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CHAPTER ONE

INTRODUCTION

The research work carried out and presented in the present publication, titled *Analysis of Data Needs and Availability for the Implementation of Agrienvironmental Indicators According to the Driving Forces, Pressures, State, Impacts, and Responses logical framework*, has been finalised within the Technical action plan for the improvement of the agricultural statistics (Tapas) framework. The project has been co-funded by the European community (Ec) and included in the technical action plan for year 2003, approved by Ec Decision 2003/304/Ec.

Main aim was to asses the state of art for research on agrienvironmental indicators. The present report tries to clarify where the data demand arises from, which are the priorities to be faced and which is the availability of basic data or methodologies referring to specific issues.

Main agrienvironmental issues addressed by existing policy, either generated in the integration process of the existing sectoral policy or in the development of specific environmental issue policy, are listed. The existing policy on sustainable development is also analysed referring to issues related to the agriculture sector.

Monitoring of agrienvironment related phenomena is thus required, through a harmonised system of indicators. Conceptual frameworks existing at international level on environmental indicators and on sustainability, and the related indicator lists, are presented, in some cases showing overlapping and differences. Such lists represent a reference point to refer to and the data demand arising at international level, so that assessing basic data availability at national level in order to comply with such lists is becoming necessary. Integration of such lists can also be required whenever it is recognised that a specific issue, not considered at international level, needs to be faced at national level.

Monitoring agrienvironmental issues involves an enormous variety of

skills including statistical work and scientific research. Statistical approach has to proceed knowing the steps ahead made on the comprehension of a specific phenomenon. On the other hand, data producer and data user, having institutional tasks, should work in closer cooperation to better evaluate existing database, and where necessary to immediately clarify which is the evolution of the data demand.

Main effort has been put in reporting activity undergone in diverse Institutions working on several aspects of the agrienvironment issues, such as different Units working in the National institute of statistics (Istat) and other Institutes that have specific institutional tasks.

In this paper the international legislative framework (paragraph 2) with reference to agrienvironmental issues is firstly described, referring to sectoral policy (paragraph 2.1), to specific environment policy (paragraph 2.2) and to sustainable growth policy (paragraph 2.3). Than highlights are given on existing tools - as indicators and spastics - to monitor environmental issues related to agriculture sector (paragraph 3), with a reference to availability of information arising from specific legislative initiatives, such as the ones on prevention and control of gas emission (paragraph 3.1.1), the Waste statistics Regulation (paragraph 3.1.2) and the arising Regulation concerning Pesticides statistics (paragraph 3.1.3).

It follows a description of the statistics demand on agrienvironment issues arising from international organisms (paragraph 4). The indicator conceptual frameworks are thus depicted referring to the existing relationships between human activities and the environment (the so-called *driving forces*, *pressures*, *state*, *impacts*, *responses* scheme) (paragraph 4.1) and to the sustainable development approach (paragraph 4.2). Highlights on main activities run at international level to define the indicator lists are given for the Esepi project (paragraph 4.1.1), the Irena project (paragraph 4.1.2), the Oecd activity (paragraph 4.1.3), the Sustainable development indicators list (paragraph 4.2.1), and for the indicator list on sustainability of agricultural activity and rural development (paragraph 4.2.2).

Then a review of available indicators, of basic data and, in some cases, of the related calculation methodology, in relation to some specific issues, is presented (paragraph 5). Focuses on specific issues are provided. The Environmental methodologies and statistics Unit in Istat provided an

overview of the agricultural practices that can affect pressures on the environment, that might be worth to monitor, evaluating statistical activity done in the last years in Istat to integrate existing surveys on such issues (paragraph 5.1). The same Unit performed also a deepening[(a)] on availability of data and information collected through farm structure survey on use of water in agriculture for irrigation purpose (paragraph 5.2). The mentioned contributions show the enormous work done since 1998 integrating existing surveys, mainly surveys on farm structure, and planning of new one (use of plant protection products) in order to comply with the increasing data demand arising on agrienvironmental issues. Furthermore, the Statistics on agriculture inputs Unit in Istat presented its activity related to statistics on sale (paragraph 5.3.1) and use (paragraph 5.3.2) of plant protection products. Highlights on the activity carried out by Istat are provided with reference to the waste generation and management issue (paragraph 5.4). Methodology applied by Istat to calculate Gross nitrogen balance indicator is also depicted and results are presented at national level. The other Institution involved in this project was the Agency for the protection of the environment and for technical services (Apat)[1] on ongoing production of data and on future improvements on some gas emissions from the agriculture sector (paragraph 5.6), such as ammonia (paragraph 5.6.1), carbon dioxide (paragraph 5.6.2), methane and nitrous oxide (paragraph 5.6.3). Lastly a full list of agrienvironmental indicators organised by theme and derived from variables surveyed through agriculture census of year 2000 is presented (paragraph 5.7).

Finally the main conclusions are drawn (paragraph 6).

a The elaboration on 2000 agriculture census data was carried out by Teresa Di Sarro (Istat, Department for Statistical production and Technical-scientific co-ordination, Unit for Environment statistics and Sustainable development.).

1 Agenzia per la protezione dell'ambiente e per i servizi tecnici.

CHAPTER TWO

AGRIENVIRONMENTAL ISSUES AND RELATED POLICIES

Economic activity requires natural resources to be carried out, and they generate energy and material flows whose final effect is the depletion of natural resources, in qualitative and quantitative terms. In turn, life of living organisms is threatened for changes occurred in the environmental compartments. Emerging environmental issues have been addressed in policy making adopting different strategies: integrating such issues into sectoral policies and orienting a specific legislation to prevent and control environment compartment pollution. Beside these aspects, with the adoption of the sustainable development strategy, the approach became more complex since not only the relationship between human activity and environment has to be taken into account but also the ones with the social dimension, all of them occurring both in space and time.

2.1 Common agricultural policy and rural development

Sectoral policies have to be considered for the role they have been playing in the last decade for taking into account elements for environment protection in order to achieve specific objectives.

The European council held in Cardiff in June 1998 reveals efforts done by the European commission to integrate the environmental aspects in any kind of policy, followed by the European council held in Vienna in December 1998, which underlines the need that such integration becomes real in the agriculture policy through the reform called *Agenda 2000: for a Stronger and Wider Union*[2]. The integration of the environmental issues in

[2] European commission Communication. *Agenda 2000: for a Stronger and Wider Union*. Com (2000) 97.

social and economic policy is becoming a fundamental tool to comply with the durable development objectives at member state level.

Preparing Common agricultural policy (Cap) reform, the proposal for a Council Regulation[3] contains a reference for defining the European model of agriculture that should apply production methods which are sound and environmental friendly, able to supply quality products. Furthermore, the Regulation 1254/99 on the common organisation of the market in beef and veal states that is necessary to strengthen incentives to extensify production reducing stocking density. Actually the Cap started being reoriented at the beginning of the Nineties, focusing on the forest management and environment protection concerns, through the adoption of specific agricultural practices. Later it has been reinforced by the communication Agenda 2000 presented by the Commission the 16 July 1997, oriented to describe the general development perspectives of the European union and of its policies.

Objectives referring to agriculture in Agenda 2000 are diverse and are directed to comply with the need of increasing the competitiveness of European agricultural products on internal and foreign market with a higher integration of the environmental issues. The integration of environmental goals into the Cap and the development of the role that farmers can and should play, in terms of management of natural resources and landscape conservation, have a fundamental role. The environmental needs are met thanks to:

- the reduction in payments to sustain prices converted to direct payments, that should bring reduction in intensity of production and a more equilibrate use of the polluting factors;
- the possibility for Member States to make direct payments to farmers conditional upon the respect of environmental binding requirements;
- the support given to the accompanying measures, particularly the agrienvironmental ones, started in year 1992. Such measures involve the extensivation of production, the reduced use of plant protection products and chemical fertilisers, the conservation of crop

[3] European commission Communication. *Proposal for a Council Rregulation (EC) on Support for Rural Development from the European Agricultural Guidance and Guarantee Fund (EAGGF).* Com (1998) 158.

and livestock biodiversity and of some particular natural habitats[4], and the afforestation of agricultural land[5], in order to prevent hydro-geologic problems.

Mentioned objectives can be achieved thanks to the Regulations 1257/99/Ec and 1750/99/Ec on rural development, through which rural development programme, based on environment protection, can be adopted at regional level. Farming practices were considered also as a fundamental tool to reach the all the abovementioned goals, and organic agriculture is reported as the production method that improves the sustainability of farming activities, contributing to the general aims of the Regulation. The Agricultural council also recognised the role of good farming practices in October 1999, mentioning them as a way to preserve environment, furthermore organic agriculture, integrated production and traditional low input farming and typical local productions were mentioned for their role in affecting in a positive way the environmental, social and economic dimension.

Cap reform, run through Agenda 2000, has been reviewed at a mid term stage in year 2004[6]. Main aim is to simplify the multiple payments scheme in a single one, decoupling payments from a specific production process. Furthermore, a ceiling for total Cap cost has been set up at member state level. The savings originated through a reduction in payments - to perform from 2005 until 2012, called modulation process - will be used for financing other policy issues. Part of them (80 percent of the total savings) will be directed to finance the second pillar of the Cap - the rural development programme implemented through the already mentioned Regulation 1257/99/Ec -, whereas the remaining 20 percent for balancing the existing differences in total given subsidies among States.

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4 European council Regulation 2078/92/Eec of 30 June 1992. *On Agricultural Production Methods Compatible with the Requirements of the Protection of the Environment and the Maintenance of the Countryside.* Official Journal L 215 of 30 July 1992.

5 European council Regulation 2080/92/Eec of 30 June 1992. *Instituting a Community Aid Scheme for Forestry Measures in Agriculture.* Official Journal L 215 of 30 July 1992.

6 European council Regulation 1782/03/Ec of 29 September 2003. *Establishing Common Rules for Direct Support Schemes Under the Common Agricultural Policy and Establishing Certain Support Schemes for Farmers and Amending Regulations 2019/93/Eec, 1452/01/Ec, 1453/01/Ec, 1454/01/Ec, 1868/94/Ec, 1251/99/Ec, 1254/99/Ec 1673/00/Ec, 2358/71/Eec, and 2529/01/Ec.* Official Journal n. L 094 of 31 March 2004.

The subsidy will be thus completely run on surface basis[7] and the monitoring system based on the identification of agricultural parcels through remote sensing will provide basis for geo-referenced database. Besides increasing financing for rural development plans another positive effect in environmental terms would be the adoption of the cross-compliance principle. Farmer should respect management requirements as referred in Annex III of the Regulation, where for the environment issue several Directives are mentioned (Directives 79/409/Eec on the conservation of wild birds, 80/68/Eec on the protection of ground water against pollution caused by certain dangerous substances, 86/278/Eec on the protection of the soil and particularly in case sewage sludge is used on agricultural soil, 91/6776/Eec concerning the protection of water against pollution caused by nitrates from agricultural sources, and 92/43/Eec on the conservation of natural habitats and of wild flora and fauna). The subsidy will be conditional upon the adoption of environmentally oriented practice, to pursue food safety, animal health and welfare and the maintenance of the farm in good agricultural and environmental condition. Good environmental conditions are established under Article 5, where it is stated that each Member State can define its own requirements that may refer also to standards already applied in the context of rural development Regulation. Furthermore, priorities in environmental issues and standards to deal with are listed in the Annex IV of the Regulation 1782/03/Ec.

Permanent pasture was recognised to have an important environmental role and thus this area has to be maintained in such condition, also set-aside schemes have to be maintained.

2.2 Environmental policies

European union (Eu) put a great effort in recent years in taking into accounts in programmes and policies the emerging environmental issues. Referring to such activity, the Eu Environment action Programme (Eap) represents an important milestone.

[7] At first stage should cover all products included in the arable crop regime as well as grain legumes, seeds, beef and sheep. Also the revised payment for rice and durum wheat, and for the milk sector will be with time included. The same will happen for starch potatoes and dried fodder. For some crops requiring still a supporting system a specific supplementary payment is maintained.

Particularly, the 5th Eap *For a Sustainable and Durable Development* defined the guidelines for a European strategy run on voluntary basis for the period 1992-2000. Since then, several communitarian actions took place referring to the economic sectors considered as pollution factors, such as industry, energy, tourism, transports and agriculture[8].

The 5th Eap identifies agriculture activity as one of the factors responsible for the environment depletion, due to the increase in intensive cropping, to recourse to chemical fertilisers and to the surpluses storage. In this framework, main aims identified are:

i) reduction of nitrates level in ground and surface water;
ii) stabilization or increment of the soil organic matter content;
iii) significant reduction in use of plant protection products;
iv) definition and adoption of programmes for environment protection.

The 6th Eap, titled *Environment 2010: Our Future, Our Choice*, defines, for the period 2001-2010, the actions to undertake in order to achieve objectives summarised in the following points:

— the development of a monitoring activity to assess the environment state and the ongoing changes, identifying the priority areas where Union can play a central role;
— the encouragement of the integration of environment protection needs in the Union policy, and whenever adopting environmental laws, the social and economic dimension of the sustainable development have to be taken into consideration;
— the decoupling between resource use and economic growth through the improvements in resource use efficiency, reducing use of resources and waste generation;
— the stabilization of greenhouse gases concentration so that the planet temperature won't change in a significant way, also recoursing to renewable energy sources;
— the protection and remediation of the natural system functionality, halting the loss of biodiversity in the Union and at global scale, and the protection of soil from erosion and pollution;
— a higher control on contaminants that can bring "non acceptable"

8 European commission Communication. *Towards Sustainability: a European Community Program of Policy and Action in Relation to the Environment and Sustainable Development.* Com (92) 23 final.

risks for human health and for the environment.

Four priority areas are identified: i) climate change, ii) nature and biodiversity, iii) environment, health and life quality, and iv) sustainable use of natural resources and waste management. Agriculture, as productive sector, affects all these areas, since it is:

- potential supplier of biomasses that can be used as energy sources, thus reducing recourse to sources of fossil origin and the net emission of greenhouse gases (Ghg);
- responsible of the introduction into the environment of chemical substances with negative effects on humans and environment; under this issue it is of main importance to reduce such use, through the adoption of environmentally oriented farming methods, and to rule their production and introduction into the market;
- responsible for the safety quality and harmlessness of food products, that can be improved through regulation and/or modification of the productive process adopted;
- a potential tool for biodiversity protection.

Among the cited main objectives and topics and referring to the international initiatives framework, it is important to remind the legislation arising in the last decade to prevent and control environment compartment pollution. Compartments covered are air - with respect to gaseous emissions -, water - concerning mainly pollution risk from nitrates and chemical substances, soil - on which legislation still requires a framework to be drawn.

Referring to air compartment, pollutants can be originated from different economic sectors and the main problems are related to: air quality, long-range transboundary air pollution, ozone depletion and climate change. All aspects mentioned before are connected with emissions in atmosphere, both from anthropogenic and natural sources, of pollutants that change the composition of atmosphere. The difference between aspects mentioned before are the spatial and temporal scale. For example, long-range transboundary air pollution has to be analysed at least in a continental scale, and climate change in global scale. In the following, a brief review on legislative acts referring to agriculture sector will be provided.

Referring to air pollution issue, the Convention on long-range transboundary air pollution was signed in 1979 (entering into force in 1983) creating the framework for controlling and reducing the damage to human

health and the environment caused by transboundary-air pollution, due to SO_2, NOx, VOC and NH_3 pollutants. At European level, the Environment council adopted the Framework Directive 96/62/Ec on ambient air quality assessment and management, followed by daughter directives, which set numerical limit values. Among them, the Directive[9] 2001/81/Ec on National emission ceilings (Nec) aims to limit emissions of acidifying and eutrophying pollutants and ozone precursors from diffuse source into the atmosphere. By the year 2010 at the latest, Member States shall limit their annual national emissions to amounts not greater than the emission ceilings. For Italy the limit for NH_3 has been set up at 419 kilotonnes. Nevertheless - according to the national programme and projections, in a baseline situation - Italy will not be able to respect the ceiling since it is estimated that its emission will reach 433 kilotonnes of NH_3 by 2010[10]. The Programme was prepared by the Ministry of Environment and the territory in collaboration with Apat and Enea[11].

Furthermore, the Integrated Pollution Prevention and Control (Ippc) Directive 96/61/Ec[12] sets up common rules on permitting for industrial installations in order to reduce emissions. These permits must contain conditions based on best available technologies (Bat) to be adopted in specific agriculture activities. For the agriculture sector, activities included are only breading of poultry or pigs with more than: (a) 40 thousands places for poultry, (b) 2 thousands places for production pigs (over 30 kilogrammes), or (c) 750 places for sows, which are the most responsible production processes in terms of ammonia emission. In Italy, the directive has been adopted in year 1999 with the Legislative Decree n°372/99[13].

Referring to the climate change issue, the Intergovernmental panel on climate change, in 1990, put into evidence the risk of a global warming with effects on climate balance due to the increase of Ghg emissions of anthropogenic origin caused by industrial development and use of fossil fuel. The United nations Framework convention on climate change

9 In Italy, the Nec directive has been adopted with the Legislative Decree n° 171 (21/05/04).

10 http://europa.eu.int/comm/environment/air/pdf/200181_progr_it.pdf.

11 Ente per le nuove tecnologie, l'energia e l'ambiente.

12 http://europa.eu.int/comm/environment/ippc/.

13 Decreto legislativo 4 agosto 1999, n. 372. *Attuazione della direttiva 96/61/CE relativa alla prevenzione e riduzione integrate dell'inquinamento.* Gazzetta ufficiale n. 252 del 26 ottobre 1999.

(Unfccc) was signed during the summit of the Earth in Rio the Janeiro in June 1992. The Unfccc was ratified by Italy in the year 1994 with the law n.65 of 15/01/94. Under the Convention, all Parties must report on the steps they are taking to implement the Convention through the national communications.

With the adoption of Kyoto protocol, in December 1997, the emission reduction objectives for Annex B Parties (i.e. industrialised countries and countries with economy in transition) were established. The Kyoto protocol entered into force on 16 February 2005, since the minimum threshold of countries representing at least 55 percent of total carbon dioxide (CO_2) emission - with reference to year 1990 - has been reached, with the recent adhesion of the Independent state confederation. European union, sensitive to this phenomenon, adopted the protocol in year 2002[14] ratifying emissions reduction with targets per Member States[15] (for Italy, a decrease of 6.5 percent for Ghg emission by 2008-2012 - in comparison with 1990 levels - has been established), already identified in the European council in 1998. The contribution to total emission reduction is determined to expectation of economic growth in each country, in fact some States can increase their own emissions. In order to comply with the requirements, a strategy has to be developed involving mainly transports, energy, agriculture and industrial sectors.

For agriculture and for climate change issue CO_2, nitrous oxide (N_2O) and methane (CH_4) are the main involved gases.

Referring to CO_2, forest and agriculture activity can play an important role in reducing the net carbon dioxide emission in the atmosphere, which is one of the main gases responsible for global temperature increase. Agriculture and forestry sector represent a relevant CO_2 sink, due to biomass growth in forest and in cultivation activity, to carbon dioxide sequestration in soil and to production of biomasses that can be used as renewable energy source, thus reducing recourse to fossil fuel.

Carbon sequestration in agricultural soils is accountable under Article

14 European council Decision 2002/358/Ec of 25 April 2002. *Concerning the Approval, on Behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the Joint Fulfilment of Commitments Thereunder*. Official Journal L 130 of 15 May 2002.

15 Italy ratified the Kyoto Protocol with the law n.120 of 01/06/02 and the Interministerial committee for economic planning (Cipe) adopted the National action plan to reduce greenhouse gas emissions on 19th December 2002.

3.4 of the Kyoto protocol (additional human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories). The Bonn agreement, formulated at Cop6bis in July 2001, clarifies the implementation of Article 3.4 as follows: "In the context of agriculture, eligible activities comprise cropland management, grazing land management and revegetation provided that these activities have occurred since 1990, and are human-induced". The Marrakech Accord agreed at Cop7 in November 2001 sets legally binding guidelines for reporting and accounting for agricultural carbon sinks.

On October 2003, the European commission Communication *Towards a Thematic Strategy for Soil Protection*[16] highlighted the need of a thematic strategy for soil protection, with different objectives, as protecting soil in its role in storing CO_2. The communication urges the European commission to draw up by 2007, in cooperation with the Member States and the competent regional authorities, a *scientific soil catalogue*. This catalogue should include information on the nature of the soil, its biography, health and vulnerability, degradation and erosion processes and contaminated areas, recognising the existence of high-value soils (in terms of agriculture, geology, ecology, history or the countryside) and the need to draw up recommendations for their conservation and sustainable use.

Waiting for the implementation of such strategy, there are some legislative acts already in force at international and national level ruling soil protection. Agricultural land can, in fact, be the final destination for several materials of bio-organic nature, so that legislation is required to prevent polluting phenomena. In fact, sludge and bio-waste can contribute to the increase of the soil carbon content. Indeed, sewage sludge is a nutrient supplier, while compost is also a provider of well-stabilised organic matter improving soil properties, due to its capacity to the formation of humus, which in turn determine soil characteristics as water retention capacity, good physical properties, and etcetera. Nevertheless, the application of sludge and bio-waste can pose certain environmental problems mainly related to: excessive supply of nutrients, introduction of

16 European commission Communication. *Towards a Thematic Strategy for Soil Protection.* Com (2002) 179.

pollutants, such as heavy metals and organic compounds, spreading of human, animal and/or plant pathogens. For some bio-waste legislation is already in force, nevertheless a more broad framework might soon arise.

Furthermore the utilisation on land of sewage sludge from treatment of wastewater of domestic, urban, or industrial origin, is ruled at national level by the decree n. 99 of 27 January 1992 which represents the implementation of the Directive 86/278/Eec (whereas management issues - transportation, storage, treatment, and etcetera - are ruled by the Decree n. 22/97).

Furthermore, at national level the Decree 11 November 1996 n. 574 containing new rules on agronomic utilisation of sludge generated in olive grinding process defines the maximum sludge quantity that can be utilised on agricultural land, and the modality of spreading.

