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THE SUSTAINABILITY OF ITALIAN AGRICULTURE: A SET OF INDICATORS

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***Abstract**: This paper provides an overview of the INEA work on sustainability indicators. Sustainability evolution of the Italian Agriculture is summarised using a set of indicators that take into account social, economic and environmental dimensions of agriculture. The paper concludes giving a schematic representation of the Italian agriculture progress towards sustainability.*

1. Introduction

This contribution is based on a report, prepared by INEA, whose purpose was the assessment of the progress of Italian agriculture towards the path of sustainability, through the selection and implementation of a set of indicators.

Sustainable developments at sectoral (i.e. agriculture) and territorial (rural areas) level represents a main objective of the European Union strategy, as can be derived from many of the most recent documents. They state that "all policies" - such as those implemented through Structural Funds - "must have sustainable development as their core concern" (European Commission, 2001).

Early studies on sustainability were developed by the United Nations immediately after the Rio Summit. It followed the work of OECD during the nineties, which adopted the PSR - *Pressure, State, Response* framework to represent agriculture-environment relationships. Together with the activities of the Joint Research Centre and EUROSTAT, the European Commission developed a series of indicators aimed at assessing the V Framework Programme progress. Important studies on sustainability were produced also at national level; among these we can cite the experience of Australia (Commonwealth of Australia, 1998), Finland (Aakkula, 2000), United Kingdom (MAFF, 2000) and Canada (McRae T. *et al*., 2000).

What comes out is that there is no universally accepted definition of the concept of sustainability, nor general consensus on its representation. Even if one start from a common base concept, the parameters chosen are different and vary consistently by context, data availability, and researcher background.

Indeed a crucial aspect attains the definition of sustainability. That is, make a choice within the numerous definitions one finds in literature, and the subsequent meanings and interpretations. In fact there is no universally agreed definition of the concept of sustainability.

In this contribution we adopt the definition included in the Brundtland report (WCED, 1987, p. 43). The latter is the most widely quoted and generally accepted, especially at institutional level. According to this very broad definition "sustainable" is that "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This approach to sustainability underpins an opportunities-based view. The idea of preservation of opportunities implies the maintenance of the productive potential of the economy. The latter will be achieved if variations in the stock of productive assets (labour and all other productive resources) allow output non-declining over time. Moreover, this definition implies problems of substitutability between productive assets, raising the issue of distinction between strong and weak sustainability. Whatever the adopted definition the "operational" interpretation of the concept of sustainability includes a multidimensional dimension: environmental, social and economical.

Further defining problems and complexities emerge expressing the notion of sustainability with reference to a particular economic sector, namely the agriculture. In order to provide useful insight for policy makers, avoiding sectoral policy inconsistency, it is, indeed, necessary to take into account interactions between agriculture and other economic sectors, being the sustainability of the economic system as a whole the ultimate aim.

In this contribution we analyse sustainability, in its three dimensions - namely economic, social and environmental, with reference to the agricultural activity, taking into account the rural areas.

Territorial dimension is taken into account recognising regional specificity and differences in space of interactions between the environment, the economy and society.

To take informed decisions policy makers need to be supported with a tool allowing the measurement of possible progress towards this objective.

Indicators represents one way of monitoring and evaluating how policy measures and economic activities respond to sustainability concern. They are generally accepted as a "vehicle for summarising, or otherwise simplifying and communicating information about phenomena that is of importance to decision-makers" (Moxey *et al.,* 1998). "Indicators provide the basis for assessing progress towards the long-term objective of sustainable development. Long-term targets only have meanings as policy goals if progress towards them can be assessed objectively" (European Commission, 2001). They can help in highlighting the trade-offs between the three dimensions of sustainability (i.e. economic, social and environmental), and between sectors of economic activity; thus providing a basis for policy recommendation.

In the process of selecting indicators we mainly refer to European Commission documents such as "A Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development" for the socio-economic dimension; and "Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy" together with international experience within OECD (Organisation for Economic Co-operation and Development) , EEA (European Environmental Agency), ECNC (European Centre for Nature Conservation) for the indicators referring to the environmental dimensions.

