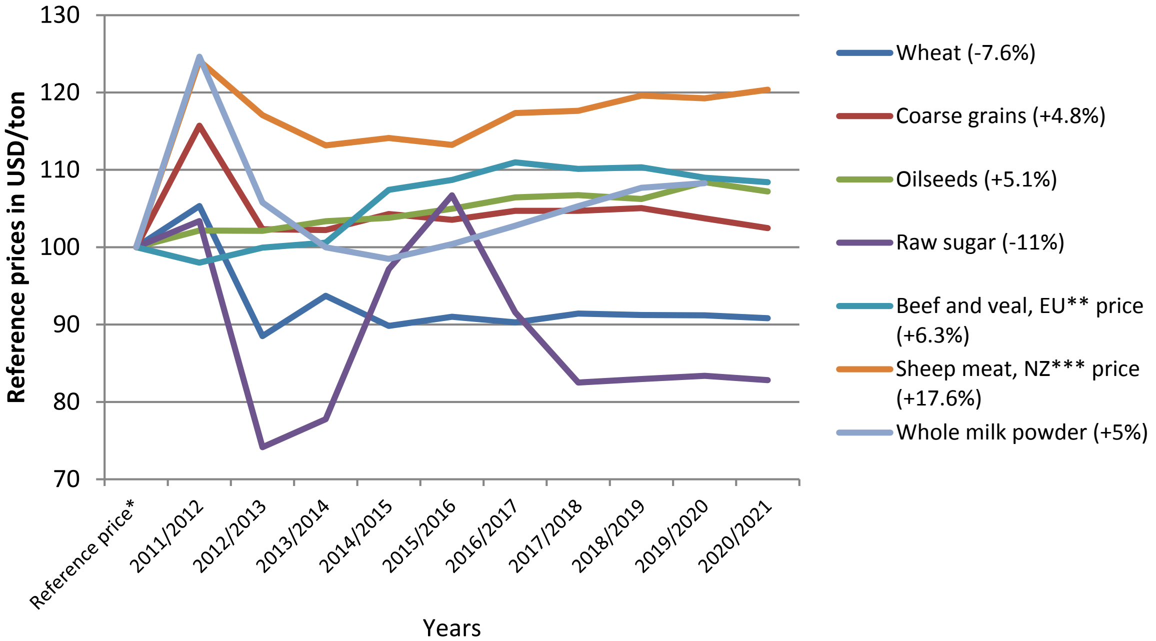
4.4.2. Livestock Breeding

In livestock breeding it is not possible to distribute production costs between each product because a single herd can provide milk, meat and wool. The methodology used to calculate the animal products' PTs was elaborated to take into account every sub-product. In today's context, many cattle breeding farms exist thanks to animal sub-products so it is very important to include these factors in the calculations. Therefore, for each product, the price that would nullify the total livestock GAV (ϕ^L) is calculated (the other products' prices are fixed; Equation (A21)). A PT relative to each animal product is then obtained (PT^L; Equation (A22)) which is adjusted according to the product's weight in the Animal Gross Product (AGP). The weighted addition of each animal product is added to the weighted addition of each crop to represent the global CI of a production system (Equation (A20)).

4.5. Construction of Scenarios

Today it is difficult to foresee the evolution of agricultural and commodities' prices because of their volatility. In general, studies predict an increase of prices for agricultural products up to 2020 compared to the 2001–2010 decade. The OECD (Organization for Economic Co-operation and Development) and the FAO's (United Nations' Food and Agriculture Organization) forecasts predict an increase of up to 20% in cereal prices and 30% in animal products' prices. These forecasts are based on a series of hypothesis such as faster economic growth in developing countries, the continuous decrease of population growth in developed countries, the maintenance of moderate inflation levels and the increase of liquid fuels' prices amongst others [27]. Nevertheless, in comparison to the 2010 prices used for all the economic calculations of this paper, forecasts are variable according to the considered products. The OEDC-FAO's predictions for agricultural prices are presented below in Figure 4.

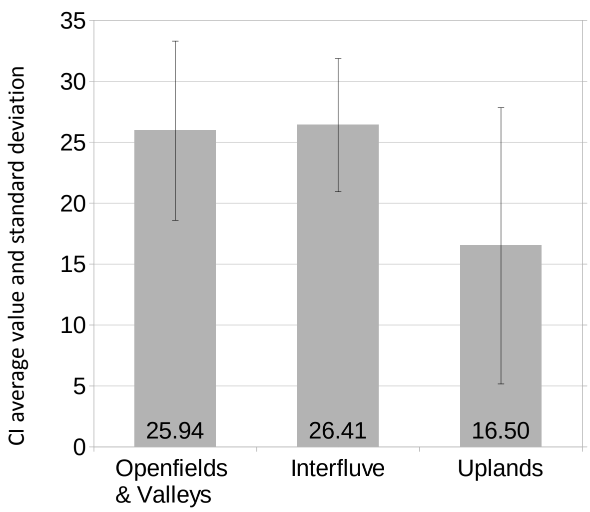
Figure 4. Relative Prices in USD$/ton (average of 2008–2009 and 2010–2011's prices = 100) (OEDC-FAO forecasts).



