# Evaluating Agricultural Sustainability in Spanish Provinces

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**Abstract**

We provide a sustainability assessment of Spanish agriculture at provincial scale using a multidimensional set of indicators selected according to established frameworks for sustainable development, their relevance in the Spanish context and data availability. Results point to the existence of four clusters of provinces according to their performance in terms of agricultural sustainability. Higher economic sustainability in provincial agriculture seems to be mostly associated to more intensive use of agricultural labour and agricultural machinery and where wealth growth is faster. Social sustainability seems to be linked to higher diversification of economic activities and quality productions under PDO and PGI. Best environmental sustainability is achieved where the extension of agricultural land is larger, where less agricultural area is burned, and where there is better carbon stock and sequestration by agricultural ecosystems. It is expected that results could improve policy coherence and decision-making for more sustainable agricultural systems in Spanish regions.
*Keywords:* Sustainable agriculture, indicators, Spanish provinces.

## 1. Introduction

Sustainability stands among most relevant topics in agricultural research worldwide and Spain is no exception. The increasing concerns regarding the deterioration of natural resources on which agricultural output and rural economies rely are behind this development. Revealed evidence suggests that biodiversity conservation, environmental protection and social empowerment are preconditions for medium and long-term sustainable economic development.

In Europe, sustainability has been gaining momentum within the policy debate on the future of the Common Agricultural Policy (CAP) currently underway (European Commission, 2017). The objectives of the future CAP tend to be designed in a direct linkage to the principles of sustainable development as conceived in international frameworks such as the Sustainable Development Goals (SDGs) (Figure 1). In addition, objectives and targets for specific themes (e.g. climate change mitigation, water management) should be strongly aligned to relevant frameworks such as the 2030 climate and energy package of the Paris Agreement (COP21). This means that targets should be formulated to ensure that European agriculture contributes in a significant manner to the achievement of the commonly agreed international objectives.

Moreover, the concept of sustainability should be applicable at multiple levels (EU, national, regional) in order to provide policy coherence between the different administrative levels and ensure that resources are directed towards specifically established targets. This requires the formulation of clear and tangible objectives according to national and regional priorities, taking into account both the structure of the agricultural sector and international obligations.

Despite the interest of sustainable agricultural systems at administratively smaller units such as provinces, no studies have been conducted in this area in Spain to the best of our knowledge. This study contributes to overcome this limitation. Its objective is twofold: 1) to propose a conceptual approach to selecting a multidimensional set of sustainability indicators suggested as most relevant for Spanish agriculture, and 2) to provide a quantitative measurements for these indicators at provincial scale (Spain is administratively divided into 17 Autonomous Communities and 50 provinces).


**Figure 1: The CAP commitment to SDGs**. Source: European Commission (2017).

This type of assessment can be especially useful for national and regional public managers when taking locational decisions aiming at prioritising practical actions including i) coordination of national agricultural policy, ii) distribution of CAP and national agri-environmental payments to farms and regions, iii) orientation of regional agricultural policies though differentiated interventions in specific provinces due to their singularities and the existence of territorial boundaries with administrative competence at that level, iv) enhancing sustainable agricultural practices where appropriate, e.g. organic and integrated productions, v) providing resources to provinces with high risk of rural depopulation and major socio-economic vulnerability.

## 2. Research methodology

### *2. 1. Indicator selection and data collection*

Based on a review of the specialised literature and international indicator systems used in assessing sustainable agriculture (Costanza et al., 1997; Spangenberg, 1998; European Commission, 2006; Pintus and Giraud, 2009; Rametsteiner et al., 2011; Pülzl et al., 2012; FAO, 2014; Wustenberghs et al., 2015; Schader et al., 2017), 22 agricultural sustainability indicators have been selected in this study: eight economic, five social and nine environmental indicators (see detailed description of indicators in Appendix 1). The selection process of indicators has been carried out based on three premises: the coherence with the established frameworks for sustainable development (UN, OECD, EU frameworks, see e.g. Kniivilä et al., 2012; Wustenberghs et al., 2015), the relevance of these indicators in the Spanish context, and data availability at provincial level.