The choice to strongly refer to indicators proposed by the European Commission and other institutions and agencies will allow to test them according to data currently available at Italian level.

The *economic dimension* mainly refers to resources efficient use, competitiveness and vitality of agricultural sector, and to its contribution to the development and conservation of rural areas. Within this dimension indicators are related to the capacity to efficiently transform available inputs, to the diversification of income sources within farm families, to the competitiveness and profitability of the sector itself.

The *social dimension* refers to equity, not only at territorial level (among rural and no rural areas), but also at sectoral level (among agriculture and other economic sectors) and among social groups. Issues included in this dimension are those linked to employment opportunities and to farmers access to resources and social services. Indicators are mostly related to human capital, its characteristics and protection.

The *environmental dimension* refers to natural resources management and conservation. Environmental system is analysed on the basis of a list of policy relevant environmental objectives – conservation of landscape and biodiversity, protection of water resources, soil and air. Indicators refer to the Driving forces, Pressure, State, Impact, Response model; the latter allows to appropriately structure and organise the environmental information.

Indicators are selected referring to a group of priority objectives preliminary identified for each dimension. Indicators are implemented on the basis of data that are currently available. The constraint of data availability allow to verify current possibilities of a "sustainability analysis".

Referring to the time dimension, indicators rely on time series as long as possible. The appropriate length for data time series depends on type of indicator. In some cases time series are shorter than required. This is especially the case of environmental data which refer to issues only recently identified by our society as important and therefore to be measured and assessed. In these cases we consider indicators anyway in order to establish a baseline for assessing trends in the future.

As to the space dimension the geographical unit adopted refers to administrative boundaries at as small level as possible (regional, provincial). Each indicator is presented using one or more graphs

showing trends by administrative region, and a synthetic representation, through Chernoff icon, showing trends by macro-region, that is Northern, North-East, North-West, Middle, South and Islands.

The lack of fully developed indicators or existing data did not preclude an issue or indicator from being considered.

The overall number of indicators calculated is 37, of which the first 11 are of a socio-economic nature and aim at analysing production efficiency of the agricultural sector, its capacity to create employment and to contribute to the maintenance of rural areas.

The other 26 indicators give information on the impact of agriculture on the different components we structure the analysis of the environment. Within this dimension, ad-hoc indicators were calculated for the following five components:

1) Soil
2) Atmosphere
3) Water resources
4) Biodiversity
5) Landscape

Soil is not a static element, it needs to be considered as a dynamic and not renewable natural resource. For a long time, excessive exploitation by agriculture has contributed to the degradation of its chemical and biologic characteristics. Consequently, the indicators that were selected aim to evaluate the soil health state through measures that highlight the pressure of agricultural activity, deriving from animal breading, fertilisers and pesticides use, excess of pollutants.

The evaluation of the impact of the agricultural activity on the atmosphere quality is much more complex. Even if agriculture is not the main contaminant of the atmosphere, it influences the reduction of the ozone layer through gas emissions (methane, carbon dioxide and ammonia) and energy consumption. Indicators related to the air aim to evaluate the amounts of these emission.

Also the relationship agriculture-water shows a complex picture, due to difficulties found trying to isolate the contamination derived exclusively from agricultural activities. The evaluation of sustainability of water use in agriculture has been performed taking into account indicators related to the use of water resources and their management, like, for example, the technology used and the different supply sources, which analyse the quantity aspect, and indicators such as nutrient balance and nutrient leaching, exploring the quality side.

Biodiversity is the variety in life and its processes, and is usually considered at three levels:

- *Genetic biodiversity* ("within species"), refers to the diversity of fundamental genes within a single specie (plant or livestock);
- *Biodiversity of species* ("between species") is the variety of living species present in a specific place;
- *Ecosystem biodiversity* ("of ecosystem") refers to the variety of species, processes and ecological functions observed in different ecosystems which are "formed by populations of species relevant to agriculture or species communities depedent on agricultural habitats" (OECD, 2001).