Notes: * 2008–2009 and 2010–2011's price average = 100, ** European Union, *** New Zealand.

Two different price scenarios were built to analyze the production systems' competitiveness reactions in an uncertain context with maintained price volatility [28]. The first scenario (Scenario 1) only takes into account outputs' price forecasts (average values of OEDC-FAO forecasts, between parentheses on Figure 5). The second scenario (Scenario 2) takes into consideration, besides the OEDC-FAO predictions, the forecasts provided by the EIA [3] about liquid fuel's prices (published in the 2011's International Energy Outlook). This same data was used as a hypothesis by the OEDC-FAO to make agricultural price calculations. In this scenario, there is an increase of 30.5% in oil prices between 2010 and 2020. It is important to analyze this scenario because oil prices have a direct influence on the prices of fuel and fertilizer which are essential inputs for the production systems reviewed in this paper.

Figure 5. CI average value and standard deviations in each sub-area.



5. Results

Competitiveness Analysis

Unsurprisingly, the CIs obtained for each production system are different. The following table (Table 5) presents the obtained values in decreasing order.

Table 5. Production systems competitiveness index's values.

	Rank		Production system name	CI
High CI	1	III.OB	Medium farm of rain-fed agriculture with watered alfalfa, "churras" sheep and Limousine cows	**75**
	3	I.II.OM1	Small farm of rain-fed agriculture and Assaf sheep breeding for milk production	**39.3**
	4	I.OM2	Medium farm of rain-fed agriculture and Assaf sheep breeding for milk production	**39.2**
	2	III.OM	Big farm of rain-fed agriculture and Assaf sheep breeding for milk production	**38.8**
	5	II.R1	Big farm of rain-fed agriculture and other sources of income	**38.1**
	6	I.I1	Small farm of rain-fed agriculture and watered alfalfa	**37.8**
Intermediate CI	7	I.DC	Medium farm of rain-fed agriculture, watered alfalfa, dairy cows and veal calves	**35.4**
	8	I.I2	Medium farm of rain-fed agriculture with watered alfalfa and cereals	**32.0**
	9	I.R1	Medium farm of rain-fed agriculture and other sources of income	**28.6**
	10	III.R1	Medium farm of rain-fed agriculture	**25.4**
	11	II.I1	Big farm of rain-fed agriculture and watered crops (potatoes, sugar beet, alfalfa, sunflower and cereals)	**24.6**
	12	III.I1	Medium farm of rain-fed agriculture with watered cereals	**24.2**
	13	III.I2	Medium farm of rain-fed agriculture with watered potatoes and sugar beet	**21.5**
	14	II.R2	Small farm of rain-fed agriculture with predominance of wheat growing	**16.5**
Low CI	15	III.Om2	Small farm of rain-fed agriculture and "churras" sheep breeding for meat production	**15.8**
	16	III.Om1	Very small farm of rain-fed agriculture and "churras" sheep breeding for meat production	**15.4**
	17	I.Org	Small farm of rain-fed organic agriculture	**11.4**
	18	I.R2	Small farm of rain-fed agriculture with predominance of barley growing	**6.5**
	19	I.I3	Big farm of rain-fed agriculture with watered potatoes and sugar beets	**3.0**
	20	III.R2	Small farm of rain-fed agriculture with predominance of rye growing	**−2.3**
Mean: 26.3; Standard deviation: 17.2				

The average competitiveness of the production systems located in "Open fields and Valleys" and "Interfluve" is higher than that of the systems of the "Highlands" sub-area (even though in this sub-area, many competitive livestock breeding farms generate a high standard deviation value) as may be seen in Figure 5.

To understand the contribution of the different explicative variables, and for the construction on competitiveness, a multiple linear regression was made. The model with the higher R^2 (0.643) includes three predictive variables (besides the constant), which are the type of farm, fertilizations costs per hectare and producers' average ages. Table 6 presents these results.

Table 6. Linear regression model explicative variables' coefficients.

Model	Non standardized coefficients		Typified coefficients	t	*p*-value
	B	Typ. Error	beta		
(Constant)	5.252	1.098		4.783	0.000
Type *	0.293	0.119	0.389	2.464	0.025
Total fertilization cost per hectare	−0.019	0.007	−0.434	−2.843	0.012
Producers' average age	−0.039	0.015	−0.403	−2.599	0.019

* The categories used are: 1 for rain-fed agriculture, 2 for irrigated agriculture, 3 for rain-fed agriculture + livestock breeding and 4 for irrigated agriculture + livestock breeding.