Referring to existing legislation on water, concerns are mainly on prevention of water pollution from nitrates of agriculture origin. Main act is the national decree n. 152 of 11 May 1999, defining constraint to prevent water pollution, and implementing Directive 91/271/Eec on the treatment of urban wastewater and Directive 91/676/Cee on prevention of water pollution from nitrates of agriculture origin. The latter provides the identification of areas vulnerable to nitrates, defining also the related good practice code[17]. The issue of prevention of water pollution from chemical substances is addressed by a certain number of directives as the Directive 86/289/Eec on dangerous substances discharges, and as the Directive 80/778/Eec (amended by Directive 98/83/Ec), on drinking water which defines the maximum concentration in water for any single pesticide. Lately, the Directive 60/200/Ec on water framework sets out a “strategy against pollution of water”. As a consequence the first list of priority substances, including plant protection products, to assess and monitor has been adopted through decision 2455/01/Ec and a proposal for a new Directive to prevent ground water from pollution has been adopted[18].

[17] Decreto ministeriale del 19 aprile 1999, n. 86. *Approvazione del codice di buona pratica agricola.* Gazzetta ufficiale n. 86 del 4 maggio 1999, S.O.

[18] European commission Communication. *Proposal for a Directive of the European Parliament and of the Council on the Protection of Groundwater against Pollution.* Com (2003) 550.

2.3 Policies for a sustainable development

The sustainable development strategy, taking place recently at European level, refers to the definition adopted by the World commission on environment and development[19] at the beginning of the 80es, and it is based on analysis run on existing relationships between development and the related environmental risk.

In the report written by the Commission, development is defined sustainable when satisfies the needs of today alive humans without compromising the possibility of future generations of satisfying theirs. In this sense, time is taken into consideration in terms of needs to meet at present and in the future, and in terms of capital (human, economic and social) that can be used in different combinations to satisfy such needs.

All the dimensions included (the economic, social, environmental and institutional one) in the sustainability framework have to be described and monitored over time and space in statistical terms. Referring to very complex concepts an effort to integrate different issues and sectors and different data sources is necessary.

The United nations Commission on sustainable development is the first of all organisms that faced the problem of indicator definition on this subject[20]. This Commission settled in 1992, following the United nations Conference on environment and development held in Rio de Janeiro, in order to monitor the implementation of such agreements at local, national and international level.

The European council agreed “a strategy for sustainable development which completes the Union’s political commitment to economic and social renewal, adds a third, environmental dimension to the Lisbon strategy and establishes a new approach to policy making” in the Gothenburg summit (June 2001). This strategy focuses on four main areas: combating climate change, ensuring sustainable transport, addressing threats to public health, and managing natural resources more responsibly. In the Commission Communication *A Sustainable Europe for a Better World: a*

19 World commission on environment and development. *Our Common Future.* Oxford: University Press, 1987.

20 Uncsd. *Indicators of Sustainable Development: Framework and Methodologies.* Uncsd, 1996.

European Union Strategy for Sustainable Development[21] the main threats to sustainable development are identified. Among others, the ones related to agriculture sector are: emissions of greenhouse gases from human activity causing global warming; the longer-term effects of the hazardous chemicals in use; threats to food safety; the loss of bio-diversity, which has accelerated recently; waste volumes continuously growing, even faster than GDP; soil loss and declining fertility, responsible for eroding the viability of agricultural land.

A further document issued by the Commission was released at the European council hold in Seville - in preparation for the Johannesburg Summit - entitled *Towards a Global Partnership for Sustainable Development*[22] that complements the previous document by adding a new external dimension to the ones already drawn up.

Policy also exploited sustainability issue in relation with agricultural activity. A specific action on this sector was promoted through the Commission Communication *Directions Towards Sustainable Agriculture*[23], where it has been stated that policies are required to develop Eu agriculture on a sustainable path, ensuring an agricultural model which is environmentally sound, economically viable and socially acceptable. Diversification of the economic activities should be considered, also including tourism related activities, and farming should contribute to the maintenance of a viable rural community.

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21 European commission Communication. *Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development.* Com (2001) 264 final.

22 European commission Communication. *Towards a Global Partnership for Sustainable Development.* Com (2002) 82 final.

23 European commission Communication. *Directions Towards Sustainable Agriculture*. Com (1999) 22 final.

CHAPTER THREE

TOOLS TO MONITOR ENVIRONMENTAL ISSUES RELATED TO AGRICULTURE SECTOR

Policy makers in order to evaluate policy implementation and progress towards established goals require adequate tools. As stated in the 6th Eap availability of data set on environmental situation, referring both to state and to factors affecting environment state, is very limited and incomplete, therefore there are different actions that can be implemented in the next future so that a more appropriate and meaningful evaluation can be made.

Actions highlighted in the programme are reported below:

- develop and publish regularly headline environment indicator report;
- produce regular indicator reports on the state of the environment;
- regularly report progress against sets of integration indicators covering in particular agriculture and forests, energy, fisheries and marine, tourism, industry, regional policy and transport;
- development of epidemiological indicators and damage cost indicators and of relevant valuation databases;
- institute a wide-ranging review of information and reporting system leading to the introduction of a more coherent and effective reporting and evaluation system incorporating high quality and comparable environmental data and information;
- support Member States in setting up adequate data-collection systems and in particular to set priorities and to optimise the use of scarce budgetary resources;
- reinforce the development of geographical information systems and space monitoring applications, including the “Global monitoring for the environment and security” initiative in support of policy-making and implementation.

It is quite clear that a complete intervention refers to any step of the information production process, from data collection to data delivering, passing through adoption and development of analysis tools such as the geographic information system. Evaluation can thus be realised properly when a consistent set of indicators is identified and implemented regularly.

The European commission in several occasion stated the necessity for the improvements of statistical information to monitor the environmental programme and policy implementation, and to describe existing relationships between agricultural practices and environment in order to better address environmental programme targets and actions.

On such topic, several communications of the European commission to the Council and to the Parliament[24] have been adopted.

Among tools identified at European level it is possible to underline the role of the programme for Research, technological development and demonstration (Rtd) activity and programme for research and the Technical action plan for the improvement of the agricultural statistics (Tapas).

The Framework programme for Rtd defines the priorities for the European union, and it is organised in specific programmes, each one of them with priority objectives and actions. At present, Union's 2002-2006 sixth framework programme for research[25] is concentrating the major part of its efforts on seven priority fields. Among these, the ones referring to farming activities are the *food quality and safety* and the *sustainable development, global change and ecosystem* areas.

Referring to food quality and safety, since the bovine spongiform encephalitis crisis, a greater attention and effort has been put on this field. The declared objectives for this research field are as follows:

- to establish the integrated scientific and technological bases needed to develop an environmentally friendly production and distribution chain of safer, healthier and more varied food including crops, meat and sea food;
- to improve understanding of the link between food and health;

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24 European commission Communication. *Indicators for the Integration of Environmental Concerns into the Cap*. Com (2000) 20; European commission Communication. *Statistical information needed for indicators to monitor the integration of environmental concerns into the Cap*. Com (2001) 144 def.

25 http://europa.eu.int/comm/research/rtdinfo/en/special-fp6/index.html.

— to control food-related risks, relying in particular on biotechnology tools and the results of post-genomic research;
— to control health risks associated with environmental changes.

In the research framework, it is to mention also the creation of the European food safety authority (Efsa), an independent body, established in January 2002, responsible for the scientific evaluation of risks, communicating directly with the general public and issuing health warnings if necessary. Under the Sixth framework programme, the choice of the priority theme food quality and safety is designed to support this new agency in its essential work.

The objectives for sustainable development, global change and ecosystems field mainly focus on energy supply and transport. The main research programme objectives should be as listed below:

— the development, dissemination and adoption of innovative technologies and sustainable solutions in energy;
— production and consumption, in particular through increased use of renewable energies;
— the development and introduction of environment friendly safe and competitive mobility systems for passenger and goods transport, including all forms of surface transport, i.e. road, rail and sea;
— enhanced understanding and forecasting capacities in regard to global changes, ecosystems and biodiversity as well as the creation of new management models.

One of the essential areas of European energy research in the medium to long term includes alternative fuels of agri-forestry origin.

European union, with Council Decision 96/411/Ec and with the following Decision 2298/00/Ec of the European parliament and council, promotes research activity among member States, so that statistics can also describe the new characteristics of the agriculture sector, given the Cap reform. The main objectives are addressed every year through Tapas plans, on the base of which economic resources are defined to finance future projects. For year 2004 the Commission Decision 2004/366/Ec approving the first phase of the technical action plan 2004 for improving agricultural statistics, among other fields, supported measures aiming to develop or improve statistics for calculation of agrienvironmental indicators. Priority indicators are the ones defined in the Communication from

the Commission to the European parliament and to the Council 2001/144/Ec entitled *Statistical Information Needed for Indicators to Monitor the Integration of Environmental Concerns into the Common Agricultural Policy*. Furthermore, there is particular emphasis on indicators on the consumption of pesticides, pesticide residues in agricultural products, the use of fertilisers, water-use intensity, energy and use and production of renewable energy sources by agriculture. Lately the attention of the Tapas plan is switching to rural development related topics, so that agrienvironmental issues are hereby included.

Highlights on legislative initiatives for reporting on specific issues are given in the following.

3.1 Legislative initiatives for specific topics

Some specific legislative initiatives, in terms of obligations for some statistics production and delivery, have been taken at European level on topics related to agri-environmental issues. Such initiatives refer specifically to statistics production on emissions, on waste production and management, and on pesticides (authorised, sold, and used products). Wide statistical information will soon become available to calculate indicators defined and included in several indicator lists (paragraph 4).

3.1.1 Legislation on emissions

Referring to some of the environmental agreement and legislation which have entered into force - already mentioned (paragraph 2.2) - on emissions issue, there are some reporting activities that determine the creation of register and data sets that have to be implemented and constantly updated, thus providing data and methodologies to calculate related indicators.

According to Directive 2001/81/Ec on national emission ceilings (Nec), there are two reporting obligations: the national inventory and emission projections and the national programme on air emissions, using Emep/Corinair guidelines. Gases covered by this Directive are SO_2, NOx, VOC and NH_3. Among these, NH_3 is the relevant gas related to agricul-

ture sector activities and the national emission inventory is prepared by Apat with the support of the Research centre on animal production (Crpa)[26] according to Emep/Corinair guidelines.

According to Article 15 of the Ippc directive, the European pollutant emission register (Eper) has been established at European level. According to the Italian Decree of 23 November 2001, data from the Italian Eper are validated and communicated by Apat to the national Ministry of the Environment and the territory and to the European community. In Italy the National emission register has been created and it is called Ines[27].

Under the Unfccc, Parties have to submit to the secretariat National greenhouse gas inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal protocol. For Annex I Parties, two sequential processes have been established: a) the annual reporting of national greenhouse gas inventories (National inventory report - Nir - and Common reporting format - Crf); and b) the annual review of the inventories, which is finalized with a review report. Under the Unfccc, the institution in charge of reporting in Italy is Apat. Till now Italy has complied with the presentation of the three national communications, the Crf and the Nir. Information from recent Crf and Nir can be found in the Unfccc web site[28], previous ones can be found in the National network for environmental information (Sinanet) web site[29].

Methane (CH_4) and nitrous oxide emissions (N_2O) are estimated for the agriculture sector while carbon dioxide emissions from forest, cropland and grassland soils are included in Land use, land use change and forestry (Lulucf) sector. National emission inventory for the agriculture sector is prepared by Apat with the support of the Crpa.

Carbon sequestration in agricultural soils is accountable under Article 3.4 of the Kyoto protocol (additional human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks

26 Centro ricerche produzione animale di Reggio Emilia.

27 Ines, Inventario nazionale delle emissioni e loro sorgenti. http://www.sinanet.apat.it/Ines/default.htm.

28 http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/618.php.

29 http://www.sinanet.apat.it/ItalianSubmissions/.

in the agricultural soils and the land-use change and forestry categories). The Marrakech accord agreed at Cop7 in November 2001 sets legally binding guidelines for reporting and accounting for agricultural carbon sinks. Furthermore, the European commission Communication *Towards a Thematic Strategy for Soil Protection* requires the definition and the implementation of a *scientific soil catalogue*, including the nature of the soil, its biography, and etcetera.

3.1.2 Waste statistics Regulation

Recently the Regulation 2150/02/Ec on Waste statistics (WStatR) has been adopted to provide a legal basis for the collection of complete statistical data on generation and management of waste from businesses and private households in the European community Member States (Ms).

The WStatR is composed by three annexes.

Annex I sets up the framework for data-collection and reporting on waste amounts generated in private households and economic sectors classified within the coverage of Sections A to Q of the Statistical nomenclature of economic activities in the european community (Nace Rev. 1), including waste arising from recovery and/or disposal operations[30]. Statistics have to be produced with reference to some aggregated waste categories and to sectors. Waste categories (48 waste categories as amended by Regulation 574/04/Ec[31], which 21 are hazardous and 27 are non hazardous wastes) are defined and listed in Section 2 of this Annex, whereas sectors (20 items, of which 19 are referring to economic sectors

[30] Radioactive waste, already covered by other legislation, is excluded.

[31] As since 1 January 2002 the European waste catalogue was repealed and replaced by the List of waste (LoW, Commission Decision 2000/532/Ec, amended by Commission Decision 2001/118/Ec), after the coming into force of the Regulation a revision of Annex I and Annex III has been conducted by Eurostat. The Commission Regulation n. 574/2004 amends Annexes I and III of the Regulation 2150/2002. In more details, Annex I of this new Regulation replaces Annex I, Section 2(1) of Regulation 2150/2002 while Annex II of this new Regulation replaces Annex III of Regulation 2150/2002. While this new Annex I integrates the list of waste categories for which statistics have to be produced, the new Annex II replaces the previous *Waste statistical nomenclature with a Table of equivalence*. This Table of equivalence defines the relationship between the substance oriented waste statistical nomenclature (Ewc-Stat Rev. 3) and the European List of waste (LoW) established by Commission Decision 2000/532/Ec. The legal obligation to revise Annex III of the Regulation 2150/2002 was also used to address other technical issues and to improve the coherence between LoW and Ewc-Stat.

- based on Nace Rev. 1.1 - and one to households) are identified in Section 8.

Annex II of the WStatR sets up the framework for data collection and reporting on waste amounts treated by type of treatment operation. This Annex refers to the recovery and disposal operations listed in Annex IIA and IIB of the Waste framework Directive (75/442/Eec). Also in this Annex[32] some waste categories are listed according to each recovery or disposal operations: 14 waste categories for incineration, 17 for operations which may lead to recovery (excluding energy recovery) and 16 for disposal other than incineration.

In compiling the statistics, Ms shall observe a particular statistical nomenclature defined with reference to the *mainly substance* of waste. This statistical nomenclature (Waste statistical nomenclature, Ewc-Stat Rev. 3, Commission Decision 94/3/Ec) has a direct connection with the European List of waste (established by Commission Decision 2000/532/Ec, as amended) which represents the reference nomenclature for all national and European reporting obligations. The List of Waste is a *process oriented* waste nomenclature. Annex III of WStatR, amended by Regulation 574/04, defines the equivalence between the statistical nomenclature and the List of Waste.

Ms will furnish data on waste generation and waste treatment for every second year after the first reference year. The first reference year for which data has to be produced is the second calendar year following the entry into force of this Regulation and the results are to be transmitted within 18 months of the end of the reference year. Given that the Regulation has been adopted and published in the Official journal of the European communities in 2002, the first reference year will be 2004 for which data shall be transmitted to Eurostat within 18 months of the end of the reference year, i.e. in 2006.

Data coming from Ms according the Annexes of the WStatR will provide an overview of waste lifecycle starting from its generation to its final destination.

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[32] In the last months some modifications were made to Annex II of the WStatR accordingly to the changes defined in the Commission Regulation n. 574/2004 for Annexes I and III. In more detail the number of waste categories for the recovery and disposal operations has been revised. The Draft commission proposal of this new Annex II has been adopted in the Spc meeting on 18 November 2004.

During the adoption process of the Regulation in Council and in the European parliament it was decided to have pilot studies on new and difficult areas in the field of waste statistics and the Nace A - including agriculture, hunting and forestry activities - and Nace B - referring to fishing activity - sectors were identified, among others, as areas requiring further deepening.

In year 2004, Istat carried out a pilot study specifically for the above-mentioned sectors distinguishing two different projects[33]. The first one, referring to methodological aspects, was carried out by the Environmental methodologies and statistics Unit of Istat. This project titled *Methodological approach for statistics on waste generated in agriculture, forestry and fishing* analysed the phenomenon of waste generation and management in agriculture, hunting, forestry and fishing, in order to draw up a framework in which tools for data compilation could be implemented. The final report of this project contains also a brief review on the legislative content, to which we remind for further details[34].

The second project, carried out by the Agricultural service of Istat is related to the collection of data on some material generation and management realised at farm level[35].

Referring to agriculture, information demand arising from the WStatR requires Ms an effort in:

- defining waste generated per sector, specifically for Nace A and B sectors;
- establishing the proper waste allocation to the generating economic activity even when the holdings run more than one economic activities;
- describing adopted waste treatment methods;
- defining proper statistical methodologies to quantify waste.

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33 Both projects are published in *Waste Statistics on Agriculture, Forestry and Fishing Sectors.* Roma: Istat, in corso di pubblicazione. (Essays).

34 Bellini, G., e M. Cammarrota. *Methodological Approach for Statistics on Waste Generated in Agriculture, Forestry and Fishing*. Rome: Istat, 2004. (Final report to Eurostat).

35 Ballin, M. *Statistics on Waste Management in Agriculture, Forestry and Fisheries: Waste Statistics Regulation 2150/02/Ec*. Rome: Istat, 2004. (Final report to Eurostat).

3.1.3 Thematic strategy on the sustainable use of pesticides

Regulation proposal for release of statistics on lists of authorised plant protection products (Ppp), sale and use, per country, is under discussion in the Dg Agri and has been recently presented at the Statistical programme committee meeting[36]. As stated in the 6th Eap, measures have to be taken for reduction in use of toxic substances – such as pesticides - and more appropriate techniques to distribute them have to be adopted. Pesticide is a generic term to indicate the substance or the product that kill pests, whether used in agriculture or for other purpose. Pesticides include both plant protection products[37], as defined in Article 2 of Council Directive 91/414/Eec of 15 July 1991 concerning the placing of plant protection products on the market, and biocidal products[38], as defined in Article 2 of Directive 98/8/Ec of the European parliament and council of 16 February 1998 concerning the placing of biocidal products on the market. In the following the term Ppp will be used.

The *Thematic Strategy on the Sustainable Use of Pesticides*[39] has been thus developed in order to reduce impact on human health and the environment. Main objectives are the following:

- minimising the hazards and the risks associated with pesticides use;
- improving controls on the use;
- reducing levels of harmful substances;
- encouraging the use of low-input or pesticide-free crop farming;
- establishing a system to report and monitor progresses, including development of appropriate indicators.

Given the existing legislation on authorisation of active substances and the identification of maximum residue levels on food and feedstuff, the idea is to develop a monitoring system that can fill the gap between the

36 Eurostat. *Spc 2004/54/11/en*. Luxembourg: Eurostat - 54th Meeting of the Statistical programme committee, 17th -18th November 2004.

37 Ppps are active substances and preparations containing one or more active substances that are used to protect plants or plant products against harmful organisms or prevent the action of such organisms. They can be used in different economic sectors.

38 Biocides are active substances and preparations used to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect of pests in non-agricultural sectors. Since some overlapping may occur, legislation clarifies differences between the two categories.

39 European commission Communication. *Towards a Thematic Strategy on the Sustainable Use of Pesticides*. Com (2002) 349 final.

first phase and the last one, in the pesticide lifecycle, focusing on use. The thematic strategy underlines trends in use of Ppps, which is still increasing despite policy integration process with environment issues, showing risks associated with production and use of such substances for direct or indirect exposure. It is also underlined which are the lack in knowledge such as, in the indirect exposure case, the effects on specific population target groups such as children or elderly, that should be studied specifically, and the potential cumulative effects of different Ppps. Referring to their fate and effects on the environment, spray drift, leaching or run-off are identified as causes of uncontrolled dissemination of Ppps that can lead to soil and water pollution. Other causes of pollution can be caused by cleaning of containers and equipments after application, as illegal disposal of Ppps or containers. Biodiversity can also be affected by Ppps use. Such negative effects can be reduced by respect of good application practices, through technical inspection of distribution equipment, by the spreading of new Ppps marketed in soluble containers, the introduction of a system of safe collection and destruction of Ppps containers and unused products, a system of weather and pest forecast, and a system of training for farmers, supporting the adoption of low-input or Ppps free farming technique.

As previously described in paragraph 2.2, policies directed to prevent such negative effects are, among others, the Directive 80/778/Eec on drinking water and the Directive 2000/60/Ec on water framework, which set out a “strategy against pollution of water”, together with the already mentioned agri-environmental measures, integrated in the sectoral policy within the Cap reform process. These Directives identify substances to monitor and establish active substances concentration thresholds to classify the water chemical status.

Instruments for monitoring progresses done are statistics and indicators, thus, beside indicators included in the Irena list (some referring to driving factors, pressures and actual or potential Ppps concentration in soil and water), a proposal for a regulation of the European parliament and council on pesticides statistics is under discussion. Main issues are production and delivering of statistics on list of authorised Ppps, sale and use of Ppps per economic sector (agriculture, horticulture, forestry, uses in public areas, gardening and use by amateurs, other sectors of use) and

per active ingredient. The regulation will define for the coverage of statistics, the reference period, the periodicity for results transmission to the Commission, and the criteria to depict the quality report. The authorised Ppps list, sale and use should have different periodicity (biannual for the list, yearly for sale, every five years for use with a medium term assessment on the most important crops or activities covering 80 percent or more of all uses).

In all case, the reporting unit is in weight of active substances contained in Ppps. For this purpose a harmonised list of active substances, based on the chemical family they belong to, has been prepared.