The indicators selected make reference mainly to the last two issues, because data currently available does not allow cover genetic biodiversity.

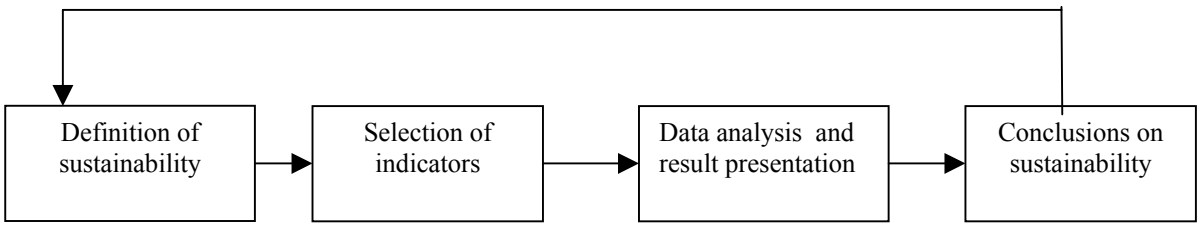
The landscape issue is both similar and related to biodiversity. In the report the landscape is evaluated through indirect indicators, like structure indicators that make reference to factors that strongly shape landscape, such as processes of concentration, intensification and specialisation of the agricultural activity.

Inclusion of indicators under one or another issues is a matter of interpretation and perspective. Categorisation is not rigid, and a number of indicators can indeed fall into other issues depending on the question they have to answer. Moreover "a balance among the number of economic, environmental and social indicators is not necessarily required given the different degree of aggregation, the inexact categorisation of indicators, and uncertainties about the most appropriate measures to use" (U.S. Interagency Working Group on Sustainable Development Indicators, 1998). Nevertheless the economic and social issue need further refinement.

Furthermore, the set of indicators is valid for a certain point in time. It should be flexible, because it can vary as priorities shift or our base of knowledge expand.

2. The report structure

The report is structured as follows. The three dimensions previously mentioned (environmental, economic a social dimensions) were first analysed separately and then they were considered altogether in order to estimate a complete and organic measure of sustainability. As previously pointed out, for each dimension a group of priority objectives was identified, the indicators refer to those objectives. Only the simultaneous pursuing of all objectives assure that a more general objective of sustainability is achieved. The following scheme, drawn from Aakkula J., 2000, shows the steps followed:



In order to be compared with the international experiences previously cited, the indicators were classified using the DPSIR (*Driving forces, Pressure, State, Impact, Response*) scheme, that represents the causal chain of relationships among agriculture sector and environment.

According to the definitions of EEA, the *driving forces* (D) are the primary causes of environmental impact (i.e. prices, subsidies, incentives, income).

The *pressure indicators* (P) regard directly the causes of problems and refer to the human actions that produce environmental impacts.

The *state indicators* (S) describe the environmental conditions regarding quality and quantities of natural resources (i.e. nitrogen concentration on groundwater).

The *impact indicators* (I) refer to variations of state and effects on human activities.

The *response indicators* (R) are the measures adopted in order to solve the problem (i.e. agri-environmental measures, more restrictive regulations); they measure the society actions towards environmental changes. They are distinct from the actions to prevent and reduce negative impacts

derived from human activity, actions to restore environmental damages, and actions that preserve or restore environmental resources.

The selected indicators classified according to such scheme are presented in Table 1.