The CI's reaction to Scenario 1 is globally positive for production systems with livestock breeding and agricultural systems with a CI inferior to 10 points (see Table 7). However, for production systems without animals and with a CI greater than 10, competitiveness evolution is negative. These results are influenced by significant differences between the trends considered for each crop so the analysis must be interpreted in relative or comparative terms.

For each one of the scenarios, a regression analysis was made to identify potentially explicative variables for the CI variation (categorized). The results of both regressions are presented in Table 8.

Table 7. Competitiveness Index reaction to different price scenarios (reference CI presented in decreasing order).

Production system name		Reference CI	Scenario 1		Scenario 2	
			CI	Variation (%)	CI	Variation (%)
III.OB	Medium farm of rain-fedagriculture with watered alfalfa, "churras" sheep and Limousine cows	75	**86.5**	15.4	**71.7**	−4.4
I.II.OM1	Small farm of rain-fed agriculture and Assaf sheep breeding for milk production	39.3	**40.4**	2.8	**37.2**	−5.3
I.OM2	Medium farm of rain-fed agriculture and Assaf sheep breeding for milk production	39.2	**40.8**	4.0	**35.0**	−10.7
III.OM	Big farm of rain-fed agriculture and Assaf sheep breeding for milk production	38.8	**42.0**	8.3	**28.7**	−26.0
II.R1	Big farm of rain-fed agriculture and other sources of income	38.1	**38.1**	0.0	**27.0**	−29.2
I.I1	Small farm of rain-fed agriculture and watered alfalfa	37.8	**38.0**	0.6	**34.9**	−7.5
I.DC	Medium farm of rain-fed agriculture, watered alfalfa, dairy cows and veal calves	35.4	**36.7**	3.5	**21.9**	−38.2
I.I2	Medium farm of rain-fed agriculture with watered alfalfa and cereals	32.0	**32.5**	1.6	**23.1**	−27.8
I.R1	Medium farm of rain-fed agriculture and other sources of income	28.6	**28.6**	0.0	**17.2**	−39.8

Table 7. *Cont.*

Production system name		Reference CI	Scenario 1		Scenario 2	
			CI	Variation (%)	CI	Variation (%)
III.R1	Medium farm of rain-fed agriculture	25.4	**25.4**	0.0	**13.1**	−48.6
II.I1	Big farm of rain-fed agriculture and watered crops (potatoes, sugar beet, alfalfa, sunflower and cereals)	24.6	**24.6**	0.0	**7.1**	−71.1
III.I1	Medium farm of rain-fed agriculture with watered cereals	24.2	**24.2**	0.0	**8.7**	−64.1
III.I2	Medium farm of rain-fed agriculture with watered potatoes and sugar beet	21.5	**21.5**	0.0	**1.3**	−94.2
II.R2	Small farm of rain-fed agriculture with predominance of wheat growing	16.5	**16.6**	0.5	**3.2**	−80.5
III.Om2	Small farm of rain-fed agriculture and "churras" sheep breeding for meat production	15.8	**27.2**	72.0	**11.9**	−25.0
III.Om1	Very small farm of rain-fed agriculture and "churras" sheep breeding for meat production	15.4	**27.2**	76.5	**24.6**	59.9
I.Org	Small farm of rain-fed organic agriculture	11.4	**11.4**	0.0	**4.5**	−60.3
I.R2	Small farm of rain-fed agriculture with predominance of barley growing	6.5	**9.2**	40.3	**−5.8**	−189.2
I.I3	Big farm of rain-fed agriculture with watered potatoes and sugar beets	3.0	**4.0**	33.9	**−12.7**	−520.7
III.R2	Small farm of rain-fed agriculture with predominance of rye growing	−2.3	**-0.5**	−77.8	**−16.9**	648.1

Notes: Green: Considerable positive variation of the CI in the considered scenario, Red: Considerable negative variation of the CI in the considered scenario.

Table 8. Multiple linear regression model results to explain variation of the CI.

Scenario	Model	Non standardized coefficients		Typified coefficients	t	*p*-value
		B	Typ. Error	beta		
Scenario 1	(Constant)	5.503	0.828		6.649	0.000
	Cost structure *	−1.150	0.248	−0.741	−4.633	0.000
	CI	−1.079	0.268	−0.644	−4.027	0.001
Scenario 2	(Constant)	2.566	0.726		3.534	0.003
	CI	0.722	0.183	0.560	3.939	0.001
	Cost structure *	−3.177	1.016	−0.444	-3.126	0.006

* Part of costs directly depending on liquid fuel prices over total production costs.