CHAPTER FOUR

STATISTICS DEMAND ON AGRICULTURE AND ENVIRONMENT ARISING FROM INTERNATIONAL ORGANIZATIONS

Statistics demand, to monitor achievement of defined targets or to show progresses in the integration of environment related issues in sectoral policy, is organised in indicator lists defined at International level. These lists originated for different reasons and targets, thus, partial or complete, overlapping among indicators may occur. Therefore, it is important in indicator development and implementation process to bear in mind what are the main goals to achieve and which are the existing indicators in order to make harmonization possible.

In the following the main conceptual frameworks, *driving forces, pressures, state, impacts and responses* (Dpsir) and *sustainability* schemes, and the related indicators lists are presented, in some cases showing indicators overlapping.

4.1 The Dpsir conceptual model and related indicators lists

Environmental phenomena are for their peculiar nature complex. Reasons for this complexity arise for their origin, for the modalities with which they arise and for the relationship with the territory. The knowledge on the existing relationships, in terms of flows of energy and materials, in the bio-sphere and in the techno-sphere is the first step in phenomenon analysis and for the promotion of programmes and actions for the environment protection. The events occurring in the bio-sphere develop according to circles which are basically closed, whereas the actions referring to the technosphere imply the use of natural resources coming from the biosphere, main-

ly to produce goods, and releasing at the same time residues that in turn modify the chemical and physical composition of the receiving media.

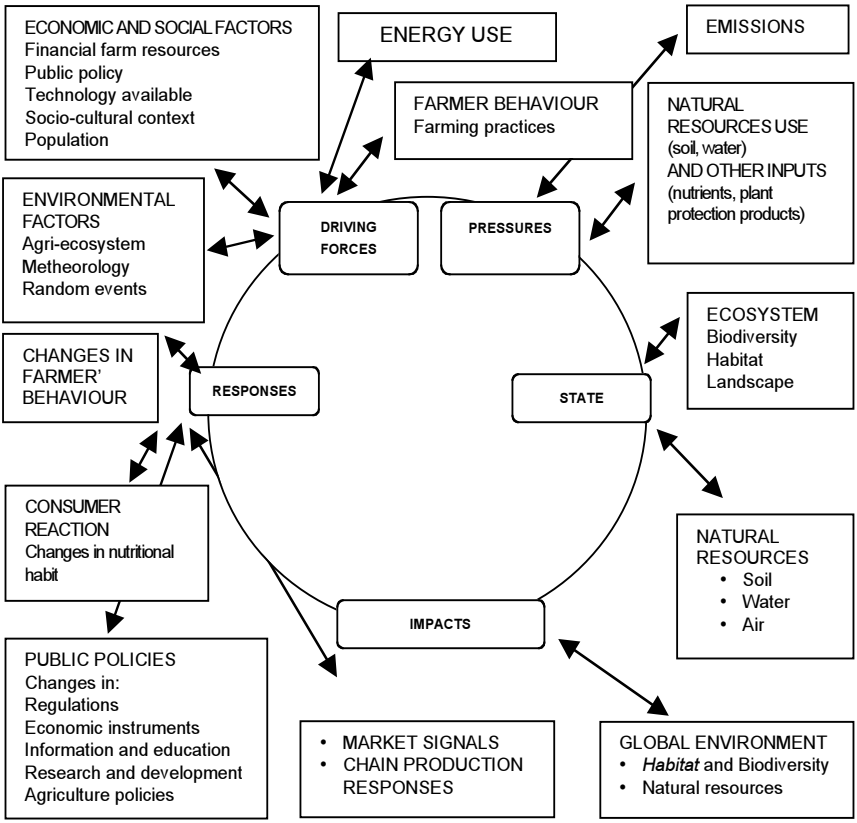
At international level, the conceptual model to describe such relationships was defined by the Organization for economic co-operation and development (Oecd) first and than integrated by the European environmental agency. This scheme is known as *driving forces*, *pressures*, *state*, *impacts*, and *responses*. It includes driving forces, the activities or contexts that are responsible of pressure on the environment; pressures, exerted on environmental media that refers to the abovementioned flows and able to change the state - in qualitative and/or quantitative terms - of environmental resources; impacts are thus originated and due to changes in state; the cycle closes with responses, that public and private actors apply to prevent damages and/or restore adequate environmental conditions, which in turn will start a new cycle.

Referring to pressures, the scheme is applied at six economic sectors, including agriculture, and ten different environmental themes, identified on the base of the issue areas on which environmental policies refer to. The themes are: *air pollution*, *climate change*, *biodiversity loss*, *marine environment and coastal zones*, *ozone layer depletion*, *resource depletion*, *toxic substances dispersion*, *urban environmental problems*, *waste*, and *water pollution and water resources*.

According to this framework, agriculture activity is a production process located in the technosphere. This activity modifies in diverse ways the biosphere compartments (soil, air, water) and resources as biodiversity, both at local and global level, modifications that depend on several factors and particularly on how farming activity is conducted.

In figure 4.1 main components of the conceptual Dpsir scheme, for the agriculture case, are represented. This framework allows a better comprehension of the complex relationships through which the agriculture activity interacts with the environment, to identify modalities and phenomena worthy of monitoring, and useful actions to modify activities that generate pressures. It is important to underline that farming practices adopted at farm level can be used to describe the generation of pressures, whereas pressures consist, among others, in the use of natural resources, of substances for fertilisation and for plant protection and in the emissions and waste generated in several farming processes.

FIGURE 4.1 Dpsir scheme components for the agriculture sector



Source: Oecd scheme[40] modified by the author

[40] Oecd. *Environmental Indicators for Agriculture. Methods and Results.* Paris: Oecd - Publications Service, 2000.

Analysing the relationships in the Dpsir scheme can help in identifying the necessity of:

- improving knowledge on physical, chemical, and biological factors that determine modifications in the environment component and that are related to changes occurred in farming practice, in input use and in kind of production realised;
- improving knowledge on economic, socio-cultural and policy factors that affect agriculture activity and thus the related effects on the environment;
- quantifying each component of the Dpsir scheme through high quality data collection.

Furthermore, the scheme is useful to:

- define indicators that are coherent and classifiable according to the scheme itself;
- address basic statistical production to calculate such indicators,
- highlight data gap;
- support the analysis on ways and timetables to fill existing information gaps.

4.1.1 European system of environment pressure indices

The actions defined in the 5th Environment action programme for the integration of the environmental issues into economic policies have been implemented thanks to the European commission Communication Com(94)670, in which knowledge tools for the implementation of actions are identified. The European system of environment pressure indices (Esepi), aimed at describing in physical terms the pressure generated by human activities on the environment for each environmental issue (paragraph 4.1), represents the operational synthesis.

The project, organised according to three modules, made possible Esepi realization[41]. The modules are as follows:

- Environmental pressure information system projects (Epis), with the objective of preparation of an information system that can provide

[41] Jesinghaus J. *Pip Project: First Results of the Second Survey among the Scientific Advisory Groups: Short Version.* 26 November 1996.

the environmental pressure indicators required integrating physical and economic data;

— Pressure indicators pilot projects (Pip), with the objective of identifying the demand for indicators, making reference to the different environmental problem areas;
— Sectoral infrastructure projects (Sip), with the objective of bearing in mind the demand, to identify the supply of indicators, making reference to the different sectors.

The Pip at first identified a very wide indicators list, reviewed in order to include only the priority indicators. In 1999, the results of the project Towards a European system of environmental pressure indicators and indices (Tepi) have been published, including 60 pressure indicators, six for each environmental theme.

Following the realisation also of the Sip projects, a final study *Environmental Pressure Indicators. Sectoral Indicators Project: Harmonisation of the Sip Results*[42] was carried out to identify a univocal list. Lists of indicators identified with the Tepi report or evaluated by the Scientific advisory groups were also taken into account. The criterion adopted to select a limited and significant group of pressure indicators per sector of activity was the relative importance with respect to the "environmental indicators area" and the sectors considered. Referring to selecting criteria, it is important to recall that the former lists of indicators were identified in relation with analytical soundness, political relevance, and elasticity of response of the indicator itself.

In the following the list considered for agriculture sector is reported (Table 4.1). According to this approach only indicators referring to pressures or to driving forces have been identified per environmental problem area.

In some cases, as for water abstraction and use, pressures can be relevant for more than one environmental problem area (for the specific case resource depletion and water pollution and water resources). Main guideline was to keep as clear as possible the distinction between human and ecological problems. Referring to resource depletion, the criterion to select relevant indicators was the availability or the capacity to regenerate

42 Costantino, C., A. Femia. "Environmental Pressure Indicators – Sectoral Indicators Project: Harmonisation of the Sip Results". In Contabilità ambientale e 'pressioni' sull'ambiente naturale: dagli schemi alle realizzazioni. Roma: Istat, in corso di stampa. (Annali di statistica).

TABLE 4.1 Indicators list defined for the agriculture sector

Environmental problem area	Indicator	Note (Unit of measure: um)	Dpsir classification
Air pollution	Emissions of nitrogen oxides (NOx)	Total annual emissions (Tonnes per year)	Pressure
	Emissions of non-methane volatile organic compounds (Nmvoc)	Total annual emissions (Tonnes per year)	Pressure
	Emissions of particles	Total annual emissions (Tonnes per year)	Pressure
	Emissions of ammonia (NH3)	Total annual emissions (Tonnes per year)	Pressure
Climate change	Emissions of methane (CH4)	Mainly generated in livestock breeding activity (Tonnes per year)	Pressure
	Emissions of carbon dioxide (CO2)	Total annual emissions (Tonnes per year)	Pressure
	Emissions of nitrous oxide (N2O)	Mainly generated in intensive farming activity with high use of nitrogen fertilisers (Tonnes per year)	Pressure
	Emissions of nitrogen oxides (NOx)	Total annual emissions (Tonnes per year)	Pressure
	Emissions of aerosol particles	Total annual emissions (Tonnes per year)	Pressure
	Emissions of carbon monoxide (CO)	Total annual emissions (Tonnes per year)	Pressure
Loss of biodiversity	Protected area loss, damage and fragmentation	Mainly generated from transport infrastructure (% of protected areas loss with respect to a reference year)	Pressure
	Wetland loss through drainage	Agriculture is identified as main responsible factor (% of protected areas loss with respect to a reference year)	Pressure
	Agriculture intensity: area used for intensive arable agriculture	Crop identified as intensive with respect to general agronomic information on the specific crop (ha)	Driving force
	Clearance of natural & semi-natural forested areas	% of natural & semi-natural forested areas is lost to allow the practice of agricultural activity (% of area loss)	Pressure
	Change in traditional land-use practice	Traditional land-use practice are linked to a more diverse land-use (ha)	Driving force
	Pesticide use on land	(kg or tonnes of active substances per ha of Uaa, weighted by toxicity)	Pressure
	Loss of forest diversity – increase in exotic monoculture	(um not defined)	Pressure
	Increase in cultivations of hybrid cultivars	(um not defined)	Pressure
	Loss of genetic resources	Ind. refers to agricultural crops (um not defined)	Pressure
Marine environment and coastal zones	Eutrophication (amounts of nitrogen and phosphorus introduced into waters)	Even if the Eutrophication can become evident in marine environment (Tonnes per year)	Driving force
	Fishing pressure	(Tonnes per year)	Pressure
	Wetland loss in coastal zones	Agriculture is identified as main responsible factor (Ha per year)	Pressure
	Discharges of halogenated organic compounds	(Tonnes per year)	Driving force
	Faecal pollution	It refers to faecal material discharged to water (Tonnes per year)	Pressure

Environmental problem area	Indicator	Note (Unit of measure: um)	Dpsir classification
Ozone layer depletion	Emissions of carbon dioxide (CO2)	(Tonnes per year)	Pressure
	Emissions of nitrous oxide (N2O)	(Tonnes per year)	Pressure
	Emissions of methyl bromide (CH3Br)	This product is used in agriculture as soil fumigant (Tonnes per year)	Pressure
	Emissions of methane (CH4)	(Tonnes per year)	Pressure
Resource deplention	Nutrient-balance of the soil (nutrient input/ nutrient output)	The balance can reveal the existence of nitrogen surplus (kg per ha)	Pressure
	Timber balance (new growth/harvest)	The balance can reveal the existence of removal exceeding new growth capacity (m^3 per m^3)	Pressure
	Exceedance of fish catch quota	(um not defined)	Pressure
	Use of energy (total quantity)	(um not defined)	Driving force
	Water consumption (total quantity)	(Millions of cubic meters per year)	Driving force
	Ground water abstraction for agricultural purposes	(Millions of cubic meters per year)	Pressure
	Surface water abstraction for agricultural purposes	(Millions of cubic meters per year)	Pressure
	Soil erosion	(um not defined)	Pressure
Dispersion of toxic substances	Consumption of pesticides by agriculture	(Tonnes per year; by toxicity, or other environmental characteristics if available)	Pressure
	Emissions of persistent organic pollutants (POPs)	(Tonnes per year)	Pressure
	Index of heavy metals emissions to water	(um not defined)	Pressure
Waste	Hazardous waste (according to the directive 91/689/Ewc)	See paragraph 5.4 for related statistical activity (Tonnes per year)	Driving force
	Waste from agriculture	See paragraph 5.4 for related statistical activity (Tonnes per year)	Driving force
Water pollution and water resources	Pesticides used per hectare of utilised agriculture area	(kg or tonnes of active substances per ha of Uaa)	Pressure
	Nutrient (N+P) use (eutrophication equivalents) Ms – Sip	(um not defined)	Driving force
	Emissions of organic matter as BOD	(um not defined)	Pressure
	Emissions of heavy metals, by metal	(um not defined)	Pressure
	Ground water abstraction	(Millions of cubic meters per year)	Pressure
	Surface water abstraction	(Millions of cubic meters per year)	Pressure
	Water used	(Millions of cubic meters per year)	Pressure

Source: Istat. *Contabilità ambientale e 'pressioni' sull'ambiente naturale: dagli schemi alle realizzazioni.* (a cura di Costantino C., A. Femia e A. Tudini). Roma: Istat, in corso di stampa. (Annali di statistica).

of the specific resource. For instance wood harvest can affect wood stock only when removal exceeds the regeneration capacity of timber, in a given period of time. Direct intake and consumption referred to a specific sector

can have different figures, in fact direct intake can be realised from a sector for the use of another one.

In more general terms the identification of an indicator list represents a way to better define the basic information needs, and the more they are simple and keep separated different acting pressures the more this data demand is clear. There is thus a general tendency to avoid synthetic indices for whose interpretation ancillary information might be necessary, making phenomenon analysis more complicated.

4.1.2 The Irena project

The Irena (Indicator reporting on the integration of environmental concerns into agriculture policy) project has been launched in year 2001, following the Commission Communications Com(2000)20 *Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy*, and Com(2001)144 *Statistical Information Needed for Indicators to Monitor the Integration of Environmental Concerns into the Common Agricultural Policy*.

The project, conducted at Eu level, is coordinated by the European environmental agency (Eea). Other partners involved are the Directorate general for Agriculture and the one for Environment, Eurostat and the Joint research centre[43]. Thus Commission's services started the statistical work to develop indicators, identifying proper indicators and related definitions, also identifying available and exploitable data sources or data collection methods, implementing methodologies. This work, done at European level involving - through Eurostat activity - Member States (Ms), would guaranty harmonisation and comparability of the developed indicators among the Ms themselves.

It is important to remind main aims of the work undergone and the criteria adopted for choosing agrienvironmental indicators.

As stated in Com(2001)144 "a solid set of indicators is needed: i) to help monitor and assess agrienvironmental policies and programmes, and to provide contextual information for rural development in general;

[43] The related final report *Agriculture and Environment in the Eu-15: the Irena Indicator Report* is available. All documentation is available at Eea web site http://reports.eea.eu.int/eea_report_2005_6.

ii) to identify environmental issues related to European agriculture; iii) to help target programmes that address agrienvironmental issues; iv) to understand the linkages between agricultural practices and the environment. The main criteria for choosing agrienvironmental indicators are: a) policy-relevance - address the key environmental issues; b) responsiveness - change sufficiently quickly in response to action; c) analytical soundness - based on sound science; d) measurability - feasible in terms of current or planned data availability; e) ease of interpretation - communicate essential information in a way that is unambiguous and easy to understand; f) cost effectiveness - costs in proportion to the value of information derived". For each indicator the level of development is indicated through a classification which ranges from (a) to (d). The group (a) contains indicators for which statistical data to implement them are immediately identified, for indicators in group (b) statistical work might require integration of data coming from different sources, group (c) contains indicators that still need further analysis in order to better define them, and in group (d) indicators are the ones were a deeper methodological work is needed to identify the proper indicator. The identified indicators are also classified according to Dpsir scheme. Nevertheless the final indicator classification, depending also on changes occurred during project development, can have been changed. In fact, the deepening occurred in indicator analysis revealed that for some of them the reference category needed to be changed, sometimes with an upgrade, in other cases with a downgrade, depending on the observed phenomenon and on availability of data sources and calculation methodology.

For each indicator a fact sheet, a methodology/data fact sheet or an indicator fact sheet has been produced, depending on phase of the analysis and development of the indicator. The methodology sheet focuses more on methodology proposed and on preliminary results and assessment of data sources, whereas the indicator fact sheet contains the final indicator assessment, done through obtained results, giving possible actions to perform at farm, policy and research level. They contain the following information:

— the title, containing the indicator name with the number used in Com(2001)144;

- the definition of the indicator;
- the indicator links, indicating which are the related indicators among the list as input and as output;
- classification according to Dpsir model;
- key message, revealing meaning of the indicator and eventually showing some results to support relevance of the monitored phenomenon;
- the methodological approach for the methodology/data fact sheets, providing a broader description of the phenomenon and describing methodology used to calculate the indicator, containing also a description of the data sources used, and related results, in which data time series and values for Ms are provided;
- the results and assessment, for the indicator fact sheets;
- references, for datasets and methodologies.

Metadata information is provided for technical aspects (data source, description of data, geographical coverage, temporal coverage, methodo-logy and frequency of data collection, methodology of data manipulation, where necessary), and quality of the information is given through the indicator. Information quality is described through several parameters: strength and weakness (at data level), reliability, accuracy, robustness, uncertainty (at data level); furthermore an overall scoring (1 to 3 points: 1=no major problems, 3=major reservations) is given for the following characteristics: relevancy, accuracy, and comparability over time and over space.

The identified indicators are thus classified according to the Dpsir framework. In the following they are described both according to the first draft version as required by the above-mentioned Communication and to the version of September 2004[44]. Depending on the indicator, a revision has been undertaken including revision of the chosen indicator, of the definition, of the data set identified to implement the indicator and the related data collection methodology. Briefly, for each one of them, the implementation story is reported in table 4.2 to show mainly which have been the aspects that needed deeper analysis and major attention.

[44] The final version of indicators sheets is available at http://webpubs.eea.eu.int/content/irena/index.htm.

TABLE 4.2 **Irena project indicators list**

			Com(2001)144			Revised version at 09/2004
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Public policy	4	Nature protection	Area and percentage of farmland subject to such restrictions, classified by type of farmland.	Restrictions on what may be produced and on the farming practices which can be used because the area is part of a nature protection zone covered, for example, by Natura 2000 or by voluntary agreements can exist. Compensation might be necessary.	R	Proportion of Nature 2000 sites covered by targeted habitats. 33 targeted habitats have been selected from Annex I. It is possible to calculate the share of targeted area sites in total land area and share of targeted sites in total sites area.
Market signals	5.1	Organic producer prices	Index of the relationship between the prices of organic products andthose of conventional products.	The difference between the market prices of conventional produce and organic produce is an indicator of the premium attached to organic products.	R	Interpretation of price premium can be controversial. Thus, it is recommended that the price premium indicator should be replaced by an alternative indicator on organic marketed products (absolute volumes and market share).
	5.2	Agricultural income of organic farmers	Economic results of organic farms compared to similar sized farms in the same area.	A second issue affecting the conversion to organic farming practices is the income for organic farmers.	R	Organic farm incomes have to be compared to similar conventional farms (to indicate combined impacts of prices, agrienvironmental support payments and other factors that are behind the development of organic farming in the Eu).
Technology and skills	6	Holders' training levels	Agrienvironmental training of farmers.	Additional technology and skills may be expected to lessen impact on the environment.	R	1. The level of agricultural training of managers of agricultural holdings. 2. The training in agrienvironmental issues.
Attitudes	7	Organic farming	Area under organic farming.	Organic farming involves a less intensive use of land, more varied cultivation practices and entails significant restrictions on the use of fertilisers and pesticides. It is ruled by Council Regulation 2092/91.	R	Share of the organic farming area in the total Utilised agricultural area (Uaa).

		Com(2001)144				Revised version at 09/2004
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Public policy	4	Nature protection	Area and percentage of farmland subject to such restrictions, classified by type of farmland.	Restrictions on what may be produced and on the farming practices which can be used because the area is part of a nature protection zone covered, for example, by Natura 2000 or by voluntary agreements can exist. Compensation might be necessary.	R	Proportion of Nature 2000 sites covered by targeted habitats. 33 targeted habitats have been selected from Annex I. It is possible to calculate the share of targeted area sites in total land area and share of targeted sites in total sites area.
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Technology and skills	6	Holders' training levels	Agrienvironmental training of farmers.	Additional technology and skills may be expected to lessen impact on the environment.	R	1. The level of agricultural training of managers of agricultural holdings. 2. The training in agrienvironmental issues.
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			Com(2001)144			Revised version at 09/2004
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Input use	8	Fertiliser consumption	Fertiliser use by crop and by region.	Risks of negative impact to human health and environment may grow with increased consumption of fertilisers.	D	Fertiliser consumption is indicated by the evolution of the consumption of nitrogenous (N) and phosphorous (P) mineral fertilisers over time. The Fao data set - used to calculate the indicator - is based on application rate.
	9	Pesticide consumption	1) Index of pesticide use, weighted to take into account different types of toxicity and use patterns, etc. 2) Pesticide use, classified according to intrinsic characteristics e.g. toxicities to non-target species, long term effects, persistence in the environment, etc.	The risks, to human health or to the environment vary considerably from one pesticide to another, depending on specific characteristics (i.e. toxicity, persistence) of their active substances and use patterns (i.e. volumes applied, application period and method, type of crop treated, type of soil).	D	The consumption of pesticides (here plant protection products, excluding biocides and disinfectant products; it refers to active substances) is indicated by: a) Used/sold quantities of different pesticides classes (as total amount, or volume of spread a.s. per ha); b) Application rates of different pesticides classes as provided by Ecpa.
	10	Water use	Use of water per €1000 output of irrigated crops.	Irrigation techniques applied, irrigation efficiency and water loss.	D	Irrigated area by crops type; Sub: water use efficiency index (crop water requirements per European size unit of irrigated crop by major irrigated crops).
	11	Energy use	Annual use of energy, by fuel type (i.e. petroleum products, electricity, natural gas).	Emissions reduction of CO2, energy efficiency.	D	1. Annual use of energy at farm level by fuel type. 2. Annual use of energy per unit of production, per ha of crop and per livestock unit.
Land use	12	Topological change	An inventory of developments classified by type and location.	Development activities have an important impact on the environment and landscape.	D	Land use change: area of land use change from agriculture to artificial (mines and waste dumpsite, transport, industrial and commercial site, housing, services and recreation) surfaces between 1990 and 2000.