The approach used allows transforming general and to large extent abstract frameworks to a concrete proposal of a consistent set of indicators that can be quantified, monitored and evaluated. Selected indicators should capture strategic sustainability goals. They should be independent as much as possible from each other. Their number should not be very large in order to avoid major inconsistencies. Small sets of indicators are more effective and keep the focus on truly important factors. It should be pointed out that several indicators conceptually relevant for sustainable agriculture (e.g. soil quality, animal health, water and pesticide usage, risk management, working conditions, gender balance – see for instance FAO, 2014; Poppe and Vrolijk, 2018) have not been included due to the lack of data at the required spatial scale.

### *2.2. Data analysis and statistical methods*

Statistical and spatial analyses were performed by means of SPSS v22 and ARC-GIS v10.3, respectively. The original data were transformed (TfV: transformed values) in line with the method proposed for calculating each indicator, and are expressed in the corresponding unit of measurement. In some cases, the raw data were related to surface units to make them comparable and to establish a ranking of provinces.

With regard to four indicators that are considered a threat for social (SO1, SO3) and environmental (EN5, EN8) sustainability, the original values of the indicators were reversed deducting them from 100 (best sustainability), in order to be added to the rest of indicators which are positively correlated to social and environmental sustainability of each province. Indeed, this operation was not necessary for the rest of indicators because the desirable trends move in an upward direction in terms of positive sustainability added value.

Following the recommendations of Morse and Fraser (2005) and in order to standardise the data and achieve normalised values (NV), the TfV were divided by a target value (TV) for each indicator, this being the desirable threshold in the context of sustainability (Maes et al., 2011), so that:

$$NV_i = \frac{TfV_i}{TV} \qquad (1)$$

$$i = 1 \ldots 50 \; provinces$$

Table 1 provides detailed information about the extreme values (minimum, maximum) as well as the target values used and how these have been established for each indicator. In some cases, the forecasts and targets set in territorial strategies (e.g. Convention on Biological Diversity; scenarios on agricultural land by Prieto and Ruiz, 2008) were taken into account. In other cases the target value is established at level 100 expressing a no-loss situation (EC7, EN2). However, for most indicators where there are no clear, widely accepted references in the scientific literature, the regulatory setting or the agriculture sectoral plans, the distribution of frequency of values for each province was considered and the target value was set at percentile 85.

At this stage, a decision on whether or not to apply weights to the different indicators was necessary, taking into account that some of selected indicators are considered by international systems to have priority while others are considered complementary. However, several authors (e.g. Böhringer and Jochem, 2007) indicate that the processes of assigning weights usually are very arbitrary. In view of this controversy, no weights have been assigned to indicators despite their unequal relevance and priority. In this study all the indicators are considered equally.