6. Discussion

The most competitive production systems (in green in Table 5) combine mostly agriculture and livestock breeding. The most competitive production system (III.OB, CI = 75.0) is the only one that combines two herds (one ovine and one bovine, both for meat production) and irrigated alfalfa. All crops are used to feed the animals. The farms which compose this production model are located in the "Highlands", which is considered to be a disadvantaged sub-area in terms of climate and soil. This system production costs are low because most of the food used to feed the animals comes from the farm (except from the soy beans used to feed the bovines).

Other production systems which have a high CI are those that breed Assaf sheep for milk production, independently of the sub-area in which they are located (there are Assaf breeding systems in all of the sub-areas even if their technical functioning is not identical) and the size of the flock. The CI values that they obtain are CI = 39.3 (I.II.OM1), CI = 39.2 (I.OM2) and CI = 38.8 (III.OM). The exclusively agricultural production system with the higher CI (II.R1, CI = 38.1) has an important variety of rain-fed crops. It is located in an underprivileged sub-area but has relatively low production costs. This system is followed by another in which irrigated alfalfa is produced (I.I1, CI = 37.8) located in the "Openfields and valleys" sub-area.

Regarding the less competitive production systems (in red in Table 4), at the top of the list there is a production system located in the "Highlands", with a reduced area and predominance of rye growing (III.R2, CI = 2.3). It is the only one that has negative competitiveness, meaning that the production costs are higher than the Gross Product. This type of farm is generally run by retired producers. Then there is, surprisingly, a production system with a larger extension (I.I3, CI = 3.0) with irrigated crops (sugar beet, potatoes, sunflowers and cereals). Its low competitiveness is probably explained by its high production costs. To continue the list, there is a rain-fed agriculture system similar to III.R2 but located in the "Openfields and valleys" sub-area and predominantly dedicated to wheat production (I.R2, CI = 6.5) and there is also the only organic farming system (I.Org, CI = 11.4) that, despite its high selling prices, has very high production costs (because of its isolation, organic manure has to be imported from far away) and low yields. This system's competitiveness would be significantly higher if there were organic livestock breeding farms in the surrounding areas. Nevertheless, suggesting the increase of organic farming in the region would require an analysis of the market for organic products in Palencia and its surroundings. Lastly, there are the two systems dedicated to ovine meat production (III.Om1, CI = 15.4 and III.Om2, CI = 15.8) for which production costs are very variable and selling prices are disadvantageous.

The typified coefficients of each one of these variables emphasize the importance of fertilization expenses in a farm's competitiveness. The negative signs of the standardized coefficients of both producers' ages and fertilization costs show that when these features increase, competitiveness decreases. Regarding the type of production system, the positive sign shows that, in general, production systems with livestock breeding are more competitive than exclusively agricultural production systems.

It should be stressed that the share of the CAP's subsidies over the total family income does not make part of the significantly explicative variables (*p*-value = 0.174). So, it is possible to suppose that the attribution of more or less subsidies after 2013's reform will not substantially modify the production systems' competitiveness if this does not alter the producers' practices and the farms' technical functioning since aids are decoupled from production. However, subsidies will have an impact on the production systems' risk profiles since they allow producers to take risks that they would not otherwise have taken.

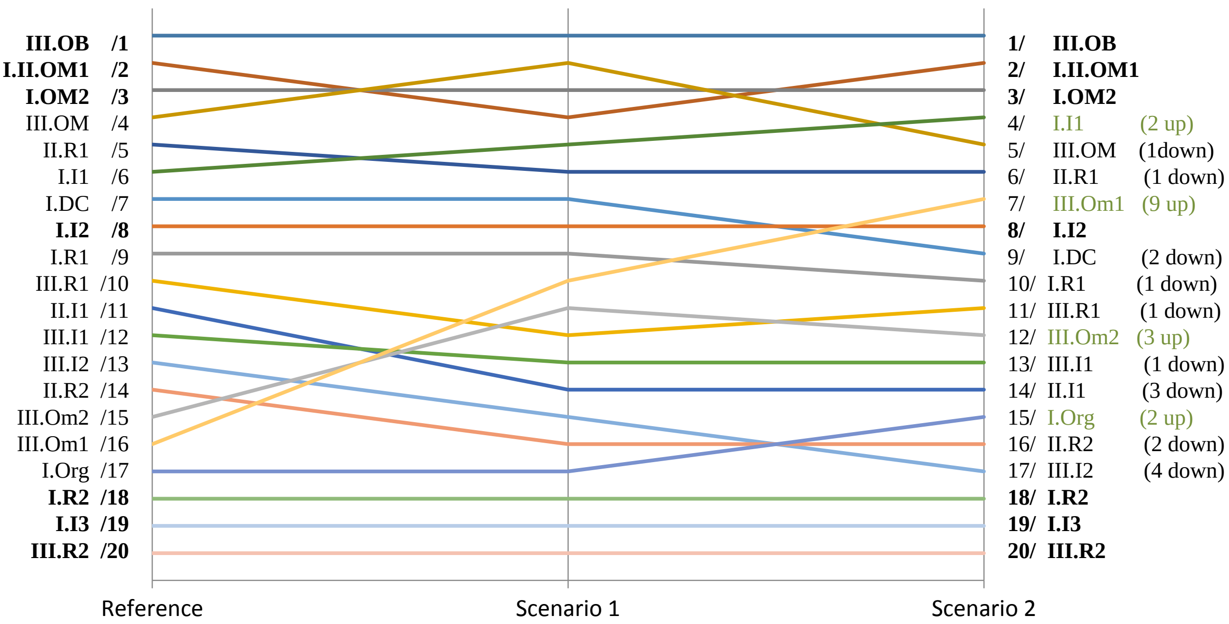
Concerning Scenario 1 (the corresponding model has a R^2 of 0.788 of Table 8), it is possible to observe an inversely proportional relationship between the CI variation and both competitiveness and cost structure. As the oil-dependent expenses decrease over the total production costs, the competitiveness increases (or the less it diminishes). In the same way, with lower initial competitiveness there will be a better, or more positive, reaction to price variation. This means that the most penalized production systems are those that today are the most competitive.