Com(2001)144					Revised version at 09/2004	
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Land use	13	Cropping/ livestock patterns	The share of each holding in each category of the typology, (typology of agricultural practices and strategies to be developed).	Changes in land use may have an impact on environment.	D	1. Trends in the share of Uaa taken up by the major agricultural land uses: arable, permanent grassland, and permanent crops. 2. Trends in the share of the major types of livestock (cattle, sheep and pigs) of the total husbandry.
Management	14	Management practices	Definition to be developed.	The indicators needed in relation to the indicator areas 14, 30 and 31 have not yet been identified.	D	14a 1. Soil cover on arable land: % of days in a year in which soil is covered by crops or soil residues. 2. Tillage system: share of farmers adopting conservation tillage practice on arable land.
						14b 1. Type and capacity of storage facility for organic fertilisers. Type of storage refers to kind of manure stored and to presence of a cover. Covered facility to reduce gas emission. The insufficient capacity demands frequent spreading, despite plant needs and weather conditions. 2. Control and inspection of pesticide spraying equipment. Control and inspection reduce spreading of unwanted over doses.

			Com(2001)144			Revised version at 09/2004
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Trends	15	Intensification/ extensification	Only an example is given, the relation between livestock numbers and fodder areas.	All production factors can be intensified. Monitor factors that can lead to higher environmental and other risks as well as a reduction in diversity.	D	1. Trends in the area of rough grazing in the total Uaa. 2. Trends in the area of temporary and perma-nent grassland. 3. Trends in the area of fodder crops and fodder maize. 4. Trends in the area of fallow and set-aside land in the total Uaa. 5. Trends in common wheat production (kg/ha). 6. Trends in rice production (kg/ha). 7. Trends in grain maize production (kg/ha). 8. Trends in total cereals production (kg/ha). 9. Trends in forage maize production (kg/ha). 10. Trends in potato production (kg/ha). 11. Trends in sugar beet production (kg/ha). 12. Trends in total oil seed crop production (kg/ha). 13. Trends in total cow milk production (kg milk/dairy cow). 14. Trends in total sheep/goat production (kg milk/LU Ewes). 15. Trends in total beef production (kg meat/fattening LU) 16. Trends in total sheep/lamb production (kg meat/LU Ewes). 17. Trends in the average SGM per hectare. 18. Trends in livestock Units per hectare Uaa. 19. Trends in livestock units per hectare of fodder area.
	16	Diversification	Importance of different categories in the Community Typology. Proportion of farmers with other gainful activities. Ratio of farmers'agricultural/non-agricultural incomes.	Multi-functionality and off-farm activities (pluriactivity), farm viability.	D	1.Importance of and changes in types of farming according to a farming systems typology based on environmentally relevant parameters. 2. Proportion of farm income derived from forestry and on-farm tourism activities as share of the whole farm income as defined in Fadn. 3. The share of farms per Fss district with other on-farm and off-farm gainful activities split up in major and subsidiary occupations.

	Com(2001)144				Revised version at 09/2004	
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Trends	17	Marginalisation	State and evolution of the density of farms with and without successors.	Marginalisation as result of deterioration in the economic or physical environment. Cessation of agricultural activity.	D	1. Proportion of holdings with farmers aged 55 years and over. 2. Proportion of holdings with Farm Net Value added per Annual work unit below e.g. 50 percent of the average Fnva/Awu in that region.
Pollution	18	Surface nutrient balance	The soil surface nutrient balance is defined as total nutrient input (organic and mineral fertilisers, atmospheric deposition, fixation by leguminous crops) minus the uptake by crops (including removals by grazing).	Indicator refers to N and P fertilisers. Surpluses are responsible for nitrates leaching in water.	P	18-1. Gross nitrogen balance, 18-2. Gross phosphorus balance. 18subNewThis indicator shows the annual atmospheric emissions of ammonia (NH_3) as a trend, and the contribution that agriculture made to total atmospheric emissions of ammonia in the last available year.
	19	CH_4 emissions	Aggregated annual agricultural emissions of CH_4, N_2O and CO_2, weighted by global warming potential.	Emission of greenhouse gases. Installation of bio-gas plants.	P	Aggregated annual emissions from agriculture of CH_4 and N_2O, and relative to 1990 baseline levels expressed as CO_2 equivalents. Emissions from agricultural transport and energy use are excluded, as these sectors are not defined as part of the agriculture sector by the current Ippcguidance.
	20	Pesticide soil contamination	Definition to be developed.	Show the extent to which pesticide residues accumulate in the soil.	P	The quantity of Ppp remaining one year after the application. A case study presented is based on a modelling approach (Pearl), illustrating the quantity of the pesticides remaining in the top soil a year after their application.
	21	Water contamination	Definition to be developed.	Focus on pollutants such as heavy metals and organic chemicals including residues of veterinary products (i.e. potential pollutants not covered by indicator 30).	P	Heavy metals and organic chemicals residues in surface and ground water.

		Com(2001)144			Revised version at 09/2004	
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Resource depletion	22	Ground water abstraction/water stress	Annual amount of ground water pumped directly by farmers from ground water sources.	It is widely believed to be one of the main causes of falling water tables. Proposed tool: data collection.	P	1. Annual water abstraction for irrigation (m^3/y). 2. Mean water allocation rates (m^3/ha/y) irrigable area is used to calculate the water allocation rates.
	23	Soil erosion	Location and estimation of the amount of topsoil loss and maps of soil erosion risk. Land cover and agricultural practices in areas at risk.	Physical factors such as climate, topography and soil characteristics are important in the process of soil erosion, but the most important factors are the land cover and the agricultural practices. Furthermore, soil erosion can be linked to agrienvironmental measures.	S	Annual soil erosion risk by water. Outputs produced by Pesera model to quantify soil erosion by water and assess the associated soil erosion risk.
	24	Land cover change	Matrix of changes in LC classified by type and size.	Matrix of agricultural uses showing entries, exits and internal changes of use is the key requirement.	P	Areas of the entries and exits to and from agricultural and forest/semi-natural land between 1990 and 2000.
	25	Genetic diversity	1) The total number and shares in production of main crop varieties/ livestock breeds. 2) The number of national endangered crop varieties/ livestock breeds.	Agricultural biodiversity.	P	1. Share in production of main crop varieties registered and certified for marketing. The production area is expressed as the seed multiplication area. 2. Number of breeds per total livestock population for respective categories of livestock (cattle, pigs, sheep, goats and poultry). 3. Distribution of endangered risk status of national livestock breeds in agriculture.

	Com(2001)144				Revised version at 09/2004	
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Benefits	26	High nature value areas (Hnva)	Definition to be developed.	This indicator is a subset of indicator 4.	P	Share of Hnva over total Uaa. Hnva includes: farmland with high proportion of semi-natural vegetation and/or low intensity agriculture or a mosaic of semi-natural and cultivated land.
	27	Renewable energy sources	Area and volume of production of coppice woodland and of oilseed crop (intended for production of biodiesel).	Reduction of net Ghg emissions.	P	1. Land use devoted to energy crops cutlivation 2. Primary energy produced from crops and by-products (broken down into, a - Oilseed crops used for production of biodiesel, b - Starch and sugar crops used for production of bioethanol, c - Woody and herbaceous crops used for production of electricity and heat, d - Crop residues used for production of electricity and heat, e - On-farm residues including animal manure used for production of biogas).
Biodiversity	28	Species richness	Monitoring species linked to typical agricultural habitats	Bioindicators. Required analysis to distinguish between natural causes and man-induced changes.	S	This indicator is based on population trends of up to 24 selected bird species that are common and characteristic of European farmland landscapes (for restricted use).
Natural resources	29	Soil quality	Agricultural areas where there is a mismatch between soil capability and the actual or impending land use.	Soil characteristics (topography, rooting depth, fertility, organic carbon, water retaining capacity, texture).	S	Top-soil (0-30cm) organic carbon content. Decline of soil organic carbon content has been identified as one of the priority areas.
	30	Nitrates/ Ppps in water	Definition to be developed.	Monitoring Nitrates and Pesticides concentration in ground and surface water.	S	Nitrates in water are indicated by annual trends in the concentrations of nitrates (NO_3 mg/l) in ground and surface water bodies. For Ppp: atrazine and simazine concentration are considered.

			Com(2001)144			Revised version at 09/2004
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Natural resources	31	Ground water levels	Definition to be developed.	Over-extraction of ground water.	S	Time series of ground water levels can detect overexploitation of ground water. Ground water overexploitation is occurring when average aquifer abstractions are greater than (or close to) average recharge rates.
Landscape	32	Landuse matrix	Number and diversity of memorable elements visible. (To be refined).	The Commission has established an inventory of national systems used for the landscape evaluation.	D	1.Fss percentage of agriculture crops types in total land area (arable land, grassland, permanent crops). 2. Clc number of agricultural classes. 3. Clc patch density. 4. Lucas number of linear elements.
Natural resources	33	Habitat and biodiversity	Density of linear elements and diversity of land cover at the level of the holding.	Agriculture contributes to the management of the natural habitat both in cultivated areas and in the interstices between them such as hedges, ditches and other boundaries.	I	Impact on habitat and biodiversity. Conservation status of Prime Butterfly areas, where target species are considered linked to agriculture. 1. % of agricultural site where agriculture exerts a negative impact. 2. % of target species in decline at the sites.
	34.1	Ghg emissions	Greenhouse gas emissions by economic sector.	Agriculture is but one sector contributing to emissions, contamination and water stress. Methodology to distinguish between different sources of nitrate emission is required.	I	Contribution of the agricultural sector to total Eu-15 emissions of the greenhouse gases CO_2, CH_4, and N_2O.
	34.2	Nitrate contamination	Nitrogen emissions to water by economic sector.		I	Share of agriculture in nitrate contamination (at present methodogy is not developed).
	34.3	Water use	Water use by economic sector.		I	Share of agriculture in water use.

Com(2001)144					Revised version at 09/2004	
Thematic area	**No.**	**Indicator**	**Definition/1st**	**Concept/key words**	**Dpsir**	**Definition/last**
Landscape diversity	35	Agricultural and global diversity	Indices of overall and of agricultural diversity and of their evolution through time.	Landscape is the result of the interactions between agriculture and other users of land.	I	Impact on landscape diversity. Evolution of some of the indices presented under ind. 32 (crop type distribution change and change in linear features).

D: Driving forces; P: Pressures; I: Impacts, S: State; R: responses
Clc: Corine land cover
Fss: Farm strutcure survey
Pesera: Pan-european soil erosion risk assessment
Lucas: Land use/cover area frame statistical survey
Ecpa: European crop protection association (Industry)
Pearl: Pesticide emission assessment at regional and local scales
Ppp: Plant protection products

Problems encountered in indicator definition and development are:

— develop a better indicator definition;
— develop a methodology;
— checking discrepancies between data produced for a given country and data available at country level;
— indicator calculation and evaluation, to find a good descriptor of the investigated phenomenon, and to find an evident relationship between the indicator and the agricultural activity;
— highlight data gaps, at European and at country level.

4.1.3 Oecd

Oecd agrienvironmental indicators have been classified under 4 main theme areas (Table 4.3), each one including one or more sections:

— agriculture in the broader economic, social and environmental context (including two sections on *contextual information* and indicators on *farm financial resources*);

TABLE 4.3 **Oecd agrienvironmental indicators list and overlap with Irena indicators**

Themes	Sub-themes		No.	Indicator	Overlap with Irena indicators	
					Irena indicator number	Overlap grade (C=complete; P=partial; N= no overlap)
I. Agriculture in the broader economic, social and environmental context	1. Contextual information		I.1.1	Agricultural GDP	-	N
			I.1.2	Agricultural output	15	P
			I.1.3	Farm employment	17	P
			I.1.4	Farmer age/gender distribution	17	P
			I.1.5	Farmer education	6	C
			I.1.6	Number of farms	13	P
			I.1.7	Agricultural support	-	N
			I.1.8	Stock of agricultural land	13	P
		Land use	I.1.9	Change in agricultural land	12/13	P
			I.1.10	Agricultural land use	13	P
	2. Farm financial resources		I.2.1	Farm income	5.2/16	P
		Agrienvironmental expenditure	I.2.2	Public and private agri-environmental expenditure	1	P
			I.2.3	Expenditure on agri-environmental research	-	N

Themes	Sub-themes		No.	Indicator	Overlap with Irena indicators	
					Irena indicator number	Overlap grade (C=complete; P=partial; N= no overlap)
II. Farm management and the environment	1. Farm management	Whole farm management	II.1.1	Environmental whole farm management plans	4/7	P
			II.1.2	Organic farming	7	C
		Nutrient management	II.1.3	Nutrient management plans	-	N
			II.1.4	Soil tests	-	N
		Pest management	II.1.5	Use of non-chemical pest control methods	-	N
			II.1.6	Use of integrated pest management	-	N
		Soil and land management	II.1.7	Soil cover	14	C
			II.1.8	Land management practices	14	P
		Irrigation and water management	II.1.9	Irrigation technology	-	N
III. Use of farm inputs and natural resources	1. Nutrient use		III.1.1	Nitrogen balance	18	P
			III.1.2	Nitrogen efficiency	-	N
	2. PPP use and risks		III.2.1	Pesticide use indicator	9	C
			III.2.2	Pesticide risk indicator	-	N
	3. Water use	Water use efficiency	III.3.1	Water use intensity	10	C
			III.3.2	Water use technical efficiency	10	P
			III.3.3	Water use economic efficiency	10	P
			III.3.4	Water stress	22	P
IV. Environmental impacts of agriculture	1. Soil quality		IV.1.1	Risk of soil erosion by water	23	C
			IV.1.2	Risk of soil erosion by wind	-	N
	2. Water quality		IV.2.1	Water quality risk indicator	21/30/34.2	P
			IV.2.2	Water quality state indicator	21/30	P
	3. Land conservation		IV.3.1	Water retaining capacity	-	N
			IV.3.2	Off-farm sediment flow	23	P
	4. Gross Ghg emissions		IV.4.1	Gross agricultural greenhouse gas emissions	19	C
	5. Biodiversity	Species diversity	IV.5.1	Genetic diversity	25	C
			IV.5.2	Wild species	28	C
			IV.5.3	Non-native species	28	P
			IV.5.4	Ecosystem diversity	33	P
	6. Wildlife habitats		IV.6.1	Intensively farmed agricultural habitats	15	P
			IV.6.2	Semi-natural agricultural habitats	24/26	P
			IV.6.3	Uncultivated natural habitats	24/32	P
			IV.6.4	Habitat matrix	28	P
	7. Landscape	The structure of landscape	IV.7.1	Environmental features and land use patterns	32	P
			IV.7.2	Man-made objects	32	C
			IV.7.3	Landscape management	-	N
			IV.7.4	Landscape costs and benefits	12/35	P

— farm management and the environment (including only the *farm management* section);
— use of farm inputs and natural resources (including sections on *nutrient use*, on *Ppp use and risks*, on *water use*);
— environmental impacts of agriculture (with sections on *soil quality*, *water quality*, *land conservation, gross Ghg emissions, biodiversity, wildlife habitats, landscape*).

In the table 4.3 overlapping between indicators identified in the Irena list and in the Oecd list is presented (the list refers to Oecd indicators presented in year 2003).

It is worthy to underline the existence of a wide area of overlapping between the two lists. In terms of thematic areas, Irena list differs from the Oecd one, since it focuses more on public policy indicators and on indicators related to economic parameters on organic farming and, on changes occurring in farming systems (intensification, specialisation) and on some pollution related phenomena. Methodological work is stepping towards and a wider overlapping might still be realised. In some cases, harmonisation can still be desirable, nevertheless targets and objectives of the two lists might be still different and not necessarily, a complete overlap might be achieved.

4.2 Sustainability framework and related indicators lists

The organisational framework adopted in the sustainable development approach for selecting the related indicator list was drawn from the one discussed during the 9th session of the Commission on sustainable development (Csd) of the Un. Moving from a *driving force-state-response* approach they finally adopted the one focusing on themes and sub-themes of sustainable development. This approach revealed to be more appropriate to assist national policy decision-making and performances measurement by focusing on relevant policy issues.

Issues covered by theme and sub-theme are reported in table 4.4, as defined by the Commission Communication - upon Council request - in the Report from the Commission to the Council: *Analysis of the 'Open List' of*

45 European commission Communication. *Analysis of the 'Open List' of Environment-related Headline Indicators*. Com (2002) 524 final.

TABLE 4.4 Theme and sub-theme scheme for sustainable development indicators

THEME	SUB-THEME
1. Economic development	Investment Competitiveness Employment
2. Poverty and social exclusion	Monetary poverty Access to labour market Other aspects of social exclusion
3. Ageing society	Pensions adequacy Demographic changes Financial stability
4. Public health	Human health protection and lifestyles Food safety and quality Chemicals managements Health risks due to environmental conditions
5. Climate change and energy	Climate change Energy
6. Production and consumption patterns	Eco-efficiency Consumption patterns Agriculture Corporate responsibility
7. Management of natural resources	Biodiversity Marine ecosystem Fresh water resources Land use
8. Transport	Transport growth Social and environmental impact of transport
9. Good governance	Policy coherence Public participation
10. Global partnership	Globalisation of trade Financing for SD Resource management

Source: Com (2002) 524 final

Environment-related Headline Indicators[46].

On the other hand, an indicator framework has been developed also for the sustainability of the agricultural activity. The Commission staff working paper on the framework for indicators for the economic and social dimensions of sustainable agriculture and rural development[46] depicts such framework that outlines linkages between different dimensions.

The key issues of sustainability are the maintenance of a certain level of capital stocks (natural, human and man-made capital) as well as achieving efficiency and equity.

46 European commission. *Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development.* Sec (2001) 266. (Staff working paper).

Maintenance (protection, renewal) of a combination of stocks (natural, human and man-made) to sustain wellbeing can be done according to different criteria which refer to *weak* or to a *strong* sustainability. The *weak* approach implies that different forms of capital can substitute each other in order to maintain the total capital, whereas the *strong* one requires the conservation of total capital and of specific components, i.e. natural capital has to be constant or maintained according to carrying capacity or resilience rules.

Sustainability requires the combination of efficiency conditions and inter-generational and intra-generational equity. The inter-generational equity stresses that the use of resources should generate a welfare today that is not at the detriment of future welfare (the essence of the sustainability definition in the Brundtland report), whereas the intra-generational equity would consist in the possibility for all members of all societies to access to resources, reaching a certain level of wellbeing.

4.2.1 Sustainable development indicators

Lately the European strategy towards a sustainable development has been characterised by several Councils defining framework and policy content and tools to monitor involved phenomena. At first (March 2000), the Lisbon council identifies the goal of an economy *knowledge based* with a growing attention to social coesion. In order to evaluate progresses towards these objectives the Annual report was set up based on a shared list of structural indicators. The Nice council (December 2000) focused on the relevance of social protection goals, thus improving the indicators identified on poverty and social exclusion area. The Stockolm council (March 2001) stresses the necessity to report on progresses towards Lisbon goals through a properly defined set of indicators. Finally the Gothenburg council (June 2001) defines the strategy for a sustainable development adding the environmental dimension - as new pillar - to the Lisbon strategy. Thus, in the spring report of Barcelona (March 2002), the structural indicators are presented with the inclusion of the ones on environmental issues.

In order to monitor policy implementation and effectiveness towards

defined targets, a task force has been set up at Eurostat level by the Statistical programme committee to develop a common response to the need for indicators on sustainable development (Sdi)[47].

Nevertheless it was agreed that selected indicators were not yet adequate and the Commission upon Council request released the Report from the Commission to the Council: *Analysis of the 'Open List' of Environment-related Headline Indicators* in which the open list of indicators defined by the Council was analysed, and data and methodology availability were assessed[48].

The list of indicators has been identified adopting a scheme developed in a hierarchical structure with three different levels: the first level refers to the themes and headline indicators are identified, the second level refers to the sub-theme and indicators have been identified for the related subsections, than a third level is available with a more detailed list of indicators[49] (see an extract in table 4.5).

In the indicator identification process, one of the problems encountered was the proper allocation of a specific issue under the proper theme. In fact, many of the issues of sustainable development can be seen as belonging to more than one theme. Main effort was thus put into a univocal indicator classification, in order to avoid duplication, trying to better defining boundaries between themes.

Some of the boundaries are here reported for agriculture related issues, to show how this kind of problem has been solved, and which principles have been applied.

In general, sectoral contributions to various themes are generally shown as standardised sectoral breakdowns of specific indicators. Only the most relevant issues are presented in some of the sub-themes like *climate change and energy* (energy / energy consumption and production), *public health* (agriculture / pesticide residues in food products), *production and consumption patterns* (agriculture / environmentally friendly farming) and *transport* (transport growth / fuel use).

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47 Eurostat. *Spc 2004/54/11/en*. Luxembourg: Eurostat - 54th Meeting of the Statistical programme committee, 17th -18th November 2004.

48 In this document the indicators have been classified according to a feasibility scale, ranging from group 1 - the most feasible - to group 4 - the least feasible one -.