**Table 1. Extreme and target values by selected agricultural sustainability indicator.**

| Sustainability dimension | Code | Indicator | Lowest value (LV) | Highest value (HV) | Target value (TV) | |
|---|---|---|---|---|---|---|
| | | | | | Value | Criterion used |
| Economic | EC1 | Agricultural productivity | 11 892.93 | 86 723.98 | 40 488.53 | 85th percentile of data set |
| | EC2 | Capital stock | 1 006.20 | 11 242.17 | 7 551.18 | 85th percentile of data set |
| | EC3 | Rural development | 1.53 | 39.49 | 23.83 | 85th percentile of data set |
| | EC4 | Agricultural labour intensity index | .72 | 63.28 | 12.68 | 85th percentile of data set |
| | EC5 | Full time farmers | .45 | 20.51 | 9.13 | 85th percentile of data set |
| | EC6 | Agricultural machinery intensity index | 1.72 | 63.77 | 23.34 | 85th percentile of data set |
| | EC7 | Variation in per capita Gross Domestic Product (GDP) | 76.27 | 105.76 | 100 | 100 (no loss in per capita GDP) |
| | EC8 | Investment in R&D | .0035 | .0190 | .0149 | 85th percentile of data set |
| Social | SO1 | Farmers aging index | 28.56 | 58.83 | 50.47 | 85th percentile of data set |
| | SO2 | Non-farm enterprises | 35.66 | 98.41 | 68.00 | Median of data set, in this case 68.00 |
| | SO3 | Small farms | 4.06 | 81.06 | 62.40 | 85th percentile of data set |
| | SO4 | Salaried labour | 3.47 | 80.61 | 53.18 | 85th percentile of data set |
| | SO5 | Quality areas | 28.62 | 100.00 | 100.00 | Best of the serial data - value already reached by more than 50% of provinces |
| Environmental | EN1 | Agricultural land | 14.14 | 81.20 | 45.00 | According to Prieto and Ruiz (2008), it is expected that the agricultural area of Spain will be equivalent to 45% of the total area in 2030 |
| | EN2 | Variation of agricultural land | 80.35 | 100.35 | 100.00 | 100 (no loss in agricultural land) |
| | EN3 | Organic farming | .10 | 43.55 | 10.30 | 85th percentile of data set |
| | EN4 | Livestock pressure | .30 | 5.52 | 1.80 | 85th percentile of data set |
| | EN5 | Burned agricultural area | 96.95 | 100.00 | 99.80 | We hypothesize that 0.2% of agricultural area will be burned by 2030, the same proportion expected for forest area according the Spanish Forestry Plan 2002-2032 |
| | EN6 | Terrestrial protected areas | .08 | 65.17 | 17.00 | In the Convention on Biological Diversity, Goal 11 of Aichi proposes that by 2020 at least 17% of terrestrial and inland water areas must be protected |
| | EN7 | Natura 2000 network | 2.51 | 34.56 | 17.00 | Idem EN6 |
| | EN8 | Soil erosion | 37.60 | 96.11 | 90.45 | 85th percentile of data set |
| | EN9 | Carbon stock | 53 881.16 | 9 639114.83 | Dynamic | TV is dynamic in each province searching for at least a balance between CO2 emissions and captures |

Source: Authors' construction.

In the next stage, the normalised indicators relating to each sustainability dimension were integrated in a unique index for the purpose to obtaining, for each province, one index for economic sustainability (ECSI), another for social sustainability (SOSI) and another for environmental sustainability (ENSI). The average value for each dimension (economic, social and environmental) was calculated using the following equations:

$$ECSI_i = (Mean\ (EC1_i, \dots, EC8_i) - 1) \times 100 \quad (2)$$
$$SOSI_i = (Mean\ (SO1_i, \dots, SO5_i) - 1) \times 100 \quad (3)$$
$$ENSI_i = (Mean\ (EN1_i, \dots, EN9_i) - 1) \times 100 \quad (4)$$
$$i = 1 \dots 50\ provinces$$

The values obtained for the economic, social and environmental indices for the agricultural sector in each province were transformed into Z units in order to harmonise their measurements. This was done using the following formula:

$$Z_i = \frac{X_i - \overline{X}}{\hat{\sigma}_X} \quad (5)$$

Where $X_i$ are values resulting from operations (2), (3) and (4), $\overline{X}$ the mean of the series (50 provinces), and $\hat{\sigma}_X$ the standard deviation of the series. $Z_i$ indicates how many units each province is away from the general mean. Z scores are designed in such a way that users know if a province is above or below average and by how much. With this design, obviously, the average is zero and the standard deviation is 1.

Subsequently, a k-means cluster analysis on the standardised values of the three indices was performed in order to classify the Spanish provinces in relatively homogeneous groups according to their economic, social and environmental characteristics in the agricultural sector. Lastly, the positioning of the 50 provinces studied was shown graphically to compare their relative positions regarding each sustainability dimension.

## 3. Results

According to the integrated sustainability dimension indices resulting from operations (2), (3) and (4), only three provinces (6%) are above the desirable minimum value (target value) for economic sustainability (values above zero): A Coruña, Pontevedra and Santa Cruz de Tenerife. In the meantime, no province reaches the desirable minimum value for social sustainability, while 28 provinces (56%) surpass the established target values for environmental sustainability.[1]

Conversely, once these data are normalized (Z values), the positions of different provinces in different indices can be directly compared, and it is visually easy to notice whether a province is above or below average (zero) and by how much. Table 2 summarises the normalized values reached in each province in the economic, social and environmental sustainability indices, and indicates the cluster to which each province belongs.

[1] Note that at this stage these indices just represent the integration in one value for each province of the values of all indicators of the corresponding sustainability dimension, allowing a ranking of provinces within each dimension but not comparisons across dimensions.