If the same analysis are done for Scenario 2, the predictive variables found are the same (model with $R^2 = 0.845$). However, in this case, competitiveness is preponderant and the relation is positive meaning that the most competitive production systems are those that lose less competitiveness. It is important to highlight that in Scenario 2 the only production system with an increase in competitiveness is III.Om1 (sheep breeding for milk production on a 10 ha area) because of its independence with regard to fossil fuels.

Hence, it is clear that it is difficult to foretell evolutions in competitiveness because of the great uncertainty which characterizes raw material, energetic and agricultural prices and their often opaque interrelations.

On the other hand, in what refers to the ranking among production systems on the basis of their competitiveness, it appears that the order is modified according to the considered scenario (Figure 6). As was detailed before, competitiveness does not change to the same extent for every production system. The ranking results are presented in Figure 6. Neither the most competitive nor the three least competitive production systems' positions are changed in the various scenarios considered. The production systems for which the ranking increases the most are those that breed sheep (for meat) because of their independence in regard to oil prices. On the other hand, the most affected systems are those with the largest irrigated areas, located in the "Interfluve" and the "Highlands" (II.I1 and III.I2) and the dairy cows breeding system (I.DC) because of their respective high production costs (fuel and animal food).

Figure 6. Production systems' rankings in both considered scenarios.



Bold font: production systems whose ranking is unchanged, Green font: production systems whose ranking has improved.

7. Conclusions

An agrarian production system's competitiveness is very difficult to explain because of the diversity of factors that come into play with regards to farm management. It is important to remember that today's agricultural systems are the result of both an historical process of differentiation between farms and a production means distribution process (labor force, land, capital). The economic performance of a production system cannot be exclusively explained by technical factors but has to be approached in a systemic way with a focus that goes from specific details to general aspects (bottom-up approach).

Nevertheless, this study tries to identify, among a series of variables considered pertinent after extensive field work, those which better explain competitiveness (as this last one was understood) for modeled production systems. Among the most important explicative factors, it is important to emphasize fertilization costs. During the interviews with local producers, the importance of these expenses was already perceived because they represent an important part of total production costs and because strategies and practices in that respect are considerably diverse. Farms' economic sustainability depends consequently on the reduction of fertilization costs. Practices such as crop rotation, legume growing and conservation agriculture (amongst others) that help to preserve and/or to restitute soil fertility are extremely important. On the other hand, the type of production system is also significant in explaining the CI. Countering the historical tendency observed in the region (and in many others) of progressive abandoning of livestock breeding (because of the high demand in labor, and as a consequence of critical moments that combined low prices and disadvantageous agrarian policies), mixed and dairy farms present, in general, better competitiveness results. Besides, they decrease manure fertilization costs.

Another important output of this study is that the subsidies do not determine the level of competitiveness, so in this case we can predict that future aids from the CAP reform will not modify the current competitiveness. That conclusion is obvious in a system of decoupled aids but it can help to determine who should be the target of the subsidies.

Given all the current uncertainties, price scenario possibilities are diverse. However, any scenario's impact would affect the production systems' competitiveness. If the forecasts formulated by the OEDC-FAO should reflect the reality in the future, the most affected production systems would be those which are currently the most competitive. This situation is explained by the great dependence that these production systems have on external factors. This argument needs to be considered when deciding subsidies' distribution so that the beneficiaries have ecologically friendly practices. It is fundamental that a specific disadvantageous situation does not shift agricultural practices towards a less sustainable production model. This is important for maintaining cattle breeding because reverting a decapitalization process is very difficult or virtually impossible in today's context.