49 A draft of the *Final Report* of the Sdi task force to the Statistical programme committee has been presented at the Meeting of the Ess Task force on Methodological issues for Sdi. [Sdi/Tf/53/6(2005)]. Luxembourg: Eurostat, 25-26 April 2005.

TABLE 4.5 **List of agriculture related sustainable development indicators**

Theme (Level I)	Sub-theme	Level II	Level III	Headline Objectives in the Eu Sd Strategy (Sds) Presidency conclusions of European Council (Ec) Plan of Implementation (Pol) 6th Environmental action Programme (6Eap)
PUBLIC HEALTH [……]	Food safety and quality	- *Pesticide residues in food* - Pesticide residues in products of plant origin	[…..]	Sds: Make food safety and quality the objective of all players in the food chain. 6Eap: Reduce impacts of pesticides on human health and environment; achieve a more sustainable use of pesticides, a significant overall reduction in risks and use of pesticides consistent with the necessary crop production.
	Chemicals management	- *Chemical index*	- Occupational diseases caused by certain chemical agents	Sds: By 2020, ensure that chemicals are only produced and used in ways that do not pose significant threats to human health and the environment. 6Eap: Dangerous chemicals (especially PBTs) should be substituted with the aim of reducing risks to man and the environment (ground and surface water, air quality).
CLIMATE CHANGE AND ENERGY	Climate change	- Ghg emissions by sector (a)	- CO_2 intensity of energy consumption - *Losses caused by extreme weather conditions (insurance payouts)* - *CO_2 removed by sinks*	Sds: Meet the Kyoto commitment. However, Kyoto is but a first step. Thereafter, the Eu should aim to reduce atmospheric greenhouse gas emissions by an average of 1% per year over 1990 levels up to 2020.
	Energy	- Final energy consumption by sector (b)	- Share of renewable energy (including indicative targets), by source - *Consumption of biofuels, as a % of total fuel consumption in transport*	Ec Brussels2003: (revised SDS objective) Increase the share of renewable energy with a Eu-wide indicative target for renewable energy of 12 percent of primary energy needs and 21 percent of electricity needs by 2010. Promotion of 5,75 percent target for the use of biofuels in transport by 2010.
PRODUCTION AND CONSUMPTION PATTERNS	Agriculture	- Nitrogen surplus	- Livestock density index - Share of organic farming - Use of selected pesticides	Sds: The Cap should contribute to achieving sustainable development by encouraging healthy, high quality products, environmentally sustainable production methods, including organic production, renewable raw materials and the protection of biodiversity.

Theme (Level I)	Sub-theme	Level II	Level III	Headline Objectives in the Eu Sd Strategy (Sds) Presidency conclusions of European Council (Ec) Plan of Implementation (Pol) 6th Environmental action Programme (6Eap)
MANAGEMENT OF NATURAL RESOURCES - Population trends of farmland birds -	Biodiversity	- Sufficiency of Member States proposals for protected sites under the Eu Habitats directive	- *Change in status of threatened and/or protected species*	Sds: Protect and restore habitats and natural systems and halt the loss of biodiversity by 2010. 6Eap: Conservation of species and habitats with a special concern of preventing habitat fragmentation. Ensure that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment. Pol2002: Achieve by 2010 a significant reduction in the current rate of loss of biological diversity.
	Fresh watet resources	- Fresh water abstraction as % of available resources		6Eap: Ensure that the rates of extraction from water resources are sustainable over the long term. Achieve quality levels of ground and surface water that do not give rise to significant impacts on and risks to human health and the environment. Pol2002: Develop integrated water resources management and water-efficiency plans by 2005.
	Land use	- Land use change (Evolution of built-up, natural and agricultural land) - Exceedance of critical loads of acidifying substances and N in sensitive natural areas	- *Total area at risk of soil erosion* - *Total area of soil contamination* - Percentage of forest trees damaged by defoliation	6Eap: Conserve and restore areas of significant landscape value including cultivated and sensitive areas. Promotion of sustainable use of the soil, with particular attention to preventing erosion, deterioration, contamination and desertification. Pol2002: Accelerate the implementation of the Ipf/Iff proposals for action and by the Collaborative Partnership on Forests, and intensify efforts on reporting to the UN Forum of Forests so as to contribute to an assessment of progress in 2005.

Source: Eurostat. *Sdi/Tf/44/04 Rev. 6.* 2004
(a) According to the sectors defined by the Intergovernamental panel of climate change (Ipcc).
(b) According to sectors applied in the Eu energy statistics
Normal text = *best available* indicator i.e. indicator expected to be available; if numbered with an 'a' then is a proxy indicator for the best needed of the same number
Italic text = *best needed* indicators; needed but facing problems of definition, data availability or data quality

In the case of emissions to air: all emissions of Ghg are allocated under the theme *climate change and energy*, whereas the reduction in the Ghg emissions in countries and under the Clean development mechanism of the Kyoto protocol is under the theme *global partnership*. Emissions of

particulates are classified under *public health.* Ozone precursors are under *production and consumption patterns*. Acidifying substances are classified depending on the aspect studied: emissions are under *production and consumption patterns*, whereas their deposition in under *management of natural resources*; also nitrogen affecting the state of vegetation is in the *management of natural resources*.

For water related issues it is possible to find drinking water quality in *public health*, water use by sectors in *production and consumption patterns*, and water resources and pollution in *management of natural resources*.

The land use issue is located under *management of natural resources*, but the fragmentation of ecosystems due to transport infrastructure belongs to the *transport* theme.

From the preliminary list of indicators[50], an extract has been realised selecting issues and indicators related to agriculture for the purpose of the present project (Table 4.5).

4.2.2 Sustainability indicators for agriculture activity and rural development

The Council of Ministers of agriculture required to wide the work done for agrienvironmental indicators to cover sustainable agriculture aspects, including the economic and the social dimensions.

The Commission staff working paper Sec(2001)266 *Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development* tries to focus on the above-mentioned issues.

The Communication contains a proposal of indicators fields focusing only on the economic and the social dimension.

The exclusion of the ecological dimension is due to the fact that it has been already addressed in the Communication on indicators for the integration of environmental concerns into the common agricultural policy.

50 Eurostat. *Preliminary List of Sustainable Development Indicators Rev. 6. (27/09/04). Sdi/Tf/44/04 Rev. 6.* Luxembourg: Eurostat - Joint meeting of the working groups of the “Environmental statistics” and “Environment account” and Efta group, 4-6 October 2004.

Despite this, it is stressed that progress towards sustainable development requires that the three dimensions of sustainability and their interrelations are taken into account in the development and implementation of policies.

Common or similar indicators can be distilled from the Commission staff working paper Sec(2001)266 and the Commission communication Com(2001)144. In the following a selection of indicator fields has been done among the ones defined in Sec(2001)266 to highlight full or partial overlapping. Some proposals are also listed (Table 4.6).

This approach allows to achieve the harmonisation of the on-going work and to better understand whether differences are necessary in order to monitor different aspects of the same phenomenon or need to be overcome identifying indicators that can be used in both data sets.

Whatever solution is taken, experts of the statistical production sector and related activities need to be aware of.

TABLE 4.6 **List of indicators showing overlapping between Sec(2001)266 and Com(2001)144**

		Sec(2001)266		Com(2001)144 and Irena Operation	
		Indicator field	**Implementation/ Related policy indicator**	**Indicator field**	***Overlapping/ Meaning/Proposal***
STOCKS	Human capital	Age structure of agricultural labour force (male, female)		Ind. 17 Marginalisation	*Share of holders aged >= 55 years was considered a factor affecting farms viability.*
		Agricultural holders´ training levels (male, female)		Ind. 6 Level of the holders' training level (including on alternative production methods)	*Complete overlapping exists.*
		Agricultural education and training (including on alternative production methods)	(Training) Number of supported hours of vocational training.		
	Man made capital	Farmers´ fixed assets outside their agricultural core activity (e.g. tourism infrastructure)		Ind. 17 Marginalisation	*Overlapping exists in terms of meaning. In-farm pluriactivity can guaranty the viability and a more equalitarian income generation strategy.*
		Change in farmers´ fixed assets outside their ag. core activity (e.g. tourism infrastructure)			
EFFICIENCY	Agricultural output (Food and non-food) capital	Quantity (in energy terms)	Energy embodied in output in petajoule (PJ) (energy content of feed-grain deducted to avoid double counting).	Ind. 11 Energy use	*Overlapping exist for the part related to energy input use. Irena doesn't identify a target reffering to output energy content.*
		Infringements on residues/ contaminants legislation	(Investment aids) Gross sales of assisted quality-improved products; share of assisted products sold with quality labels.	Ind. 14 Management practices	*Good management practices can reduce residues in food and prevent environment pollution phenomenon.*
		Organic agriculture	Crops: Uaa, Uaa in conversion; animal sector: Number of farms.	Ind. 7 Area devoted to organic farming	*Complete overlapping.*

		Sec(2001)266		Com(2001)144 and Irena Operation	
		Indicator field	**Implementation/ Related policy indicator**	**Indicator field**	***Overlapping/ Meaning/Proposal***
EFFICIENCY	Food demand	Demand in petajoules (PJ) / Calorie requirements in petajoules (PJ)		Missing topic *	
	Efficiency (production)	Energy efficiency	Energy embodied in output in petajoule (PJ) (energy content of feed-grain deducted to avoid double counting) / Energy embodied in non-renewable inputs (fossil fuel and electricity, fertilisers, pesticides, machinery, buildings) in petajoule (PJ) (5-year average to smooth out annual fluctuations in output values).	Ind.11 Energy use (annual use of energy per unit of production, per ha of crop, per livestock unit) *	*Overlapping exists.*
	Competitiveness/viability	Value added	1_Farm net value added / Awu (per region in comparison with Eu-average) and other support) / Awu (per region in comparison with Eu-average). 2_ Farm net value added / Uaa (per region in comparison with Eu-average). 3_Total Cap-support (price and other support) / Awu (per region in comparison with Eu-average). 4_Total Cap-support (price and other support) / Uaa (per region in comparison with Eu-average).	Ind.1 Area under agrienvironment support	*Partial overlapping. Indicators developed in Irena operation make calculation of several indicators included the Cap support for* Area devoted to agrienvironmental measures/Uaa. **Defining an indicator to show the share of the total Cap support devoted to agrienvironmental measures.**
		Composition of farm household income	Farm, farm-related, off-farm income.	Ind. 5 Market signals: organic producer price premiums (refers to prices and incomes) Ind. 15: Trends: intensification/ extensification, specialisation Ind. 17 Marginalisation	Farm's survival in the market can be realised in several ways, among others applying the organic production method, differentiating agricultural production, adding farm related actvities such as agri-tourisme.

CHAPTER FIVE

INDICATORS COMPILATION AND DATA AVAILABILITY IN ITALY: SOME CASE STUDIES

Statistical activity recently focused on implementation of basic data set in order to comply with growing data demand on agrienvironmental issues. Several Institutions work at different levels in order to deepen knowledge on specific phenomena and on relationships between agricultural activity and the environment, to define indicators and implement them, and, where necessary, to develop suitable methodologies for calculation purposes.

At Istat activity of existing surveys integration, where feasible, has been conducted recently and mainly focused on farm structure survey (Fss), whereas, for specific phenomena, ad hoc surveys or analysis seemed to be necessary as the case for plant protection products use or for water used for irrigation purpose.

Integration of Fss started with the 1998 survey with a specific section on *environment and territory* mainly focusing on farmland system structure, on soil management practices, on water, pesticide and nutrient use[51]. Then the agriculture census follows and most of the questions were reported, some of them with changes, mainly due to the necessity of simplifying the questionnaire and to lessen burden on respondents, and mainly oriented to shift from a quantitative request to a qualitative request (i.e. hectares ploughed with a specific tillage practice vs farms adopting a specific tillage practice).

51 De Rosa, M., G. Bellini, G. Innocenzi, e M. Sabbatini. *Un approccio metodologico per le statistiche ambientali socio-economiche e gli indicatori ambientali per valutare come i fattori sulla produzione agricola influiscano sull'ambiente*. *Ae/Wg/045/05.3*. Luxembourg: Eurostat - Joint Meeting of the Working group Agriculture and environment and the Working group Environment and sustainable development, 29-30 October 2003.

In year 2002 the survey on some fruit tree plantations was run and this was the occasion to deepen some particular phenomena related to use of Ppps (kind of equipment used, quantity of spread products and decision criteria adopted for the intervention) and of fertilisers, since the fruit trees category represent one the most spread kind of crops.

Lastly, Fss run in year 2003 represented the tool for collecting information on generation and management of waste and of bio-organic by-products at farm level. Most of the questions referring to agrienvironmental issues proposed in previous years were kept, adding few new ones.

Furthermore some activities were started under Tapas action as the survey on Ppps use. Focuses on specific phenomena were done through Eurostat funded research projects (water resources and water use in agriculture, waste generation and management in agriculture).

At present the enormous quantity of information produced requires to be analysed and in the following an attempt is made.

As already stated, other Institutions conduct activities in relation with agrienvironmental indicators compilation, thus an overview is presented. The reports represent a contribution from different experts, and the perspective given to the documents might be different one another. Sometimes this depends on the specific point of view, as for data producers and prime data users with an institutional purpose, some other times it might depend on the implementation phase pursued or on the scientific knowledge reached in a specific sector. In any case, they all represent an effort to show problems encountered and represent the first step towards harmonisation, where necessary, of activities undertaken.

This exercise revealed to be helpful also in terms of data set exploitation and evaluation and to develop new statistics in the purpose also of identifying new indicators. In fact, it is clear that indicators are an important statistical tool that can be represented by a simple variable (i.e. hectares of cultivated land per crop type), or by the result of a complex model, implying the use of basic data and of technical coefficients as the case of emission estimates. As already described on previous paragraphs, environmental policies require monitoring of specific pressures that affect the environmental media and are increasingly focusing on specific and critical phases of the pressure generation process, which most contribute to the final generated pressure. Referring to agriculture, it is necessary to iden-

tify the most critical phases that might be represented by the adopted agricultural practices. As a consequence, in the indicator definition process we have to consider as indicators the ones describing the pressure itself – representing the priority data demand - and at the same time it is reasonable to include also the ones describing the most critical phases identified. These indicators would refer to critical agricultural practices that affect a specific pressure (i.e. gas emissions and related manure management, etcetera). Furthermore, the definition of indicators - not already included in the existing lists - might be necessary, referring to national environmental conditions.

In the following, focuses on some agrienvironmental issues are presented with reference to existing indicators or with a proposal for new ones, showing also data availability and data gaps, starting from the simplest one to the most complex one.

The issues covered are as follows.

At first, the issue on adopted agricultural practices is faced. The importance of these practices is due to the fact that generated pressures can be mitigated enormously. Arising legislation is increasingly referring to them, highlighting that farmers' skills and behaviour, and the technology applied can really make agriculture more environmentally friendly. In statistical terms, they represent relevant parameters to take into account in some indicator estimation, as for emissions, and might represent themselves indicators.

Than, an analysis is conducted on water use in agriculture for irrigation purpose, as agriculture represents the most water consuming economic sector. Other inputs used are Ppps and availability of statistics for Ppps sale and use is presented, given the growing legislative attention on this matter.

As other economic activity, agriculture contributes to generation and management of waste. A regulation has just been adopted on this matter and an evaluation of the phenomenon is necessary[52].

Among inputs used, nitrogen can affect in negative way water and air

[52] For a full dissertation on this topic see *Waste Statistics on Agriculture, Forestry and Fishing Sectors*. (Bellini G. ed.). Roma: Istat, in corso di pubblicazione. (Essays).

state, thus the calculation of the gross nitrogen balance was run to verify the existence of surpluses or not.

Agriculture also generates emissions, the most relevant ones being ammonia and some Ghg, thus a description of the estimation methodology is reported as first attempt to verify information gaps on relevant gas sources and sink activities (agricultural practices being a relevant part of them).

Lastly a set of agrienvironmental indicators and derived from variables surveyed through agriculture census of year 2000 is presented. Indicators are in this case organised according to the environmental themes defined in the Esepi project, plus a set of contextual indicators (referring mainly to main categories of farmland use).

5.1 Farming practices

Referring to agrienvironmental indicators it is important to underline role of pressure and driving force indicators. As described previously in the report, pressure indicators help in understanding relevance of flows between the human-technological sphere and the environment and their entities determine changes in environment state. Ways of reducing such pressure in agriculture activity is to create legal bindings to the agricultural practices performed by farmers that are relevant for critical phenomena. Policies are thus oriented in defining which are the best or the good agricultural practices that can prevent or reduce pressures, in some cases there are also subsidies to support environmentally oriented behaviour. These phenomena can be monitored through driving force indicators.

Driving indicators can thus be classified according to the environmental themes that have been defined in the Esepi project. Sometimes problems of classification may derive from the fact that a specific practice can have several effects, on diverse environment compartments.

Legislative acts referring to agricultural practices derive either from integration of sectoral policy or from specific environment policy, such as air, water pollution prevention, soil depletion prevention, reduction in distribution of toxic substances, and etcetera.

An analysis has been conducted on farming practice related to air

emissions, water pollution prevention, and soil depletion prevention and to dispersion of toxic substances.

5.1.1 Farming practices affecting air, water, soil

Agricultural practices related to *air pollution* and *climate change* are mainly linked to fertiliser and manure management, to stable conditions and - in some cases - to soil management practices. Referring to manure it is important to know the form (solid or liquid) of the produced and managed manure, since gas emissions amount can considerably change from one type another (paragraph 5.6).

Particularly the Integrated pollution prevention and control Directive defines the best available technologies (Bat) related to manure management (in diverse stages: production, storage and distribution), and shed conditions, in order to reduce ammonia and methane emission to air, soil and water.

The declaration of emission to air is mandatory when the superior air emission limit of 100 tonnes per year for methane and 10 tonnes per year for ammonia is overcome (even if only one pollutant results to be above the limit).

Referring to agriculture, intensive stock farming of swine or poultry can be classified as Ippc activity, depending on size of stock bred as follows:

— installation with more than:

a) 40 thousands places for poultry;

b) 2 thousands places for swine production (weight more than 30 kg);

c) 750 places for sows.

The emission declaration includes four different sets of information:

— I part: identification of the settlement and of emission source activity;

— II part: emission to air;

— III part: emission to water (only for disposal in surface water after in-site depuration);

— IV part: emission to water after off-site depuration (not obligatory).

The declaration form related to emissions has been prepared jointly by Apat and the Research centre for animal production (Crpa). Information required to fill in this form were defined according to the variables neces-

sary to run an algorithm[53] to calculate ammonia and methane emission in different steps of manure management, by application of Bats in intensive livestock farming. Starting from phosphate, nitrogen and organic matter excreted by animals, feeding strategies, designs of floors and manure management in the different housing system, on-farm treatments, and type of storage, applying manure methods are taken into account to calculate mentioned emission. Livestock heads per category and specie, structural housing characteristics, stored dejection volume, and several other basic parameters are thus necessary inputs of the calculation.

All this information will be recorded first at national level and than at European level in the European pollutant emission register.

Beside the necessity of collecting information on some of the mentioned shed characteristics or adopted manure management, the policy on gas emission underlines also the relevance of livestock concentration. An indicator on this phenomenon seems to be reasonable. This livestock concentration can be represented by the share of livestock (per specie) bred in intensive – as defined by the Ipcc Directive - livestock farming. In Italy for example, poultry heads bred in such intensive conditions are 98,324,937, which represents 69 percent of total heads, whereas referring to pigs, 43 percent of heads (including swine weighting more than 20 kg) are bred in intensive stockfarms.

Several typologies of manure treatments, performed before spreading on land, can modify nutrients content and form, thus increasing or reducing particular gas emission.

Manure management issue provides link also with the environmental theme resource depletion and *water pollution* and - in terms of agricultural practices -, beside the ones already mentioned for storage conditions, it refers to manure distribution on soil and to soil management techniques.

Referring to integration of sectoral policy and to resource depletion theme, the *Common Agricultural Policy – Mid Term Review*[54] identifies a

53 Fabbri, C., L. Valli, e G. Bonazzi. *A Method to Asses the Reduction of Ammonia and Methane Emissions by Application of Bat in Intensive Livestock Farming.* Convegno Ramiran, 2004.

54 European council Regulation 1782/03/Ec of 29 September 2003. *Establishing Common Rules for Direct Support Schemes Under the Common Agricultural Policy and Establishing Certain Support Schemes for Farmers and Amending Regulations 2019/93/Eec, 1452/01/Ec, 1453/01/Ec, 1454/01/Ec, 1868/94/Ec, 1251/99/Ec, 1254/99/Ec 1673/00/Ec, 2358/71/Eec, and 2529/01/Ec*. Official Journal n. L 094 of 31 March 2004.

series of directives to respect and priorities among the environmental issues to deal with through the adoption of specific standards as reported in the table below. In the latter, it is interesting to see that soil depletion is the main issue (Table 5.1).

TABLE 5.1 Environmental issues and standards

Issues	Standards
Soil erosion: protect soil through appropriate measures	- minimum soil cover - minimum land management reflecting - site-specific conditions retain terraces
Soil organic matter: maintain soil organic matter levels through appropriate practice	- standards for crop rotation where applicable - arable stubble management
Soil structure: maintain soil structure through appropriate measures	- appropriate machinery use
Minimum level of maintenance: ensure a minimum level of maintenance avoiding the deterioration of habitats	- minimum livestock stocking rates or/and appropriate regimes - protection of permanent pasture - retention of landscape features - avoiding the encroachment of unwanted vegetation on agricultural land

Source: Regulation 1782/03/Ec, Annex IV

Soil depletion can depend on soil organic matter content decline, which can be replenished by distributing, when applied at a proper plant growth phase and in appropriate weather conditions, materials of bio-organic nature.

The code[55] of good agricultural practices, implemented as required by the Nitrates Directive, includes several practices such as the identification of the less problematic spreading periods, the modality to proceed with the distribution on slopes or in difficult soil condition, the proper capacity of manure storage infrastructure, and the best distribution techniques in order to prevent water contamination. Different parameters related to weather conditions (mainly rainfall periods), in addition to crop rotation plans and crop cover techniques, to fertilisation plan, and to soil characteristics have to be taken into account in order to reduce nitrate leaching and water contamination.