**Table 2. Normalized values (Z) of sustainability indices and grouping of provinces.**

| Cluster | Province name | Z-ECSI | Z-SOSI | Z-ENSI |
|---|---|---|---|---|
| 1 | Álava | .23567 | .06047 | -1.21002 |
| | Alicante | -.06283 | -1.30247 | .33438 |
| | Almería | .50368 | -.83074 | .17179 |
| | Asturias | .32236 | -.68014 | -.67319 |
| | Ávila | -.57997 | -.46249 | -.53317 |
| | Cantabria | .49215 | -.59168 | -.95342 |
| | Castellón | -.25010 | -1.23613 | .44213 |
| | Ciudad Real | -1.12803 | .06333 | .04305 |
| | Cuenca | -.79398 | -.14511 | -.92607 |
| | Guadalajara | -.90163 | -.73908 | -.85478 |
| | León | -.15300 | .04910 | -.98702 |
| | Madrid | -.32981 | -.01857 | -.03073 |
| | Palmas, Las | .59035 | .00284 | .41489 |
| | Teruel | -.22561 | -.35073 | -1.10441 |
| | Valencia | .07453 | -1.33040 | .73070 |
| | Zamora | -.29918 | .03415 | .08309 |
| 2 | Coruña, A | 2.23977 | -1.58990 | -.77717 |
| | Guipúzcoa | .95158 | -1.82564 | -1.03559 |
| | Lugo | 1.59810 | -.76542 | .11038 |
| | Ourense | .97567 | -1.30399 | -.86675 |
| | Pontevedra | 2.76118 | -1.71282 | -1.39656 |
| | Santa Cruz de Tenerife | 3.02382 | .10824 | .56617 |
| | Vizcaya | .65626 | -2.28596 | -1.12941 |
| 3 | Albacete | -1.00878 | .54521 | -.54505 |
| | Barcelona | 1.05291 | .30746 | -.71691 |
| | Burgos | -.36056 | .78483 | -1.13567 |
| | Girona | .54998 | 1.46797 | -.10676 |
| | Huesca | -.29163 | .92242 | -.77150 |
| | Lleida | -.19873 | .99908 | .46460 |
| | Navarra | .15733 | .40545 | -.30797 |
| | Palencia | .69634 | 1.33972 | -.70445 |
| | Rioja, La | .85245 | .38243 | -.61960 |
| | Salamanca | -.70390 | 1.01322 | .28122 |
| | Segovia | -.54879 | 1.50733 | -.63035 |
| | Soria | .29586 | 1.01569 | -1.06106 |
| | Valladolid | .29364 | 1.96862 | -.27887 |
| | Zaragoza | -.85630 | 1.00210 | -.60789 |
| 4 | Badajoz | -1.23007 | .44775 | .61609 |
| | Baleares | -.42362 | -.41867 | .68566 |
| | Cáceres | -1.66964 | -.16310 | 1.20293 |
| | Cádiz | -.27508 | .95820 | 1.49708 |
| | Córdoba | -1.16906 | 1.02796 | 1.32213 |
| | Granada | -1.04827 | .43923 | .55216 |
| | Huelva | .23172 | 1.78891 | 3.60461 |
| | Jaén | -1.36536 | -1.45722 | 1.89115 |
| | Málaga | -1.21869 | -.21087 | .87715 |
| | Murcia | .26039 | .88636 | 1.20089 |
| | Sevilla | -.65818 | .10259 | .98278 |
| | Tarragona | .12225 | -.40924 | 1.65097 |
| | Toledo | -1.18717 | .19971 | .23835 |

Hierarchical clustering of the three standardised sustainability indices yielded four clearly distinguishable groups of provinces (Table 3). The discriminant analysis suggests that, originally, the four groups are already clearly separated. Cluster 1 presents balanced values in all three sustainability dimensions, cluster 2 presents rather high values for economic sustainability and low values for social sustainability, cluster 3 includes provinces with high values for social sustainability, while the provinces of cluster 4 presents high values for environmental sustainability.