With the objective of making propositions, and keeping sustainability in mind, these results allow the authors to orientate recommendations towards the implementation of legumes in crop rotations (not forgetting that there is a certain number of interesting endemic species of legumes in the area useful for human and animal consumption for which would be necessary to guarantee an outlet) and the maintenance of livestock breeding both for its contributions to soil fertility and its competitiveness (especially given the considered price scenarios).

The CAP is a key tool to condition and orientate agricultural development, and in that sense, its reform should prevent the proposed practices becoming an economical sacrifice for producers. In these contexts, the proposal about the green pay must only be oriented to certain sustainable production systems.

On the other hand, it is important to say that if the uncertainty regarding the evolution of oil prices is added to international agricultural price volatility, the possible evolutions in terms of competitiveness are diverse. In the probable case of an increase in oil prices, the most affected production systems would generally be those that are most competitive today because they are too dependent on fuel.

Acknowledgments

We appreciate the cooperation of farmers from the area of study that anonymously have been instrumental in the accomplishment of work. Christine Chambon has actively participated in data collection and in making the diagnosis of the study area. We also thank Aviva Bergman for her assistance in the review of the English translation of the original Spanish version of the paper.

Author Contributions

Research for this paper was designed by both authors, as well as the writing of the paper. Economic indicators and Competitiveness Index were calculated by Andrea Baudoin Farah and statistical treatment was performed by Almudena Gomez-Ramos. Price scenarios and discussion were developed by both authors. Also, want to thank the reviewers for their suggestion that has contributed to improve the final version of the paper.

Appendix

Equations (A1)–(A5): Calculating the Gross Product (GP, in 2013 Euros).

Market prices are represented by the symbol P (in €/kg), the average yield is represented by the symbol *y* (in kg/ha or kg/animal), the area dedicated to each crop by the symbol S (in ha) and the number of animals by the symbol N. For Equations (A2) and (A4), *i* represents the number of crops and *j* the number of animal products. The GP (Equation (A5)) is the addition of the Vegetal Gross Product (VGP; Equation (A1)) and the Animal Gross Product (AGP; Equation (A3)).

$$\text{For crops, } VGP = \sum_{k=1}^{i} GPk \quad \text{(A1)}$$

$$\text{For each crop } k, \quad GPk = yk \times Sk \times \mathrm{P}k \quad \text{(A2)}$$

$$\text{For animal products, } AGP = \sum_{k=1}^{j} GPk \quad \text{(A3)}$$

$$\text{For each animal product } k, \quad GPk = yk \times Nk \times Pk \quad \text{(A4)}$$

$$GP = VGP + AGP \quad \text{(A5)}$$

Equations (A6)–(A8): Calculating the Intermediate Consumptions (ICO, in 2013 Euros).

Total ICO are the addition (Equation (A8)) of Vegetal Intermediate Consumptions (VICO; Equation (A6)) and Animal Intermediate Consumptions (AICO; Equation (A7)).

$$VICO = \sum_{k=1}^{i} ICk \quad \text{(A6)}$$

$$AICO = \sum_{k=1}^{j} ICk \quad \text{(A7)}$$

$$ICO = VICO + AICO \quad \text{(A8)}$$

Equation (A9): Gross Added Value (GAV, in 2013 Euros).

$$GAV = GP - ICO \quad \text{(A9)}$$

Equations (A10) and (A11): Net Added Value (NAV, in 2013 Euros).

NAV is calculated by subtracting depreciations from GAV (Equation (A11)). The total depreciations (D, in 2013 Euros) are obtained using the purchase price (pp), the selling price (sp) and the years of actual use (α) of each equipment (Equation (A10) in which *m* represents the number of pieces of fixed capital of the production system considered).

$$D = \sum_{k=1}^{m} \left(\frac{ppk - spk}{\alpha k}\right) \quad \text{(A10)}$$

$$NAV = GAV - D \quad \text{(A11)}$$

Equation (A12): Family Income (FI, in 2013 Euros).

The FI provides the results of wealth distribution among stakeholders. To calculate the FI, subsidies (Sub) are added to the NAV (wealth transfer from society—through taxes–to producers). Capital remuneration (land leasing -LL- and financial expenses -FE-), work remuneration (salaries -Sal-), collective resources remuneration (irrigation and common pastures taxes –IT and CPT-) and risk remuneration (crop insurance Ins) are on the other hand deducted from the NAV.

$$FI = NAV + Sub - LL - FE - Sal - IT - CPT - Ins \quad \text{(A12)}$$

Equations (A13)–(A22): Competitiveness Index (CI)

- Agriculture

A profitability threshold (PT) was calculated for each crop (Equation (A19)). The symbol ϕ represents the price under which the GAV of a certain crop becomes negative and P that crop's market price.