55 Decreto ministeriale del 19 aprile 1999, n. 86. *Approvazione del codice di buona pratica agricola.* Gazzetta ufficiale n. 86 del 4 maggio 1999, S.O.

Other material of bio-organic nature can be used as sludge and bio-waste. This material can bring nutrients, but also unwanted effects such as introduction of pollutants, heavy metals and organic compounds, spreading of human, animal and/or plant pathogens. Legislation is in force for some materials[56], but the Commission Communication on the strategy on soil protection would bring some improvements, as the revision of the Sewage sludge Directive 86/278/Eec - on the protection of the environment and in particular of the soil when sewage sludge is used in agricultural soil - and a proposal for a Directive on the biological treatment of biodegradable waste.

Furthermore, utilisation of sewage sludge from wastewater treatment of domestic, urban, or industrial origin is ruled at national level by the decree n. 99 of 27 January 1992 which represents the implementation of the Directive 86/278/Eec.

Soil organic matter can also be restored through green manure practice (leguminous one being richer in nitrogen content).

Other ways to contain nutrient surpluses and water and air pollution risk is to know nutrient demand by analysing soil physico-chemical parameters and planning a correct nutrient distribution plan. When using slurry also storage capacity and weather conditions has to be carefully taken into account, thus a specific distribution plan is required.

Tillage practice, particularly deep tillage, is known to speed organic matter degradation thus reducing its availability and increasing gas emissions. Physical soil conditions can be also negatively affected by load of machinery passing on fields for mechanical operation (tillage, sowing, plant protection, harvest).

Other ways to protect soil are cover practice as mulch, land planting to avoid herbicide treatment. These practices can reduce the number of tillage operation preventing soil compaction.

Crop rotation also affects soil physical parameters, and erosion risk increases extremely with continuos cropping[57].

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56 Referring to bio-organic material generated in vegetal product processing, such as sludges from olive grinding process limit of spreading on land are defined by law: 50 m^3/ha for sludges from oil mill with conventional grinding and 80 m^3/ha from oil mill with continuous cycle. A communication to the local mayor is required with a technical documentation showing suitability of the soil to such treatment.

57 Caporali, F. *L'ecologia per l'agricoltura.* Torino: Utet, 1991.

Another agricultural practice that can affect gas emission and soil depletion is the burning of crop residues, mainly cereals or trimming residues. In fact land treatment of such organic material can have positive effect on soil, whereas burning causes organic material combustion and CO_2 emission.

All mentioned practices can be surveyed through farm structure survey and a list of related indicators (Table 5.2) and their availability is presented with data source and reference year[58].

TABLE 5.2 **Farming practice indicators per themes *air pollution*, *climate change, resource depletion* and *water pollution***

Indicator sub-theme	Indicator	Data Source
Livestock per category and specie	Livestock per category and specie Livestock concentration (% of total population) 1. share of poultry bread in farms with more than 40.000 places in total poultry; 2. share of swine for production (weight more than 30 Kg) bread in farms with more than 2.000 places in total swine; 3. share of sows bread in more than 750 places in total sows. *Quota of grazing livestock*	Fss, Ac *Note:* threshold between swine categories doesn't match with values highlighted by the Ippc Directive. Thresholds for swine weight in Fss and Ac are 20 and 50 kg.
Shed characteristics	*Shed floor characteristics* (Temperatures)	
Manure storage	1. Capacity per kind of manure (solid dung, mixed, slurry, other) in volume or weight 2. Maximum length of storage without emptying	1,2. Fss, Ac
Manure storage characteristics (mixed and slurry only)	1. Covered storage 2. Biogas recovery installation	1,2. Fss 2003
Manure treatment	1. Treatment (depuration) 2. Air mixing 3. Solid/liquid separation 4. Swine stables with facilities for slurry treatment	1,2,3. Fss 2003 4. Ac 2000
Spreading of manure	1. Spreading of manure (area, quantity per kind of manure) *2. Timing of spreading*	1. (Area and quantity) Fss 1998, (Area) Ac 2000, (Quantity) Fss 2003
Spreading of other bio-organic materials	Quantity of sewage sludge from treated wastewater 1. of urban origin 2. of industrial settlement origin	1,2. Fss 2003
Spreading of fertilisers	Chemical fertilisers spreading activity (area per kind of fertiliser, total spreading area)	(Area per kind of fertiliser) Ac 2000; (Total spreading area) Fss 2003
Nutrient distribution	1. Adoption of an annual nutrients distribution plan (n farms) 2. Physico-chemical soil analysis run in the last 5 years (n farms) 3. Adoption of a slurry distribution plan (n farms)	1. Fss 1998, 2003; Ac 2000 2, 3. Ac 2000, Fss 2003

58 Fss run in year 2005 collected for the first time additional information on livestock grazing activity, and non-tillage operation.

Indicator sub-theme	Indicator	Data Source
Soil protection practices	1.Green manure (leguminous and non-leguminous) (ha) 2.Mulch (ha)	1,2. Fss1998, 2003; Ac 2000
Tillage practice	Type of operation 1.Ploughing > 40cm; <= 40cm (area, farm) 2.Subsoiling > 40cm; <= 40cm (area, farm) *3.Non tillage* 4.Other tillage (area, farm) Number of operation 1. Tilled area by kind of operation and number (ha)	Type of operation 1, 2, 4. Area: Fss 1998 1,2,4. N. of farms: Ac 2000, Fss 2003 Number of operation 1. Fss 1998
Planting to avoid herbicides spreading	Crop planting to avoid herbicide spreading	Ac 2000, Fss2 003
Crop rotation	Area (ha) of 1.crop rotation 2.crop shift 3.continuos cropping	1,2,3. Fss 1998 and 2003, Ac 2000
Crop residues management	Burning of crop residues (farm)	Fss 1998, 2003, Ac 2000

Fss: Farm structure survey; Ac: Agriculture census.
Italic text: non available, Normal text: available indicator.

5.1.2 Farming practices related to dispersion of toxic substances, loss of biodiversity and water pollution issues

The other biggest area in terms of agricultural practices is the one related to spreading of plant protection products (Ppp). Environmental themes involved are mainly *dispersion of toxic substances*, and related effects can be recorded in terms of *loss of biodiversity*, and of *water pollution*. Data availability for Ppps sale and use will be presented in a following paragraph (paragraph 5.3). Main concerns already mentioned (paragraph 3.1.3) on this issue are related to the risk for people getting directly or indirectly in contact with such products or their residues.

A list of the relevant agricultural practices and of the related indicators and their availability is presented with data source and reference year in the following table 5.3.

In order to reduce the amount of product spread on crops and their dispersion in the environment, conditions of spreading have to be monitored. The form in which the product is spread can be fundamental, and it is related to the typology of sprayer used. Moreover inspection for equipment control is necessary for operating in the most efficient conditions, avoiding unwanted losses and overspreading. This material still requires framework legislation at national level.

TABLE 5.3 Farming practices indicators per themes *toxic substances dispersion, loss of biodiversity* and *water pollution*

Indicator sub-theme	Indicator	Data Source
Spreading equipment	Kind of spreading equipment: 1.lever operated knapsack sprayer 2.motorised knapsack sprayer 3.lance sprayer 4.atomizer (air blast sprayer) 5.powder sprayer (duster) 6.boom sprayer 7.other	Fruit trees Survey 2002
Equipment inspection	*Frequency of the inspection per kind of equipment*	Voluntary regional technical plans
Spreading decision criterion	Treatment based on: 1.fixed calendar interval, (week or decade), not related to wheather or pest/pathology conditions 2.presence of the pest or the pathology, even if at a minimum stage 3.suggestion from local extension services, when risk threshold is overcome 4.other criterion, in case the service is run by others or the criterion is unknown	Fruit trees survey 2002 Surveyed fruit trees: apple pear, peach, nectarine, apricot, orange, lemon, other citrus fruits, kiwi, plum, cherry, figue.
1.Integrated production	Area cultivated according to this farming method (ha)	Ac 2000, Fss 2003
2.Organic farming	Livestock heads raised according to organic farming principle	Surveyed crops: cereals, vegetables, crops for industrial processing, other short term herbaceous crops (lifecycle shorter than 5 years), wine, olive, citrus fruit trees, fresh fruit trees, other permanent crops, other Surveyed species: bovine, buffaloes, ovine, caprine animals, poultry, other.
Pest mangement (area of spreading)	1.Guided pest management 2.Integrated pest management 3.Biological pest management	2, 3. Fss 1998 1, 2, 3. Fss 2003, Ac 2000,
Holders training level	Holders training by level 1.mandatory school 2.bachelor degree (in agronomy or other) 3.laurea (in agronomy or other)	Fss, Ac. Standard question.
Ppps (area of spreading)	1.Chemical plant protection product 2.Natural Ppp 3.Herbicides	Ac 2000, Fss 2003

Fss: Farm structure survey; Ac: Agriculture census.
Italic text: non available, Normal text: available indicator.

The criterion chosen for deciding whether it is necessary to treat the pest or the pathology determines differences in the quantity used per kind of product (in terms of class of toxicity).

A way of reducing Ppps use is also related to the type of pest control adopted, such as guided, integrated and biological pest management.

Integrated production farming method si also related to decision criteria for intervention, which is mainly connected to the economic value of the product. In fact, when the economic cost due to the production loss would overcome the cost for the treatment, this can be distributed on land.

Alternative farming methods include also organic farming.

Extension services can have an important role in supporting farmers in their decision making, and in running education programmes. Holders training should thus be integrated with additional specific programmes to improve knowledge and skills on alternative farming methods.

Area of spreading for chemical and natural plant protection product, and for herbicides can be a relevant information with respect to the phenomenon of plant protection product use.

5.2 Water use in agriculture and related impact

Monitoring the use of a natural resource such as water in the agriculture sector is of fundamental importance. In fact, several studies carried out showed that, on Italian territory, water demand for crop cultivation represents the major water consuming activity, in relative terms, as in European southern countries, climate conditions determine the necessity of irrigation for some crops[59].

An excessive water abstraction can have negative consequences, such as salinisation of the ground water in coastal areas[60].

Access to water largely depends on landscape characteristics and waterbodies presence and abundance. Thus, resorted sources of water and supply systems follow different patterns and schemes in northern and central-southern regions.

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59 A more detailed dissertation on this topic is available: Bellini G. “Water resources for the agriculture sector”. In *Water Resources Assessment and Water Use in Agriculture.* Roma: Istat, in corso di pubblicazione. (Essays). This represent the publication of the results obtained in the project, co-funded by Eurostat *Assessment of Water Resources and Water Use in Agriculture in Italy - Methods and Data Sources*.

60 Irsa - Cnr. *Un futuro per l’acqua in Italia*. Roma: Irsa - Cnr, 1999. (Quaderni, n. 109).

Information on kind of source used to abstract water can have a great importance, since water sources can have different environmental value ranging from surface, underground, transitional, till non-conventional (treated wastewater and desalinated water) water.

Possible ways to access water in agricultural activity are:

— irrigation and land reclamation consortia delivering water;
— self-supply, where water is diverted or pumped directly by users;
— public water supply;
— other forms.

Water use at farm level can be influenced by the efficiency of the irrigation method applied. So that in areas where there is a need for a stricter and rational use of water different irrigation technologies with a higher efficiency rate can be adopted. Efficiency rates for the most widespread irrigation systems (units of water volume reaching the crop per 100 units of the distributed volume), as reported in the Blue plan document (Mcsd - Blue plan, 1999), are the following:

— 40-50 percent for superficial water flow and lateral infiltration;
— 60 percent for aspersion system;
— 90 percent for low pressure sprinklers and drip-emitters.

The 6th Eap and the Water framework Directive define the main policy objectives at Eu level in relation to water use and water stress. Main goals are the sustainable water use, to be promoted on a long-term protection action, of available water resources in order to ensure a balance between abstraction and recharge of ground water, and the adoption of measures to improve the efficiency of water use and to encourage changes in agricultural practices necessary to protect water resources.

Given the relevance of water use issue, the Commission Communication Com(2001)144 defines several indicators related to water resources issues, referring both to water quality and quantity issues. For water quality area, indicators – that won't be further analysed in this report – identified are:

— n. 21 Water contamination (by several pollutants);
— n. 30 Concentration of nitrates/pesticides in water (for pesticides, only atrazine and simazine are taken into account);
— n. 34.2 Nitrogen and phosphorus emissions to water (contribution of agriculture sector to overall emissions).

For water quantity issue, focuses are mainly on pressures and impact generated on water reservoir. In the Irena project, the implementation process is focusing on the following:

— n. 10 Water use efficiency;
— n. 22 Water abstraction;
— n. 31 Ground water levels (which resulted to be the most problematic one to compile);
— n. 34.3 Share of water used by the agriculture sector.

In more detail, for indicator n. 10 Water use efficiency the irrigated area by crops type has been proposed to be calculated as main indicator, and a Water use efficiency index as sub-indicator, which is the Water use per European size unit (Esu) of irrigated crop by major irrigated crops. This would show water use efficiency in relation to the value of agricultural production indicating the economic benefits per unit of resource (water) used. Water use efficiency index, is based on the crop water requirements, rainfall and estimates of evapotranspiration and the standard gross margin for each crop. The standard gross margin for each crop is used to define an overall regional standard gross margin that can be related to water consumption per Esu of irrigated crop (if proportion of regional irrigated area per crop is known). According to this approach, efficiency would only refer to the economic aspect, while it would be relevant to take into account also the water use efficiency based on technology such as the irrigation system adopted, for which efficiency of water distribution can vary a lot. This issue was actually covered by the former message of the Commission reported in the Com(2001)144 Communication.

Referring to the sub-indicator, the interpretation of higher crop water requirements (Cwr) might be controversial in fact higher Cwr due to higher evapotranspiration level doesn't necessarily mean an increase in water use since availability of water can become a limiting factor for irrigation[61].

Indicator 22 refers to the Annual water abstraction for irrigation (cubic metres per year) and to the Mean water allocation rate (cubic metres per hectare and year) which is calculated at country level dividing water abstraction volumes by irrigable areas. For this indicator it would be more

61 Anbi. *Relazione dell'assemblea*. Roma: Anbi, 2001.

appropriate to consider irrigated area than irrigable one. In Italy for example in year 2000 (data source agriculture census) differences between the two areas are relevant, being the irrigable one equal to 3,892,202 hectares and the irrigated one equal to 2,471,379 hectares. Beside Istat data source, other Institution recently collected information on irrigation phenomenon such as the Land reclamation and irrigation consortia national association (Anbi[62]) that conducted a survey in 2001 among 138 associated consortia trying to collect data on their water network characteristics and related water management. The survey shows that volume abstracted per hectare varies a lot among regions (from 1,700 cubic metres Puglia to 33,600 cubic metres recorded in Piemonte region). Main reason of high values especially in northern region (Piemonte, Lombardia and Veneto) might largely depend on water supply infrastructure characteristics. In fact, open air channels actually divert water from natural water bodies without using it all, and water can be double counted since water overflow from one farm can be used by another farm downstream, as shown in the Po river basin authority project[63].

With indicator 34.3, referring to water quantity issue Share of water used by the agriculture sector, it would be possible to understand the relevance of water used in this sector with respect to others.

Statistical information on this topic is already required to Member States through the Joint Oecd/Eurostat questionnaire on Inland water. The questionnaire focuses on water resource availability on *Fresh water resources* - including all variables relevant for the hydrological cycle -, *Annual water abstraction by source* - separately for fresh surface water, fresh ground water, non fresh water sources and reused water - and by sector, and *Water use by supply category* - with reference to public water supply, self supply and other supply - *and by sector*. The structure of the questionnaire reveals that the abstraction phenomenon is related to the kind of source exploited, which have different ecological importance, whereas information on water use refers to delivering kind of management.

62 Associazione nazionale bonifiche, delle irrigazioni e dei miglioramenti fondiari.

63 Autorità di bacino del fiume Po. *Attività di studio e ricerca a supporto della redazione del Piano di Bacino. Sottoprogetto S.P. 4.1. Uso del suolo e Agricoltura. Attività 4.16: Uso irriguo delle acque: consorzi di bonifica e irrigui, censimento delle derivazioni e delle reti sottese, quantificazione dei prelievi su base comprensoriale*. Parma: Autorità di bacino del fiume Po, 1999. (Supporto CD-rom).

This questionnaire should thus be a reference in terms of definitions adopted also for indicators identified in this thematic area.

As far as the water use in agriculture (or for irrigation purpose) is a relevant issue, and related indicators have to be compiled, Istat tried to collect more information from farms on this issue since 1998 through surveys conducted on farms structure (farm structure survey and agriculture census).

The first experience in the full investigation of water use issue was conducted in 1998. In fact, the standard farm structure survey questionnaire was integrated with an additional form on "Environment and territory". Variables related to water use were: i) quantity of water used; ii) irrigated area by crop type and by irrigation method; iii) number of watering operations to irrigate fields, iv) kind of resorted water sources (surface water, ground water, wastewater treatment plant). The experience carried out in 1998 showed that farmers didn't know the amount of water used for agricultural activities, but they can provide basic data at farm level on irrigation methods adopted, water management, and kind of water source. Data are available at regional level (corresponding to Nuts2 level in the Nomenclature of territorial units for statistics). The information collected was really rich in terms of content and some results can still be taken into account.

Those data should be further exploited in order to analyse what patterns we be found at a more detailed territorial level, in order to get a better understanding on to which extent a sampling survey can meet the data demand on this topic. The main problems to be faced are: i) the limits due to an information coming from a sample where not the irrigated surface, neither irrigated crop nor irrigation method are sampling variables; and ii) to get more information reducing the statistical burden and survey cost.

In order to avoid an excessive burden on respondents, the question was simplified in the agriculture census questionnaire in year 2000. Nevertheless, this data source is of fundamental importance for the detail we can reach at territorial level, as data are available at municipality level (Nuts5). The questionnaire covered the following variables: i) irrigated area by crop type; ii) irrigated area by irrigation method; iii) kind of water source (surface water, ground water, wastewater treatment plan); iv) water infrastructure management (self supply, consortium, a different farm, other system).

Referring to indicators that can be calculated, irrigated crop area can be used as basic information in order to calculate indicator n. 10 Water use per Esu by major irrigated crops. Furthermore, the following indicators can be calculated for the reasons highlighted:

- irrigated area by irrigation method, being an important drivers in water use efficiency - in physical terms - at farm level (the importance of the irrigation system adopted at farm level was also recognised by the former message of the Commission in its Communication Com(2001)144);
- irrigated area by water source. Not being available data on amount of resorted water per kind of source this might represent a good proxy;
- irrigated area by water supply and management. Water supply and management represent a useful information on how the supply system is organised and can help in policy making in defining which the actors are involved.

In the following some comments will be provided on 2000 agriculture census results on such matter.

Table 5.4 shows that 36 percent of the irrigated land is devoted to grain maze and rotational forage production; fruit trees and vegetables - with 7.7 percent each - and grape - with 7.4 percent - follow. Other crops category includes also rice field which can explain the high value reached by this class (24.4 percent). Grain maize and rotational forage are mainly concentrated in northern regions (91.7 percent and 70.2 percent respectively of their total surface is in north-western and north-estern regions).

Table 5.5 shows a typical territorial pattern for irrigation methods applied, in fact *superficial flowing water and lateral infiltration* and *flood* are mainly adopted in the northern regions (85.1 percent and 98.3 percent respectively), and aspersion is distributed over an area which equals 57.1 percent of total national land irrigated with this method. Even if it is recommended to substitute these systems with the more water saving ones, it is also necessary to underline that in most of these cases irrigation systems can hardly be replaced due to the existing widely extended water network and to the sandy nature of the soils involved.

The tables 5.6 and 5.7 have been computed in a similar way, combining separated information collected through the questionnaire. In fact, the resorted source and the type of supply were considered as farm clas-

sification variables in relation to the total irrigated surface declared by each farm. Figures in table 5.6 show that almost 50 percent of total surface is irrigated through water abstracted only from surface water bodies; ground water source (only this source) follows in terms of importance, as it contributes to irrigation of almost 25 percent of the total irrigated land. Agricultural land, from the point of view of supply (Table 5.7), is mostly irrigated through water delivered by consortia (52 percent), whereas self supply is used to water 23 percent of total irrigated land.

Results analysis can help in the process of indicator identification. In fact most of the farms declared to have access to only one source type (91.1 percent of irrigated farms including 82.6 percent of irrigated surface) and supply (95.2 percent of irrigated farms including 85.8 percent of irrigated surface), thus *irrigated surface per source type and per kind of*

TABLE 5.4 **Irrigated surface per crop and geographical area - Year 2000** *(absolute data in hectares)*

GEOGRAPHICAL AREAS	CROP									TOTAL
	Wheat	Grain maize	Soybean	Vegetables	Rotational forage	Vine	Citrus	Fruit trees	Other crops	
					ABSOLUTE DATA					
North-west	12,988	366,797	38,368	16,249	129,335	2,679	46	19,142	358,817	944,422
North-east	11,174	204,356	39,925	48,202	58,666	52,472	0	103,122	120,684	638,600
Centre	9,716	36,399	217	25,637	24,613	6,601	515	14,007	60,950	178,655
South	52,539	14,639	106	73,383	30,396	78,810	41,305	42,588	152,577	486,343
Islands	13,220	963	1	27,542	24,550	42,131	71,786	10,317	32,848	223,358
Italy	**99,636**	**623,155**	**78,618**	**191,012**	**267,560**	**182,694**	**113,651**	**189,175**	**725,877**	**2,471,378**
					% COMPOSITION					
North-west	1.4	38.8	4.1	1.7	13.7	0.3	0.0	2.0	38.0	100.0
North-east	1.7	32.0	6.3	7.5	9.2	8.2	0.0	16.1	18.9	100.0
Centre	5.4	20.4	0.1	14.3	13.8	3.7	0.3	7.8	34.1	100.0
South	10.8	3.0	0.0	15.1	6.2	16.2	8.5	8.8	31.4	100.0
Islands	5.9	0.4	0.0	12.3	11.0	18.9	32.1	4.6	14.7	100.0
Italy	**4.0**	**25.2**	**3.2**	**7.7**	**10.8**	**7.4**	**4.6**	**7.7**	**29.4**	**100.0**
					% COMPOSITION					
North-west	13.0	58.9	48.8	8.5	48.3	1.5	0.0	10.1	49.4	38.2
North-east	11.2	32.8	50.8	25.2	21.9	28.7	0.0	54.5	16.6	25.8
Centre	9.8	5.8	0.3	13.4	9.2	3.6	0.5	7.4	8.4	7.2
South	52.7	2.3	0.1	38.4	11.4	43.1	36.3	22.5	21.0	19.7
Islands	13.3	0.2	0.0	14.4	9.2	23.1	63.2	5.5	4.5	9.0
Italy	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Istat, Agriculture census - Year 2000

supply can be considered as important proxies of the phenomena involved. This result would support the proposal at national and international level, for considering, as long as data on actual amount of water abstracted for agriculture are lacking, *surface irrigated per source type and surface irrigated per kind of supply* as relevant indicators.