**Table 3. Average values of sustainability indices in each cluster of provinces (Z values).**

| | Cluster | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Z-ECSI | -.15659 | 1.74377 | -.00501 | -.74083 |
| Z-SOSI | -.46735 | -1.33935 | .97582 | .24551 |
| Z-ENSI | -.31580 | -.64699 | -.48145 | 1.25554 |
| Nº provinces | 16 | 7 | 14 | 13 |

Figure 2 presents the distribution of the provinces belonging to each cluster by agricultural sustainability dimension. As shown, no province is highly positioned simultaneously in all dimensions. Higher economic sustainability of the agricultural sector is observed mainly in Northern provinces and seems to be associated to more intensive use of agricultural labour (number of annual agricultural work units per 100 ha of tilled farmland) and agricultural machinery (agricultural machines density per 100 ha of cultivated area), as well as to higher increase of average wealth in the province (variation in per capita GDP 2004-2014).

Meanwhile, social sustainability seems to be positively associated with higher diversification of economic activities (higher proportion of non-farm enterprises in total firms operating in the province), lower share of small farms (less than 10 ha), and higher share of agricultural area under Protected Designations of Origin (PDO) and Protected Geographical Indications (PGI).

As for environmental sustainability, the best positioned provinces are those where there are a higher share of agricultural and grassland area in total province area combined with higher increase of this share between 2006 and 2012, where there has been less burned agricultural area between 2006 and 2012 in proportion of total agricultural land, and where there is better carbon stock and sequestration by agricultural ecosystems and grassland of the province.

## 4. Discussion and conclusion

Despite the interest and topicality of sustainable agriculture analysis at regional level, very few studies have been conducted in this area in Spain and actually none at provincial scale. The results show significant discrepancies in agricultural sustainability between different groups of provinces as well as by sustainability dimension. No Spanish province is highly sustainable simultaneously in all dimensions. This indicates that, overall, despite the increased awareness and efforts undertaken in implementing sustainable agriculture principles in Spain, still many agricultural areas are far from minimum desirable sustainability levels from a balanced, multidimensional perspective.

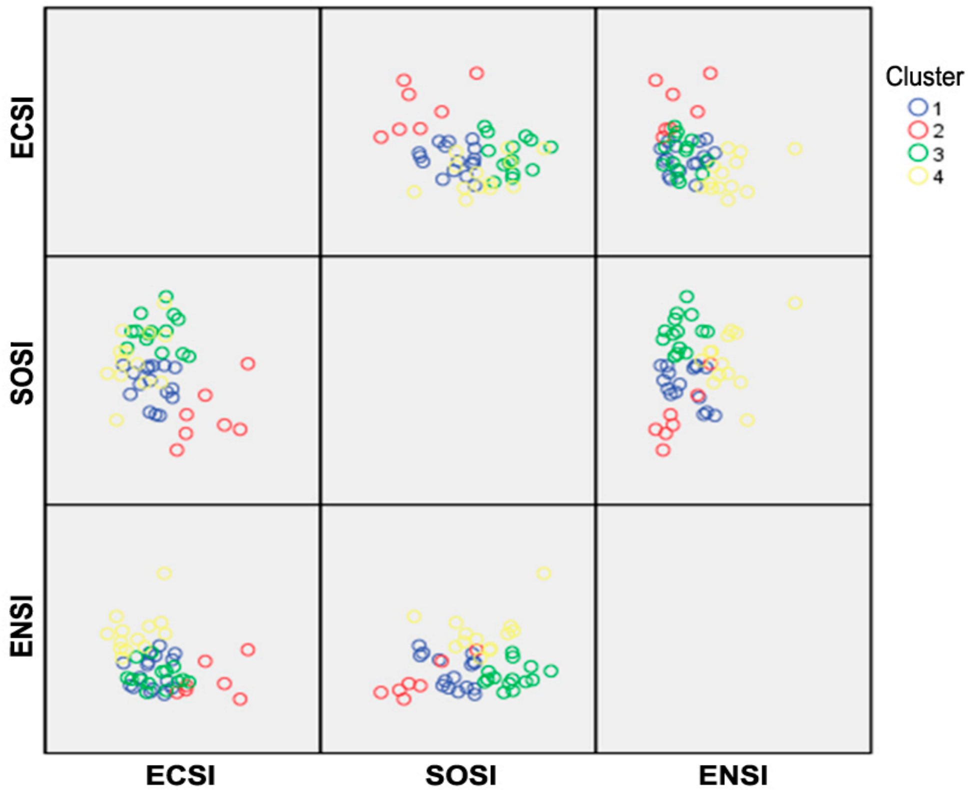


**Figure 2: Distribution of clusters of provinces according to their agricultural sustainability.**

Higher economic sustainability in provincial agriculture seems to be associated to more intensive use of agricultural labour and agricultural machinery and where wealth growth is faster. Social sustainability seems to be linked to greater diversification of economic activities and quality productions under PDO and PGI. Best environmental sustainability is achieved where the extension of agricultural land is larger, where less agricultural area is burned and where there is better carbon stock and sequestration by agricultural ecosystems.