In Equation (A13), S represents the area dedicated to each crop (in ha), *i* represents the number of crops, *TS* represents each production system's total arable area and *n* is an index to identify each production system.

$$\forall n \in [1; 20] \qquad CIn = \sum_{k=1}^{i} \frac{PTk \times Sk}{TSn} \quad \text{(A13)}$$

If we consider *p* crops, when there is fallow land, an "equivalent ICOs value" (ICO^{eq}) is calculated. In Equations (A14)–(A18), TS represents the total area of the *p* crops that are grown in rotation with the fallow land, Sf represents the fallow land area, S^{eq} represents the equivalent area, y^{eq}) represent the equivalent yields.

$$TS = \sum_{k=1}^{p} Sk \quad \text{(A14)}$$

$$S^{eq}k = Sk + \left(\frac{Sk}{TS} \times Sf\right) \quad \text{(A15)}$$

$$ICO^{eq}k = \frac{ICOk \times Sk}{S^{eq}k} \quad \text{(A16)}$$

$$y^{eq}k = \frac{yk \times Sk}{S^{eq}k} \quad \text{(A17)}$$

$$\varphi k = \frac{ICO^{eq}k}{y^{eq}k \times S^{eq}k} \quad \text{(A18)}$$

$$PTk = \frac{100 \times (Pk - \varphi k)}{Pk} \quad \text{(A19)}$$

- Livestock breeding

The area S represents the area that is dedicated to food production for a specific herd. If there are mixed herds (one for milk production and one for meat production, or one ovine and one bovine, *etc.*) each herd is attributed with a specific value of S. For a production system *n* with a total area TS, *i* crops and *j* animal products sold in the market, Equation (A20) can be established:

$$\forall n \in [1;20] \qquad CIn = \sum_{k=1}^{i} \frac{PTk \ \times Sk}{TS} + \sum_{k=1}^{j} \frac{PT^{L}k \times GPk}{AGP} \quad \text{(A20)}$$

To calculate the animal products' PTs every sub-product is taken into account. For each product, the price that would nullify the total livestock GAV (ϕ^L) is calculated (the other products' prices are fixed). In Equation (A21), AICO is the total of the ICO related to livestock breeding and N is the number of animals. A PT relative to each animal product is then obtained (PT^L; Equation (A22)).

$$\varphi^{L}k = \frac{AICO - \sum_{q=1, q \neq k}^{j} GPq}{yk \times Nk} \quad \text{(A21)}$$

$$PT^{L}k = \frac{100 \times (Pk - \varphi^{L}k)}{Pk} \quad \text{(A22)}$$

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Barco Royo, E. Sobre la PAC *y* sus reforma. Available online: http://www.upa.es/anuario_2012/pag_059-064_Barco.pdf (accessed on 7 November 2014). (In Spanish)
2. Frohberg, K.; Hartmann, M. Comparing measures of competitiveness. Available online: http://www.econstor.eu/bitstream/10419/28566/1/241163463.pdf (accessed on 7 November 2014).
3. Wei, F.; Kong, Y. Government governance, legal environment and sustainable economic development. *Sustainability* **2014**, *6*, 2248–2263.
4. Sgroi, F.; di Trapani, A.M.; Testa, R.; Tudisca, S. Economic sustainability of early potato production in the Mediterranean area. *Am. J. Appl. Sci.* **2014**, *11*, 1598–1603.