Nevertheless, data quality should be further investigated; in fact farms to which water is supplied through consortia might not be aware of kind of exploited water source.

Furthermore, figures on water abstracted arising from Anbi survey show that 54 percent of the total volume is abstracted from natural watercourses, 38 percent from artificial water bodies, and 4 percent from common wells, and other sources account for the remaining 8 percent.

TABLE 5.5 **Irrigated surface per irrigation method and geographical area - Year 2000** *(absolute data in hectares)*

GEOGRAPHICAL AREAS	IRRIGATION METHOD						TOTAL
	Superficial flowing water and lateral infiltration	Flood	Aspersion	Micro irrigation	Dripping	Other systems	
	ABSOLUTE DATA						
North-west	572,394	200,767	188,816	2,721	7,406	7,434	979,538
North-east	151,279	13,067	410,528	14,836	43,995	19,606	653,311
Centre	16,315	556	135,294	5,657	22,123	2,793	182,737
South	84,007	506	201,587	30,124	161,610	18,693	496,527
Islands	26,567	2,640	114,976	21,993	55,572	5,149	226,897
Italy	**850,561**	**217,536**	**1,051,201**	**75,332**	**290,706**	**53,674**	**2,539,011**
	% COMPOSITION						
North-west	58.4	20.5	19.3	0.3	0.8	0.8	100.0
North-east	23.2	2.0	62.8	2.3	6.7	3.0	100.0
Centre	8.9	0.3	74.0	3.1	12.1	1.5	100.0
South	16.9	0.1	40.6	6.1	32.5	3.8	100.0
Islands	11.7	1.2	50.7	9.7	24.5	2.3	100.0
Italy	**33.5**	**8.6**	**41.4**	**3.0**	**11.4**	**2.1**	**100.0**
	% COMPOSITION						
North-west	67.3	92.3	18.0	3.6	2.5	13.8	38.6
North-east	17.8	6.0	39.1	19.7	15.1	36.5	25.7
Centre	1.9	0.3	12.9	7.5	7.6	5.2	7.2
South	9.9	0.2	19.2	40.0	55.6	34.8	19.6
Islands	3.1	1.2	10.9	29.2	19.1	9.6	8.9
Italy	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Istat, Agriculture census - Year 2000

TABLE 5.6 Irrigated surface per type of source and geographical area - Year 2000 *(absolute data in hectares)*

GEOGRAPHICAL AREAS	Only one source				More than one source	TOTAL
	Surface water	Acqueduct	Underground water	Treated wastewater		
			ABSOLUTE DATA			
North-west	619,544	57,757	88,758	238	178,125	944,422
North-east	390,537	28,820	100,360	498	118,385	638,600
Centre	56,038	15,983	70,029	116	36,489	178,655
South	72,733	116,581	238,723	899	57,408	486,344
Islands	41,203	51,224	91,179	186	39,567	223,358
Italy	**1,180,054**	**270,365**	**589,049**	**1,938**	**429,973**	**2,471,379**
			% COMPOSITION			
North-west	65.6	6.1	9.4	0.0	18.9	100.0
North-east	61.2	4.5	15.7	0.1	18.5	100.0
Centre	31.4	8.9	39.2	0.1	20.4	100.0
South	15.0	24.0	49.1	0.2	11.8	100.0
Islands	18.4	22.9	40.8	0.1	17.7	100.0
Italy	**47.7**	**10.9**	**23.8**	**0.1**	**17.4**	**100.0**
			% COMPOSITION			
North-west	52.5	21.4	15.1	12.3	41.4	38.2
North-east	33.1	10.7	17.0	25.7	27.5	25.8
Centre	4.7	5.9	11.9	6.0	8.5	7.2
South	6.2	43.1	40.5	46.4	13.4	19.7
Islands	3.5	18.9	15.5	9.6	9.2	9.0
Italy	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Istat elaboration on Agriculture census data, Year 2000

In case of lack of required data on water use in the agriculture sector, estimation procedures to calculate water demand might be applied. Estimation methods for Cwr calculation have been thoroughly reviewed in *Water Resources for the Agriculture Sector*[64], activity realised for the Eurostat co-funded project *Assessment of Water Resources and Water Use in Agriculture in Italy - Methods and Data Sources*. In the agriculture sector, beside water used for irrigation purpose, water used for livestock breeding should be considered. In the framework of the construction of the Economy-wide Material flow balance (Ew-Mfb) for Italy[65], an estimate

64 Bellini G. "Water Resources for the Agriculture Sector". In *Water Resources Assessment and Water Use in Agriculture*. Roma: Istat, in corso di pubblicazione. (Essays).

65 Femia, A. *1980-1998 Material-Input-Based Indicators Time Series and 1997 Material Balance of the Italian Economy*. Rome: Istat, 2003. (Final report to Eurostat).

TABLE 5.7 Irrigated surface per kind of supply and geographical area - Year 2000 *(absolute data in hectares)*

GEOGRAPHICAL AREAS	Only one supply				More than one supply	TOTAL
	Self supply	Consortium	Other farm	Other supply		
			ABSOLUTE DATA			
North-west	104,153	606,300	6,586	55,305	172,077	944,422
North-east	117,333	399,666	3,979	28,375	89,246	638,600
Centre	98,646	32,089	1,167	33,907	12,847	178,655
South	171,795	167,218	17,540	80,768	49,023	486,344
Islands	82,217	76,151	5,576	31,763	27,651	223,358
Italy	**574,145**	**1,281,424**	**34,849**	**230,118**	**350,843**	**2,471,379**
			% COMPOSITION			
North-west	11.0	64.2	0.7	5.9	18.2	100.0
North-east	18.4	62.6	0.6	4.4	14.0	100.0
Centre	55.2	18.0	0.7	19.0	7.2	100.0
South	35.3	34.4	3.6	16.6	10.1	100.0
Islands	36.8	34.1	2.5	14.2	12.4	100.0
Italy	**23.2**	**51.9**	**1.4**	**9.3**	**14.2**	**100.0**
			% COMPOSITION			
North-west	18.1	47.3	18.9	24.0	49.0	38.2
North-east	20.4	31.2	11.4	12.3	25.4	25.8
Centre	17.2	2.5	3.3	14.7	3.7	7.2
South	29.9	13.0	50.3	35.1	14.0	19.7
Islands	14.3	5.9	16.0	13.8	7.9	9.0
Italy	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Istat elaboration on Agriculture census data, Year 2000

of the water used for livestock's drinking purposes has been produced with reference to year 1997. The estimate has been obtained by first calculating the total weight of live livestock, and multiplying this by a coefficient of 20 cubic metres of water per tonne of live weight per year[66].

The estimate of the total live weight of livestock has been produced on the basis of the number of livestock (as of the 1st of December) given by agricultural statistics of Istat: about 20 different coefficients have been used in this case, varying according to the kind, age and sex of the livestock. Further studies will be carried out on this topic and in the framework

66 Pizzoli Mazzacane E. M., et al. *Materials Flow in the Zootechnical Cycle in Italy in 1994*. Vienna: Conference 99, Nature society history long term dynamics of social metabolism, 30 September - 2 October 1999. http://www.univie.a.at./iffsocec99/htmlsiles/postersgreen.html.

of the pilot construction of a Physical Input Output table for Italy, obtaining more precise estimate for such drinking water.

5.3 Statistics on plant protection products

Istat produces several statistics derived from surveys related to sale and use of fertilisers and plant protection products (Ppp), included in the National Statistical Programme. Those results are utilised for calculation of specific indicators.

Studies on such matter are conducted to understand:

- the evolution in sale and in use, in order to see whether market trends differ from policy maker expectation at national and international level;
- the sustainability of the agriculture system and to calculate indicators for policy makers, farmers, consumers;
- the existence of nutrient surpluses measuring inputs and outputs of main nutrients;
- how to direct research on Ppps residues and fertilisers in food and water.

Indicators identified on this area - in the Irena project - refer to quantity of the product introduced into the environment through use as indicator n. 9 Pesticide consumption, which refers to the i) used/sold quantities of different pesticides categories (as total amount of active substances, or volume of spread active substances per hectare), and to the ii) Ppp doses distributed per hectare of different pesticides classes - as provided by European crop protection association (Ecpa) - per crop type.

The other aspect observed is Ppp destination in soil and water. Related indicators are the following:

- n. 20 Pesticide soil contamination, aimed at measuring the amount of Ppp remaining one year after the application in the top soil. The case study presented is based on a modelling approach (Pearl, ref. Irena Methodology / Data Sheet);
- n. 30 Ppps in water, aimed at measuring the concentration of some Ppps in ground and surface, at the moment focus is on atrazine and simazine due to higher availability of data.

Surveys on sale have been run in Istat for several years and their content have is very detailed in terms of information on Ppp and in terms of territorial level covered. Istat started its activity on surveys on Ppps use within the framework of Tapas action and will be run on regular basis depending on agreement that will take place at European level with the implementation of the European *Thematic Strategy on the Sustainable Use of Pesticides*[67].

This means that data on use available only refers to few crops and to one year for each crop, and that data is not sufficient to calculate the required indicators. In absence of use data, it would be reasonable to consider sale data as the best proxy, instead than application rates per hectare and per crop type.

In the following statistics on sale and use of Ppps - and related active substances - in some specific cultivations are presented.

5.3.1 Sale of plant protection products for agriculture use

Survey on agricultural Ppps sale is annual and data are collected from any distributor that sales his own labelled products and from the ones selling foreigner labelled products. The form is cartaceous and is auto-filled in.

Phenomena investigated are:

— sale of Ppps, per category (fungicide, insecticide and acaricides,herbicide, biological, other and insect traps), toxicity class and province (Nuts3 level);

— sale of the active substances authorised for the market.

Biological products and traps have been recently introduced in the survey, in order to complete the picture of the all phenomenon of plant protection strategy adopted at farm level.

Classification, nomenclature, definitions and calculation adopted are update according to national and European legislation in force. Ppps count 36 typology groups and 399 active substances (Table 5.8).

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[67] European commission Communication. *Towards a Thematic Strategy on the Sustainable Use of Pesticides*. Com (2002) 349 final.

TABLE 5.8 Categories of plant protection products and related active substances

PLANT PROTECTION PRODUCTS	Category Groups *(N)*	Active Substances *(N)*
Fungicide	7	91
Insecticide and acaricides	9	120
Herbicide	10	140
Other	4	35
Biological	3	13
Traps	3	-
TOTAL	**36**	**399**

Results of the mentioned surveys are reported in the present paragraph. During the analysed period, the following changes in Ppps sale and related active substances occurred:

— *in terms of Ppp total quantities (Table 5.9)*:
  - an overall decrease in Ppps sale, from 171.7 to 167.3 10^6 kilogrammes (-4.4 millions kilogrammes), due mainly to fungicides (-4.3 millions kilogrammes) and other products (-5.2 millions kilogrammes);
  - an opposite trend in herbicides, whose sale increases from 24.5 to 35.4 (+ 5.9 million kilogrammes);
  - still a reduced recourse to biological products, equal to 0.2 millions kilogrammes in year 2002;

— *in terms of active substances (Tables 5.10, 5.11)*:
  - an overall decrease in toxicity due mainly to very toxic and toxic Ppps, lowered from 19.6 to 11.6 millions kilogrammes, whereas the harmful ones, increased from 16.3 to 19.3 millions kilogrammes (+3 millions kilogrammes);
  - an increase of active substances contained per unit of Ppps weight from 76.5 to 94.7 millions kilogrammes, due mainly to the active substances contained in fungicides (+19.7 millions kilogrammes), and in insecticides (+1.5 millions kilogrammes);
  - an increment equal to 2.6 kilogrammes of active substances per hectare of potentially treated area, from 7.6 to 10.2 kilogrammes, occurred mainly in fungicides (+2.4 kilogrammes per hectare) and insectides (+0.3 kilogrammes per hectare), whereas other products decresed (-0.4 kilogrammes per hectare).

TABLE 5.9 Sale of plant protection products in agriculture, per category and toxicity classes - Years 1993-2002 *(10^6 kg)*

CATEGORIES - TOXICITY CLASSES	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Fungicides	94.8	83.4	84.1	82.9	84.4	84.7	84.2	82.9	76.6	90.5
Insecticides and acaricides	34.9	32.4	36.0	33.8	39.2	38.1	35.9	35.5	34.0	32.6
Herbicides	24.5	24.9	27.2	28.7	28.9	29.0	26.5	25.9	26.6	31.4
Other	17.5	17.3	18.3	19.4	14.6	13.4	11.5	10.1	10.3	12.3
Biological	*(a)*	*(a)*	*(a)*	*(a)*	*(a)*	*(a)*	0.1	0.1	0.1	0.2
TOTAL	**171.7**	**158.0**	**165.6**	**164.8**	**167.1**	**165.2**	**158.2**	**154.5**	**147.7**	**167.3**
Very toxic or toxic	19.6	18.2	19.0	17.6	17.9	15.6	14.4	12.6	11.0	11.6
Harmful	16.3	16.0	16.8	21.3	21.6	20.8	18.7	16.2	15.2	19.3
Not classifiable	135.8	123.8	129.8	125.9	127.6	128.8	125.1	125.7	121.5	136.3

(a) Non available.

TABLE 5.10 Active substances contained in sold Ppps per category - Years 1993-2002 *(10^6 kg)*

CATEGORIES	1996	1997	1998	1999	2000	2001	2002
Fungicides	43.5	52.6	53.6	52.8	52.4	48.5	63.2
Insecticides and Acaricides	10.3	11.9	12.0	12.1	12.1	11.9	11.8
Herbicides	10.4	10.5	10.7	9.7	9.5	10.6	11.8
Other (a)	12.3	9.7	8.3	7.4	5.8	5.8	7.7
Biological	-	-	-	-	-	0.1	0.3
TOTAL	**76.5**	**84.7**	**84.6**	**82.0**	**79.8**	**76.3**	**94.7**

(a) Data for years 1999 and 2000 includes also biological active substances.

TABLE 5.11 Active substances contained in sold Ppps per hectare of potentially treated area (a) **- Years 1996-2002** *(kg)*

CATEGORIES	1996	1997	1998	1999	2000	2001	2002
Fungicides	4.4	5.0	5.0	4.9	5.7	5.3	6.8
Insecticides and Acaricides	1.0	1.1	1.1	1.1	1.3	1.3	1.3
Herbicides	1.0	1.0	1.0	0.9	1.0	1.1	1.3
Other (b)	1.2	0.9	0.8	0.7	0.6	0.6	0.8
TOTAL	**7.6**	**8.0**	**7.9**	**7.6**	**8.6**	**8.3**	**10.2**

(a) Potentially treated area includes arable land (excluded set aside land) and permanent crops (excluded permanent meadows and pastures).

(b) The category “other” includes biological active substances.

5.3.2 Surveys on plant protection products use in specific crops

The activity to collect information on use of Ppps started in Istat as Tapas project in 1999, as recommended by the European Commission, to improve agriculture statistics.

The survey is conducted using the Computer assisted telephone interviewing (Cati) system. The phenomena investigated refer to use of Ppps and number of fields interventions realised on a specific crop. The sample is significant at national level, so that it is possible to estimate total use of fungicides, insecticides and acaricides, herbicides and other products and related active substances. Knowing the treated area, it is possible to calculate the hectare dose utilised.

Crops investigated are, from 1999 to 2002, vine, olive and apple trees, and maize; last survey in year 2003 has been conducted on some cereals such as durum and spring wheat, barley and oats. Furthermore, it is possible to calculate the share of the treated area in total area cultivated with a specific crop.

Implementing this approach to other crops it would be possible to meet data demand arising from the developing strategy on sustainable use of Ppps.

Results analysis reveals a wide range of doses used and number of interventions realised for different crops (Table 5.12).

For olive trees, on average, only one treatment is required compared to the seven performed for vine and ten for apple tree. In comparison maize is treated much less intensively with 1.3 treatments of treated area and 1.1 kilogrammes of active substances per hectare (herbicides are the

TABLE 5.12 **Treatments realised and active substances spread per category and crop** *(quantity in kg)*

CROPS	FUNGICIDES		INSECTICIDES		HERBICIDES		MIXED	TOTAL	
	N of treatments	Quantity per hectare	N of treatments	Quantity per hectare	N of treatments	Quantity per hectare	N of treatments	N of treatments	Qua he
Vine	6.3	23.3	0.3	0.8	-	-	0.2	6.8	
Apple tree	5.7	19.7	3.1	32.6	0.4	0.7	0.9	10.1	
Olive tree	0.4	4.9	0.4	1.0	..	..	0.1	0.9	
Maize	-	-	0.1	..	1.2	1.1	-	1.3	

most used Ppps on this crop). Referring to treated area, this surface reaches 90.3 percent of the total area with apple tree cultivation, whereas for olive plantations the value drops to 38.3 percent.

5.4 Waste generation and management in agricultural farm system

Referring to data demand arising from legislation in force as WStatR and to indicators identified by the Esepi project (paragraph 4.1.1), wastes generated and managed at farm level have to be monitored. Thus a research activity has been performed in Istat in order to define which materials should be included as waste generated in agricultural activity, and what kind of statistical approach can be identified in order to quantify the amount generated and managed in the agriculture sector.

Italy ran a pilot project in two phases on agriculture, hunting and forestry and fishing[68].

In the first project phase, whose results have been reported in *Methodological Approach for Statistics on Waste Generated in Agriculture, Forestry and Fishing*[69], the main methodological aspects linked to the data compilation methods that Italy could use, the area under study, the related typologies of involved wastes and the possible data sources were developed. Furthermore, considering the importance of farm in generation and management of several substances and the complexity of the farming system, additional questions were introduced in the Fss 2003, in order to investigate this phenomenon.

In more detail, insights were provided on conventional waste, and on *residues and by-product of bio-organic nature*. Conventional waste (Table 5.13) is mainly generated for use of machineries, of chemical substances for crops protection and for veterinary purpose, and of materials of plastic nature (as film for mulching, sheet to cover greenhouses and tunnel, hard sheet for greenhouses, harvesting nets, tubes for irrigation). At present materials of bio-organic nature (Table 5.14) have been defined as *poten-*

68 Both projects results have been published in *Waste Statistics on Agriculture, Forestry and Fishing Sectors*. (Bellini G. ed.). Roma: Istat, in corso di pubblicazione. (Essays).

69 Bellini, G., and M. Cammarrota. *Methodological Approach for Statistics on Waste Generated in Agriculture, Forestry and Fishing*. Rome: Istat, 2004. (Final report to Eurostat).

tial waste, and it has been stated that a review of available data calculation methodologies and of information on by-products destination available might be useful to solve the definition problems. Management of by-products at farm level is in fact a not well known phenomenon, which might be changed as the organisation of the agriculture system is, in the last decades.

In the following two separated lists for conventional and bio-organic waste are provided. As waste statistics have to be produced per economic sector and vegetal and animal processing - if conducted at farm level - is classified as Nace A, than the related bio-waste is included in the list. Typologies of waste have been ordered according to the Ewc-Stat classification. Referring to data availability at national level, in the following table is reported the availability of methodologies for their estimation.

The second phase of the pilot project named *Statistics on Waste management in Agriculture, Forestry and Fisheries. Waste statistics Regulation 2150/02/Ec*[70] has the aim to analyse the phenomenon of waste generation in agriculture and forestry, in order to draw up a framework in which statistical activities can be implemented.

The analysis of results obtained with the questions integrated in the Fss questionnaire was performed in this phase of the project.

In particular, the added questions refer to waste/by-product generation in farm and management practices adopted at farm level. For all substances considered under production perspective (metal, plastic, pesticide waste, waste from olive grinding and wine-making process), we asked to fill in the questionnaire whether the farm produces the specific substance, except for metal, plastic and pesticide waste, for which the amount produced is requested. Referring to treatment used at farm level, a selection on substances and modality of recovery and disposal has been realised. The following substances are thus included: by-product of vegetable production, waste from olive grinding (wastewater from olive grinding, dry and wet olive residues) and wine-making process, plus the item other. Typology of treatment are purification, incineration - for energy production, on land -, land treatment, disposal in water bodies, composting, other treatment.

[70] Ballin, M. *Statistics on Waste Management in Agriculture, Forestry and Fisheries: Waste Statistics Regulation 2150/02/Ec.* Rome: Istat, 2004. (Final report to Eurostat).