Table 1: Classification of indicators

		Social dimension
1	**Human capital**	Share of agriculture employment
2		Age of farmers
3		Farmer educational level
4	**Equity**	Differences among female and male employment shares
5		Annual variation of rural population (municipality level)
		Economic dimension
6	**Production efficiency**	Agriculture value added per labour unit
7		Agriculture value added per hectare
8	**Economic vitality**	Marginalisation
9		On-farm and off-farm labour of farmers
10	**Competitiveness**	Agri-food exports / GNP
11		Gross fixed investments / GNP
		Environmental dimension
12	**Soil**	Livestock units per hectare
13		Specie composition per breading
14		Phosphorus balance
15		Pesticides consumption per hectare
16	**Air**	Emission of methane (CH_4)
17		Emission of ammonia (NH_3)
18		Emissions of carbon dioxide (CO_2)
19		Direct use of energy
20	**Water quality**	Nutrient balance
21		Nutrient leaching
22		Fertiliser consumption per hectare
23	**Water quantity**	Irrigation systems
24		Irrigated area / agricultural area
25		Supply source
26	**Biodiversity**	Protected areas
27		Forestry area / total area
28		Fired walls area

		Social dimension
29		New forestry area (variation respect to 1995)
30		Organic farming area
31		Area benefiting from agri-environment support
32		Regional budget for environmental protection
33		Species condition
34	**Landscape**	Intensification / extensification
35		Specialisation
36		Agricultural area / Overall regional area
37		Concentration

Some of the selected indicators suffer from several limitations such as the presence of data gaps; the intrinsic quality, geographic limits.

The level of detail is regional, while the length of time series is not uniform, but varies depending on available statistics. The analysis was produced both at regional and macro-regional level. The macro region level are:

North-west, including the following Regions: Piemonte, Valle d'Aosta, Lombardia, Liguria.

North-east: Trentino-Alto Adige, Veneto, Friuli Venezia Giulia, Emilia Romagna.

Centre: Toscana, Umbria, Marche, Lazio.

South and Islands: Abruzzo, Molise, Campania, Basilicata, Puglia, Calabria, Sicilia, Sardegna.

The source of data is mainly official National Statistics (ISTAT), while energy consumption data comes from the FADN database, organic production from the Biobank database, and species conditions from the WWF data information.

Indicators are organised by schedule, each of which is divided into two sections. The first contains general information on the issue under examination and the second analyses the evolution of time series in the various Italian Regions and macro-regions. Comparison among regions is made using graphics in order to immediately view the trend over time, and through a schematic representation (Chernoff icon) of the progress of Italian agriculture towards sustainability (see box 1 and table2).

Box 1: Schematic representation of agriculture progress towards sustainability

☺ = Positive

😐 = Invariant

☹ = Negative

3. Final remarks and future developments

This paper represents a first attempt to show progress of Italian agriculture towards the path of sustainability, through the selection of a set of indicators. The set of indicators refers to a precise point in time, is flexible and subject to variations as political priorities and social values shift, and knowledge expands.

Indicators represent one way of monitoring sustainable development; they are a tool to assess whether patterns of economic activity are likely to satisfy sustainability objectives, and to provide a basis for policy recommendation. They help to highlight the trade-off between the three dimensions (economic, social and environmental), and between sectors of economic activity. In order to be included in the decision making process they are to be compared with some pre-specified value, e.g. thresholds and targets.

With regard to the issue of interpretation and adoption it is crucial to identify necessary and sufficient condition for sustainability. The selection of indicators is often linked to data availability raising the issue of consistent representation of real path of developments; in fact they are often data-generated rather than problem generated. Very often the selection of indicators is limited by constraints related to data availability, spatial and timing aggregation. These factors limit their potential in decision making at local level and over time.

The definition of sustainability criteria for each of the three dimensions (e.g. economic, social and environmental), and for them altogether allows reaching a complete view of the frame, taking into account the simultaneous progress of the three dimensions. The following table gives a rough overview of the selected set of indicators. Further work is surely needed on the ground of aggregation in order to build a synthetic representation of progress toward sustainability. We are in the first stage of some basic reasoning on this topic.