5. Massot Martí, A. España ante la refundación de la Política Agrícola Común de 2013. Available online: http://www.isn.ethz.ch/Digital-Library/Publications/Detail/?ots591=0c54e3b3-1e9c-be1e-2c24-a6a8c7060233&lng=en&id=103540 (accessed on 7 November 2014). (In Spanish)
6. Testa, R.; di Trapani, A.M.; Foderà, S.; Sgroi, F.; Tudisca, S. Economic analysis of process innovations in the management of olive farms. *Am. J. Appl. Sci.* **2014**, *11*, 1486–1491.
7. Trébuil, G.; Dufumier, M. Regional Agrarian Systems and Sustainability of Agricultural Production Systems in Thailand. *J. Asian Farm. Syst. Assoc.* **1993**, *1*, 557–568.
8. Rico González, M.; Gómez García, J.M. Mujeres y despoblación en el medio rural de Castilla y León. *Revista de Estudios sobre Despoblación y Desarrollo Rural* **2003**, *3*, 151–184. (In Spanish)
9. Lorite, I.J.; Arriaza, M. Effects of the EU agricultural subsidies on the irrigation management in Spain. In Proceedings of the International Cotton Conference on "Rationales and Evolution of Cotton Policies", Montpellier, France, 13–17 May 2008.
10. Martínez Gómez, V.; García Álvarez-Coque, J.M. El problema de la inestabilidad de los precios de los alimentos: Importancia y soluciones. Available online: http://cedla.org/sites/default/files/Inestabilidad.pdf (accessed on 7 November 2014). (In Spanish)
11. Bejarano Ávila, J.A. Elementos para un enfoque de la competitividad en el sector agropecuario. Available online: http://repiica.iica.int/DOCS/B0103E/B0103E.PDF (accessed on 7 November 2014). (In Spanish)
12. Dufumier, M. Understanding complexity: Classification of farm holdings for diagnostic analysis of agrarian situations. *Rural Extens. Bull.* **1995**, *7*, 17–23.
13. Acs, S.; Hanley, N.; Dallimer, M.; Gaston, K.J.; Roberston, P.; Wilson, P.; Armsworth, P.R. The effect of decoupling on marginal agricultural systems: Implications for farm incomes, land use and upland ecology. *Land Use Policy* **2010**, *27*, 550–563.
14. Tudisca, S.; Sgroi, F.; Testa, R. Competitiveness and sustainability of extreme viticulture in Pantelleria Island. *New Medit.* **2014**, *10*, 57–64.
15. Sgroi, F.; di Trapani, A.M.; Testa, T.; Tudisca, S. Strategy to increase the farm competitiveness. *Am. J. Agric. Biol. Sci.* **2014**, *9*, 394–400
16. Atance, I.; Barreiro, J. CAP MTR *versus* environmentally targeted agricultural policy in marginal arable areas: Impact analysis combining simulation and survey data. *Agric. Econ.* **2006**, *34*, 303–313.
17. Maletič, M.; Maletič, D.; Dahlgaard, J.J.; Dahlgaard-Park, S.M.; Gomišček, B. Sustainability exploration and sustainability exploitation: From a literature review towards a conceptual framework. *J. Clean. Prod.* **2014**, *79*, 182–194.
18. San Miguel Tabernero, P. *Opiniones Sobre El Proyecto De Reforma De La PAC*; Fundación de Estudios Rurales: Madrid, Spain, 2012; pp. 88–92. (In Spanish)
19. Cropper, M.R.; del Pozo-Ramos, M. Impacts of CAP reforms on animal production systems. *Grassl. Sci. Eur.* **2006**, *11*, 615–623.
20. Gallardo, R.; Ramos, F.; Ramos, E. Perturbaciones provocadas por la nueva PAC en las decisiones de ajuste estratégico en sistemas agrarios andaluces. *Econ. Agrar. Recurs. Nat.* **2002**, *2*, 131–152. (In Spanish)
21. Tudisca, S.; di Trapani, A.M.; Sgroi, F.; Testa, R. Organic farming and economic sustainability: The case of Sicilian durum wheat. *Qual. Access Success.* **2014**, *15*, 93–96.

22. Ramírez Estévez, G. *Atlas del territorio de Castilla y León*, 1st ed; Junta de Castilla y León: Valladolid, Spain, 1995. (In Spanish)
23. Apollin, F.; Eberhart, C. Análisis y diagnóstico de los sistemas de producción en el medio rural, Guía metodológica. Available online: http://www.avsf.org/public/posts/549/analisis-y-diagnostico-de-los-sistemas-de-produccion-en-el-medio-rural-guia-metodologica.pdf (accessed on 7 November 2014). (In Spanish)
24. European Commission. Proposal for a regulation of the European Parliament and of the council, Establishing rules for direct payment schemes for farmers under the Common Agricultural Policy. Available online: http://ec.europa.eu/agriculture/cap-post-2013/legal-proposals/com625/625_en.pdf (accessed on 7 November 2014).
25. Oñate, J.J.; Atance, I.; Bardají, I.; Llusia, D. Modeling the effects of alternative CAP policies for the Spanish high-nature value cereal-steppe farming systems. *Agric. Syst.* **2007**, *94*, 247–260.
26. Baudoin Farah, A.; Chambon, C. Analyse-diagnostic des systèmes agraires d'une région céréalière de la Province de Palencia à l'aube des reformes de la PAC. **2011**, unpublished work. (In French)
27. Energy Information Administration. Liquid fuels. Available online: http://www.iea.org/publications/freepublications/publication/WEO2011_WEB.pdf (accessed on 7 November 2014).
28. Organization for Economic Co-operation and Development and United Nations' Food and Agriculture Organization (OEDC-FAO). OCDE-FAO Agricultural Outlook 2011–2020. Available online: http://www.oecd.org/site/oecd-faoagriculturaloutlook/48202074.pdf (accessed on 7 November 2014).