The approach used and the results obtained provide a reference point that may be of use to policymakers when designing or adjusting socio-economic and environmental policies related to agriculture. As stated by Schader et al. (2017), sustainability assessment can support agricultural policy, *inter alia*, in designing and targeting agricultural policy more effectively according to the principles of sustainable development and according to societal needs, in monitoring and controlling the sustainability performance, in allocating payments according to the degree of achieving sustainability goals, and in enabling farmers to develop individual farm sustainability strategies in line with the sustainability goals.

Data standardisation makes it easier to compare different geographical areas. Thus, the methodology used can be replicated (with the necessary adaptations) in other countries, especially those presenting similar agricultural ecosystems. However, still there are methodological caveats that need to be explored and resolved in future research. For instance, the debate concerning the convenience to integrate indicators with or without weights remains open. Furthermore, the analysis performed is primarily static. It would be desirable to build a time series data making possible to analyse agricultural sustainability in a dynamic way over time and adapt agricultural policy according to the results achieved.

Another controversial point is the feasibility of using, for each indicator, a common target value for whole Spain or, alternatively, a dynamic and different target value adapted to the peculiarities of each province (in this study dynamic values have been used only for indicator EN9: carbon stock). A priori, this idea is suggestive though its implementation could hinder the comparison of results by province and with the national average, in addition to the complexity to finding target values adapted to the specificities of each province.

Meanwhile, the follow-up to this research will be, on the one hand, consulting key stakeholders and experts involved in sustainable agriculture in order to get their views and suggestions about the approach used and the ways to ensure further practical utility of the results. On the other hand, different thresholds for sustainability target values and different weighting methods will be applied to the selected indicators in order to explore their impact on the results.

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**Appendix 1. Indicator description.**

| Sustainability dimension | Sustainability indicator code | Indicator definition | Indicator measurement | Data source |
|---|---|---|---|---|
| Economic | EC1 | Agricultural productivity | Ratio of gross value added in agriculture, livestock and fisheries, and work units per year, AWU (€/AWU). | National Statistical Institute (NSI) and Agricultural Census 2009. http://www.ine.es/CA/Inicio.do?locale=en_US |
| | EC2 | Capital stock | Market value of tangible assets in agriculture per labour unit (€/AWU). | Sources: BBVA Foundation, NSI |
| | EC3 | Rural development | Share of public support allocated to rural development programmes (2008), in %. | Sineiro et al. (2011) |
| | EC4 | Agricultural labour intensity index | Number of annual agricultural work units per 100 ha of tilled farmland (AWU/100 ha). | Agricultural Census 2009, NSI |
| | EC5 | Full time farmers | Ratio of full time farmers whose main professional activity takes place in the farm to the total number of registered farmers (in %). | Agricultural Census 2009, NSI |
| | EC6 | Agricultural machinery intensity index | Agricultural machines density per 100 ha of cultivated area. | Census of machinery 2010, MAPAMA. http://www.mapama.gob.es/es/agricultura/temas/medios-de-produccion/maquinaria-agricola/estadisticas/ |
| | EC7 | Variation in per capita Gross Domestic Product | Index base 100 in constant prices: $EC7 = \frac{GDP2014/cap}{GDP2004/cap} X100$ | NSI:http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736167628&menu=resultados&idp=1254735576581 |
| | EC8 | Investment in R&D | Ratio of investment in research and development per Gross Domestic Product | 2013, BBVA-IVIE and NSI |
| Social | SO1 | Farmers aging index | Ratio of farmers older than 55 years to the total number of farmers (in %). The value of this indicator has been reversed (100 – indicator value) in order to be additive to other indicators positively related to sustainability. | Agricultural Census 2009, NSI |
| | SO2 | Non-farm enterprises | Percentage of non-farm enterprises in total. | Agricultural Census 2009, and Central Business Directory 2009, NSI:http://www.ine.es/dynt3/inebase/en/index.htm?padre=51&dh=1 |
| | SO3 | Small farms | Percentage of farms with an acreage of less than 10 ha. The value of this indicator has been reversed (100 – indicator value) in order to be additive to other indicators positively related to sustainability. | Agricultural Census 2009, NSI |
| | SO4 | Salaried labour | Share of paid work units in total work units per year. | Agricultural Census 2009, NSI |
| | SO5 | Quality areas | Share of agricultural area and grasslands under Protected Designations of Origin and Protected Geographical Indications. | MAPAMA:http://www.mapama.gob.es/es/cartografia-y-sig/ide/descargas/ |