Aggregation is a way to simplify the information in order to make it easily understandable and usable by decision-makers, which ask for small number of indices. Indeed, a synthetic representation of the sustainability of agriculture would facilitate the inclusion of this complex issue into policy concern. Nevertheless, in the case of sustainability indicators the use of compensatory methods of aggregation (e.g. weighting means) would distort information because of the holistic nature of the issue. A possible solution to obtain an overall picture of the progress towards sustainability can be to resort to the concept of the *dashboard*[1]. It indeed allows to control indicators all together, overcoming the problem of operations on indicators which would have introduced further subjectivity to the process of assessment, and assuring more transparency to the process.

Moreover the assessment of possible progress towards sustainability can not be done since the formulation of priority objectives in the field of economics, environment and society based on society values and goals, and the definition of targets and thresholds for each indicator. The first is mainly linked to policy decision; it is useful in setting the relative importance (and possibly weighting) of various sustainability issues and indicators. The latter can be suggested by scientists; it is useful in interpreting the direction of certain developments and trends (distance to-target-method). Especially with reference to the environment, characterised by uncertainties, irreversibility and ignorance, the precautionary principle should apply. When target or reference level are not available it could be enough to assess the trends of indicators.

A step forward that INEA propose is the analysis of the whole economic system sustainability shifting the focus from one sector to all the sectors of the economic system.

[1] This approach is proposed by IISD/Consultative Group on Sustainable Development Indicators. “Using the metaphor of a vehicle's instrument panel, it displays country-specific assessments of economic, environmental, social and institutional performance toward (or away from) sustainability”. See also U.S. Interagency Working Group on Sustainable Development Indicators, 1998.

Table 2: Schematic evaluation of indicators at macro-region revel

		North-west	*North-east*	*Centre*	*South and Islands*	*ITALY*
	Social dimension					
1	Share of agriculture employment	☹	☹	☹	☹	☹
2	Age of farmers	☺	☹	☹	☹	☹
3	Farmer educational level	☺	☺	☺	☺	☺
4	Differences among female and male employment shares	☺	☺	😐	😐	☺
5	Annual variation of rural population (Town level)	☺	☺	😐	☹	☹
	Economic dimension					
6	Agriculture value added per labour unit	☺	☺	☺	☺	☺
7	Agriculture value added per hectare	☺	☺	☺	☺	☺
8	Marginalisation	☹	☹	☹	☹	☹
9	On-farm and off-farm labour of farmers	☺	☺	☺	☺	☺
10	Agri-food exports / GNP	☺	☺	☺	☺	☺
11	Gross fixed investments / GNP	☺	☺	☺	☹	☺
	Environmental dimension					
12	Livestock units per hectare	☹	☹	☹	☹	☹
13	Specie composition per breading	☹	☹	☹	☹	☹
14	Phosphorous balance					
15	Pesticides consumption per hectare	☺	☺	☺	☺	☺
16	Emissions of methane	☺	☹	☺	☺	☺
17	Emissions of ammonia	☺	☺	☺	☺	☺
18	Emissions of carbon dioxide					
19	Direct use of energy	☺		☹	☺	☺
20	Nutrient balance	☺	☺	☹	☹	☺
21	Nutrient leaching					
22	Fertiliser consumption per hectare	☺	☺	☹	☹	😐
23	Irrigation systems	☺	☺	☺	☺	☺
24	Irrigated area / agricultural area	☹	☹	☹	☹	☹
25	Supply source					
26	Protected areas	☺	☺	☺	☺	☺
27	Forestry area / total area	☺	☺	☺	☺	☺

		North-west	*North-east*	*Centre*	*South and Islands*	*ITALY*
28	Fired walls area	☹	☹	☹	☹	☹
29	New forestry area (variation respect to 1995)	☺	☺	☺	☺	☺
30	Organic farming area	☺	☺	☺	☺	☺
31	Area benefiting from agri-environment support	☺	☺	☺	☺	☺
32	Regional budget for environmental protection	☺	☺	☺	☺	☺
33	Species condition					
34	Intensification / extensification	☹	☹	☹	☹	☹
35	Agricultural area / Overall regional area	☺	☺	☺	☺	☺
36	Specialisation	☹	☹	☹	☹	☹
37	Concentration	☹	☹	☹	☹	☹

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