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| Environmental | EN1 | Agricultural land | Share of agricultural and grassland area in total area. | Copernicus Land Monitoring Services (2016b). Pan-European. CORINE-Land Cover, CLC 2012. 18.5 version. http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012/view Accessed 26 June 2018 and GIS data (Total surface –of each province) |
| | EN2 | Variation of agricultural land | Variation of agricultural land and grassland between 2006 and 2012.The difference is quantified relative to 100 (100=base index value CLC2006 surface). | CORINE Land Cover maps 2006 and 2012 |
| | EN3 | Organic farming | Share of organic land in total agricultural land (CLC 2012). | MAPAMA, 2012 & CLC 2012 |
| | EN4 | Livestock pressure | This indicator can be interpreted from different perspectives. From the environmental point of view, we have considered it as positive: livestock keeps a less dense vegetation cover, hence the wildfire risk is lower. | Agricultural Census 2009, NSI for Animal Units and CLC2006 for Permanent Pastures Area |
| | EN5 | Burned agricultural area | Percentage of the burned agricultural area (BAA) between 2006 and 2012 with respect to the total agricultural land (AL): $EN5 = 100 - \left[\frac{\sum_{2006}^{2012} BAA}{AL} \times 100\right]$ The value of this indicator has been reversed (100 – indicator value) in order to be additive to other indicators positively related to sustainability. | CLC 2012 and European Forest Fire Information System – EFFIS http://effis.jrc.ec.europa.eu, European Commission Joint Research Centre. San Miguel-Ayanz et al. (2012) |
| | EN6 | Terrestrial protected areas | Percentage of terrestrial protected areas (Nationally Designated Spaces and Biosphere Reserves) located in agricultural areas over the total arable land | Database of Biodiversity (MARM-Ministry of Environment), GIS of Europarc-Spain and GIS data, CLC 2012 |
| | EN7 | Natura 2000 network | Percentage of area occupied by areas under Natura 2000 network (Special Protection Areas for Birds, SPA, Sites of Community Importance, SCI, Habitats of Community Importance priority) in agricultural areas over arable land | Database of Biodiversity (MARM-Ministry of Environment), GIS of Europarc-Spain and GIS data, CLC 2012 |
| | EN8 | Soil erosion | Percentage of geographical area (ha) affected by intense or extremely intense laminar and gully erosion (>25 ton/ha/year) in total erodible surface. The value of this indicator has been reversed (100 – indicator value) in order to be additive to other indicators positively related to sustainability. | National Inventory of Soil Erosion and statements erosive map (1987-2002) |
| | EN9 | Carbon stock | First we have calculated the $CO_2$ sequestration made by the agricultural ecosystems and grasslands of each province taking into account the surface area of each class of CORINE Land Cover 2012 (LC). Then, we have applied a coefficient of $CO_2$ density (D) - tons/ha (Cruickshank et al., 2000; Molin et al., 2010, OSE, 2011 and our modification). Second we have considered emissions (E) related to agricultural management in 2012 (FAO, 2018) in each province based on the area occupied by these ecosystems. The indicator is the ratio: $EN9 = \left[\frac{\sum_{i=0}^{n} LC \times D}{E}\right]$ The target value is dynamic looking for at least a balance between CO2 emissions and sequestration in each province. | CLC 2012 & FAO 2018 (http://www.fao.org/faostat/en/#country/203) |