TABLE 5.13 Conventional waste generated in agricultural activities (Nace A)

Waste classification			Availability of data compilation methodologies
Ewc-Stat	**LoW**		
Used motor oils			
01 Chemical compound wastes			
01.3 Used oils			
01.31 Used motor oils	**13 02 05**	Mineral based non chlorinatedengine, gear and lubricating oils *(hazardous)*	Apat provided two estimation methodologies: one for engine oil and one for lubricating oil (Apat, Onr, 2004).
	13 02 06	Synthetic engine, gear and lubricating oils *(hazardous)*	
	13 02 07	Readily biodegradable engine, gear and lubricating oil *(hazardous)*	
Agrochemicals and Pesticides			
02 Chemical preparation waste			
02.1 Off-specification chemical wastes			
02.11 Agrochemical product waste	**02 01 08**	Agrochemical waste containing dangerous substances *(hazardous)*	Apat provided an estimation methodology based on sold products and on container characteristics (Apat, Onr, 2004). Istat run a data collection experience through the integration of the 2003 FSS questionnaire (Bellini, Cammarrota, 2004).
	02 01 09	Agrochemical waste other than those in 02 01 08 (*non hazardous*)	
Veterinary medicines			
02 Chemical preparation waste			
02.1 Off-specification chemical wastes			
02.12 Unused medicines	**18 02 07**	Cytotoxic and cytostatic medicines *(hazardous)*	
	18 02 08	Medicines, other than those mentioned in 18 02 07 *(non-hazardous)*	
Filter materials			
03 Other chemical wastes			
03.1 Chemical deposits and residues			
03.14 Spent filtration and absorbent materials	**15 02 03**	Absorbents, filter materials, wiping cloths, protective clothing other than those mentioned in 15 02 02 *(non-hazardous)*	
	15 02 02	Absorbents, filter materials including oil filters not otherwise specified, wiping cloths, protective clothing contaminated by dangerous substances *(hazardous)*	

Waste classification			Availability of data compilation methodologies
Ewc-Stat	**LoW**		
Metallic wastes			
06 Metallic waste *(hazardous and non –hazardous)*			
06.3 Mixed metal wastes **06.32** Other mixed metallic wastes	**02 01 10**	Waste metal *(non-hazardous)*	Istat run a data collection experience through the integration of the 2003 Fss questionnaire (Bellini, Cammarrota, 2004).
End-of-life tyres			
07 Non-metallic wastes			
07.3 Rubber wastes			
07.31 Used tyres	**16 01 03**	End-of-life tyres *(non–hazardous)*	Apat provided an estimation methodology (Apat, Onr, 2004).
Waste plastics			
07 Non-metallic wastes			
07.4 Plastic wastes			
07.42 Other plastic wastes	**02 01 04**	Waste plastics (except packaging) *(non-hazardous)*	Apat provided an estimation methodology based on sold products and on amount of plastic waste collected separately (Apat, Onr, 2004). Istat run an estimation model from data collected through the 2003 FSS questionnaire (Ballin, 2004).
End-of-life vehicles			
08 Discarded equipment			
08.1 Discarded vehicles			
08.12 Other discarded vehicles	**16 01 06**	End-of-life vehicles, containing neither liquids nor other hazardous components *(non-hazardous)*	Apat provided an estimation methodology for vehicles with engine and without engine (Apat, Onr, 2004).
	16 01 04	End-of-life vehicles *(hazardous)*	
Batteries			
08 Discarded equipment			
08.4 Discarded machines and equipment components			
08.41 Batteries and accumulators waste	**16 06 01**	Lead batteries *(hazardous)*	Apat provided an estimation methodology for lead batteries (Apat, Onr, 2004).
	16 06 02	Ni – Cd batteries *(hazardous)*	
Oil filters			
08 Discarded equipment			
08.4 Discarded machines and equipment components			
08.43 Other discarded machines and equipment components	**16 01 07**	Oil filters *(hazardous)*	Apat provided an estimation methodology for lead batteries for lubricating oil filters and air filters in oil bath (Apat, Onr, 2004).

TABLE 5.14 Bio-organic waste generated in agricultural activities (Nace A)

Waste classification				Availability of data compilation methodologies
Ewc-Stat		**LoW**		
Animal waste of food preparation and products				
09	Animal and vegetal waste			
09.1	Waste of food preparation and products			
09.11	Animal waste of food preparation and products	**02 01 02**	Animal-tissue waste *(non-hazardous)*	
		02 02 01	Sludge from washing and cleaning *(non-hazardous)*	
Vegetal waste of food preparation and products				
09	Animal and vegetal waste			
09.1	Waste of food preparation and products			
09.12	Vegetal waste of food preparation and products	**02 01 01**	Sludge from washing and cleaning *(non-hazardous)*	An estimation procedure applied for plant tissues waste by Istat, National Environmental Accounts (Femia, 2003). An estimation procedure provided also by Apat (Apat, Onr, 2004).
		02 01 03	Plant-tissue waste *(non-hazardous)*	
		02 03 01	Sludge from washing, cleaning, peeling, centrifuging and separation *(non-hazardous)*	
		02 03 99	Wastes not otherwise specified *(non-hazardous)*	
		02 07 01	Wastes from washing, cleaning and mechanical reduction of raw materials *(non-hazardous)*	
Mixed waste of food preparation and products				
09	Animal and vegetal waste			
09.1	Waste of food preparation and products			
09.13	Mixed waste of food preparation and products	**02 05 99**	Wastes not otherwise specified *(non-hazardous)*	
Green waste				
09	Animal and vegetal waste			
09.2	Green wastes			
09.21	Green wastes	**02 01 07**	Wastes from forestry *(non-hazardous)*	An estimation procedure applied by Istat, National Environmental Accounts (Femia, 2003).
Faeces, urine and manure (a)				
09	Animal and vegetal waste			
09.3	Slurry and manure			
09.31	Slurry and manure	**02 01 06**	Animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated off-site *(non-hazardous)*	An estimation procedure applied for liquid and soli manure by Istat, National Environmental Accounts (Femia, 2003).

(a) As stated in the List of waste, effluents treated on-site are not considered waste.

Referring to results obtained:

— *from the waste generation point of view*

- an estimate of the plastic produced by region was performed running a model. The indicator 'amount of waste produced by the sector' can be calculated. Nevertheless, the obtained results show that the sample survey can be a very useful tool above all in iden tifying influential groups of farms for waste generation and in showing that generation of waste can be very different depending on the level of some relevant structural variables. Among structu raldata, it has to be stressed that the 'mulch area' variable, which is relevant for plastic estimate, has been introduced in the Fss questionnaire on voluntary basis as relevant information from the environmental point of view. Thus this variable can be considered an indicator itself;
- for olive grinding and wine making processes it is necessary to quantify the amount of food product processed at farm level than technical coefficient can be applied to estimate the amount of process residues produced;

— *from the waste management point of view*

- re-use in farm, in several forms, seems to be the most adopted practice and among these land treatment is the most widespread one for any kind of material. Nevertheless burning on soil of crop residues and of trimming operation residues is still a wide spreadpractice.

Referring to land treatment, it is important to underline that a comprehensive legislation exists on such matter. In fact the application on soil of some material of bio-organic nature can pose certain environmental problems mainly related to: excessive supply of nutrients, introduction of pollutants, such as heavy metals and organic compounds, spreading of human, animal and/or plant pathogens.

Referring to the purification treatment, information arises on farms that have a treatment plant for wastewater generated in the olive grinding process and for wet olive residues. In terms of indicators definition, there is still need for a deepening in order to identify the priority agriculture waste typology. This will be possible evaluating findings and conclusions generated by the pilot projects run by Member States and funded by Eurostat within the framework of WStatR implementation process.

5.5 Gross nitrogen balance

Nutrients as nitrogen and phosphorous are used in agriculture in order to increase crop productivity. An excess of such nutrients is a potential threat to the environment in the diverse compartments: degrading soil conditions, increasing nitrogen content in water, and acidifying air and increasing greenhouse effect.

A comprehensive legislation to prevent water pollution (National Decree 11 May 1999, n. 152 on constraint to prevent water pollution, implementing Directive 91/271/Eec concerning the treatment of urban wastewater and of Directive 91/676/Eec on prevention of water pollution from nitrates of agriculture origin) and legal binding on agricultural practices have been issued on the topic (paragraph 2.2).

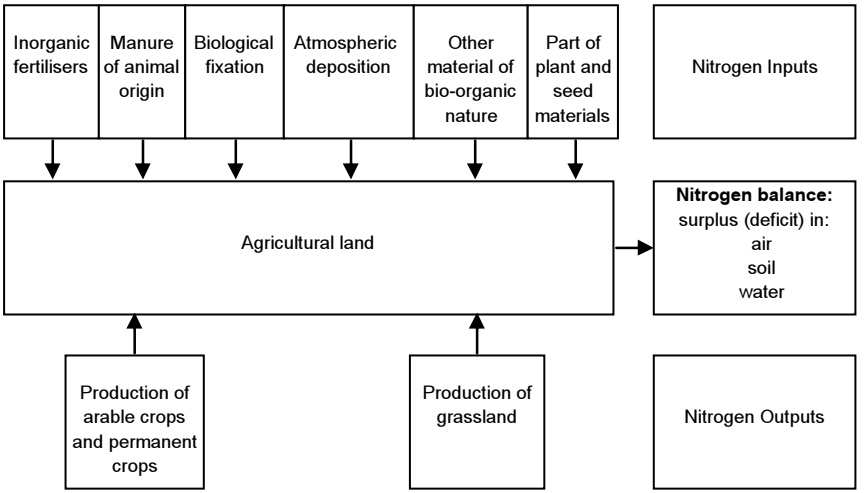
The nitrogen balance indicator represents a central indicator when referring to nutrient use issue. In fact, the difference between nitrogen available for the agriculture system (inputs represented mainly by manure of animal origin and chemical fertilisers) and uptakes (outputs) from agricultural activity due mainly to growing crops can show the existence of surplus or deficit. A persistent surplus represents a polluting factor, whereas a persistent deficit can reveal a problem of soil productivity in medium to long-term period. This surplus contains the amount of nitrogen that can leach in water and emit to air. This indicator has been considered both in the Esepi project and in the Irena list.

Calculation methodology has been reviewed during time. Here the last available approaches and last versions, proposed jointly by Oecd and Eurostat, are the following:

1. *Balance at farm level*: inputs and outputs are calculated referring to the farm and nitrogen recycled and stored in farm is not taken into account. Inputs include nitrogen imported in farm (i.e. fertilisers) and exported from farms (i.e. animal and vegetal products, excluding fodder eaten in farm, if the case. Differences between imports and exports represent the surplus or the deficit in nitrogen;
2. *Gross nitrogen balance*: also in this case the farm represents the analysis unit, but the calculation involves inputs and outputs from the farm, such as the nitrogen spread on soil (fertilisers, manure), nitrogen atmospheric deposition and biological fixation process, and

removed from soil. A diagram for inputs and outputs is presented below (Figure 5.1).

FIGURE 5.1 Inputs and outputs in gross nitrogen balance



Istat is lately working in close cooperation with other Institutes such as the Plant nutrition experimental institute of the *Consiglio per la ricerca e la sperimentazione in agricoltura (CRA)* and the University of Bologna, in order to include the proper basic data and to apply the most appropriate coefficients. The method adopted refers to the Gross nitrogen balance.

The voices taken into account as inputs are:

— inorganic and organic fertilisers (including industrial compost and treated sewage sludge), manure of animal origin excluded;

— nitrogen spread on soil through manure of animal origin: it is calculated multiplying total number of live animals per specie (bovines, ovine, swine, poultry, equine and other livestock) and category, to the kind of production (swine for reproduction, calf breeding, etc), sex and age (where available), multiplied by the coefficients of the excreted nitrogen per year;

— atmospheric deposition: utilised agricultural area multiplied by a coefficient (kg of nitrogen deposition per hectare);

— biological nitrogen fixation: realised by the cultivated leguminous crops (soya-bean, lucerne, tricolour sp., etcetera) and calculated multiplying the cultivated area by the amount of nitrogen fixed per hectare of surface, plus the biological fixation realised by free living microrganisms calculated multiplying the utilised agricultural area by the amount of nitrogen fixed per hectare of surface;
— nitrogen contained in seeds and other vegetal planted material: amount of seeds and other planted material (i.e. tuber crops) multiplied by the specific nitrogen content.

The nitrogen outputs include:

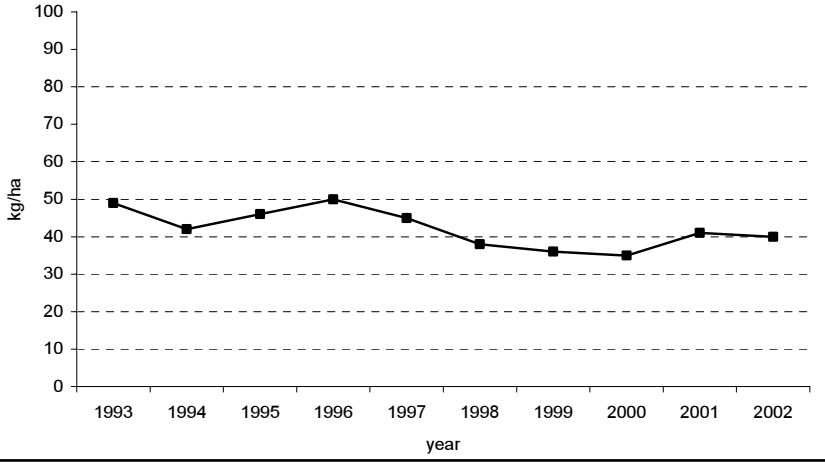
— harvested vegetal material (from herbaceous and tree plant): amount of production for vegetal plants (cereals, industrial plants, vegetables) and harvested amount of fruits for fruit trees (citrus trees, vine, other fruits) multiplied by the nitrogen content per tonne of the specific crop;
— fodder: amount of fodder produced (dry forage, green maize, grass from permanent grassland) multiplied by the nitrogen content per tonne.

Nitrogen coefficients applied (manure nitrogen content and biological fixation) are calculated by a model called Enviromental liveliness and blent agriculture (Elba) set up by the *Dipartimento di protezione e valorizzazione agroalimentare (Diproval)* of Bologna University.

Elba model defines livestock consumption (depending on availability of fodder and their nutrient content and the productive and physiological animal characteristics) per animal category and assimilation level of nutrients. Nitrogen excreted is thus estimated.

It has to be stressed that for some voices included in the conceptual scheme figures are not available, as for material of bio-organic nature distributed on land. The balance is calculated per hectares of agricultural land calculated considering arable land (excluding set-aside land), and permanent crops and grassland (excluding pastures). Results are presented in figure 5.2. The figure shows the existence of nitrogen surpluses, in fact the balance is positive (around 41 kilogrammes per hectare). The trend reveals that the balance has been slightly decreasing in the last ten years (-10 kilogrammes per hectare), thanks to the adopted policy to mainly prevent water pollution. A minimum was recorded in year 2000 with 35 kilogrammes per hectare.

FIGURE 5.2 **Gross nitrogen balance per year** (trend) *(kg/ha)*



5.6 Emissions from agricultural activity

Referring to agricultural activities, relevant indicators are related to relevant gaseous emissions. These indicators are represented by ammonia (NH_3) - which is relevant for the air pollution environmental theme -, and carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) - which are the relevant greenhouse gases for the climate change issue. In 2002, NH_3 emissions from the agriculture sector accounts for 411,329 Gigagrammes, which represents 94.5 percent of the total national ammonia emissions. In 2002, CH_4 and N_2O emissions from the agriculture sector accounts for 48 percent (816.22 Gigagrammes) and 54 percent (74.31 Gigagrammes) of total emissions, respectively.

In the following sections, methodologies used by Apat for the estimation of NH_3, CH_4, N_2O and CO_2 emissions are described. In particular, greenhouse gases estimation methodologies are described in detail in the Nir[71]. Highlights are given for activity data, emission factors (Ef) and methodologies used for estimating emissions.

71 Apat. *National Inventory Report 2004. Italian Greenhouse Gas Inventory 1990-2002*. Rome: Apat, 2004. (Rapporto n. 42/04). Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003*. Rome: Apat, in press. www.unfccc.int.

5.6.1 NH_3 emissions

For the calculation of NH_3 emissions the following sources were taken in account: animal breeding (housing, storage, manure application, grazing animals) and agricultural soils (with and without fertiliser application). Detailed methodologies are described by Crpa[72].

For the agriculture sector, data published by Istat such as population data for each livestock category, fertiliser distributed, nitrogen content and cultivated surface has been used. Milk production data has been used as such and in estimation procedure and Istat publications as well as other national publications. Livestock categories used are: dairy cattle, non-dairy cattle, buffalo, sow, other swine, equine, goat, sheep, poultry and rabbit.

Referring to the animal breeding source category, for the ammonia inventory, calculations were made on the basis of a step-by-step procedure, starting from excreted nitrogen (N) for each animal class. Nitrogen excretion rates (N excretion) have been estimated by livestock categories and are defined by livestock population characteristics in Italy on the basis of recent European literature as described by Crpa[73]. Specifically, for the dairy cattle category, the calculation of the Ef has considered milk production at provincial level, corresponding to Nuts3 level; therefore the amount of proteins required in diets has been calculated. N excretion values are related to the weight of the different animals. In table 5.15, total N excretion factor values (kilogrammes per head per year) and average weight (kilogrammes) from 2002 Italian inventory, compared with Emep/Corinair values are presented.

The calculation procedure, similar with other inventories and models elaborated at European level, is implemented through successive subtractions from the quantification of the N excreted annually for every single category of animal. This quantity can be divided in two different fluxes, depending if animals are inside (housing, storage and manure application) or outside the stable (grazing).

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72 Crpa. "Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di ammoniaca". In *Piani regionali di risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle are Padane. Allegato 1*. Reggio Emilia: Crpa, 1997.

73 Crpa. *Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo*. Reggio Emilia: Crpa, 2000.

TABLE 5.15 N excretion coefficients and average weight per animal category

ANIMAL CATEGORY	Italian N excretion (*kg/head/year*)	EMEP/ CORINAIR N excretion (*kg/head/year*)	Average weight (*kg*)
Dairy cattle	106	100	650
Other cattle	45	50	387[a]
Sow (including piglets)	25	36	160
Other swine	13	14	84[b]
Equine	50	50	528
Goats	16	20	42
Sheep	16	20	46
Broilers	0.45	0.6	1.0
Laying hens	0.66	0.8	2.0
Rabbit	0.6	….[c]	1.6

Source: Apat
a) Considered the weight of the total number of cattle without dairy cattle.
b) Considered the total weight of sows without fattening sows and piglet.
c) Corinair/Emep only provides a value for fur animals, but not for rabbits.

A fraction of N excreted in the stable is emitted in air as ammoniacal nitrogen (N_NH_3) because of volatilisation during the permanence of the manure inside the stable (housing); this fraction is subtracted from the total N excreted, in order to obtain the amount of N in the stored manure. During storage another fraction of N_NH_3 gets lost (storage), and is then subtracted in order to obtain the quota of N available for manure application. The losses of ammoniacal nitrogen respect to total nitrogen contained in the manure used for application to soils are calculated (manure application).

The quota of N excreted outside the stable - when grazing - has volatilisation losses (grazing) only at that phase. Emissions from this phase are considered in the agricultural soil category.

The sum of all N_NH_3 losses occurred for the four phases, converted to NH_3, are the global annual losses of NH_3 referred to the animal breeding category. In table 5.16 NH_3 Efs used for year 2002 are presented and compared to those proposed by Emep/Corinair.

Ammonia Efs from different stages (housing, storage, manure

TABLE 5.16 **NH_3 emission factors per phase and animal category** *(kg/head/year)*

NH_3 EMISSION FACTORS	Housing		Storage		Manure application		Total	
	Italian	Emep/ Corinair	Italian	Emep/ Corinair	Italian	Emep/ Corinair	Italian	Emep/ Corinair
Dairy cattle	7.93	8.70	10.6	3.80	16.7	12.10	35.23	24.60
Other cattle	4.6	4.40	5.0	1.90	7.3	6.00	16.9	12.30
Fattening sows	4.0	7.43	3.5	2.18	3.0	6.82	10.5	16.43
Other sows	1.8	2.89	1.9	0.85	1.6	2.65	5.3	6.39
Equine	2.6	2.90	….	….	1.9	2.20	4.5	5.10
Goat/sheep	0.18	0.24	….	….	0.31	0.22	0.49	0.46
Laying hens	0.18	0.19	0.08	0.03	0.08	0.15	0.34	0.37
Broilers	0.11	0.15	0.06	0.02	0.02	0.11	0.19	0.28
Rabbit	0.16	….	0.07	….	0.06	….	0.29	….

Source: Apat

application, grazing animals) have been calculated on the basis of Emep/Corinair emission factors (Table 5.16), taking in account the Italian specific conditions regarding temperature, animals weight, average milk production and manure management[74].

Referring to agricultural soil category source, emissions from direct application of synthetic fertilisers to soil, from grazing and from nitrogen fixed in leguminous crops have been estimated. Emissions from synthetic fertiliser are based on the detailed Emep/Corinair methodology, which provides different Efs for the different type of fertilisers, taking into account climatic conditions. Emission factors are presented in table 5.17.

Emissions factors proposed by Emep/Corinair guidelines have been used to estimate emissions from manure excreted during grazing and from fixing N leguminous crops. For example, for the goat/sheep category NH_3 emissions from grazing are calculated equal to 4 percent of the N

74 Crpa. "Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di ammoniaca". In *Piani regionali di risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle are Padane. Allegato 1*. Reggio Emilia: Crpa, 1997 Crpa. *Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo*. Reggio Emilia: Crpa, 2000.

TABLE 5.17 Emission factors of NH_3-N per type of fertiliser
(kg NH_3-N volatilized/kg N applied)

TYPES OF FERTILISER	Emission factor
Ammonium sulphate	0.10
Calcium cyanamide	0.02
Ammonium nitrate < 27%	0.02
Ammonium nitrate > 27%	0.02
Calcium nitrate	0.02
Urea	0.15
Phosphate nitrogen	0.05
Potassium nitrogen	0.02
NPK nitrogen	0.02
Organic mineral	0.02

Source: Emep/Corinair guidelines

excreted, for cattle and equine equal to 8 percent. For leguminous crops the Ef proposed is equal to 1 kilogramme of NH_3 per hectare per year.

5.6.2 CO_2 emissions from soil

Gross carbon emission can be reduced by, among others, CO_2 removal from soil, thus the importance given to this particular sink category and to soil management practices. For Italy it has been calculated that a 0.15 percent increase of organic carbon content in agricultural soils (that is an increase of 0.26 percent in soil organic matter) would be equivalent to fix an amount of carbon dioxide corresponding to the total amount of the yearly emission of fossil fuels in the whole country[75].

[75] Laraia, R. "Il ruolo della gestione dei rifiuti organici biodegradabili nella gestione integrata dei rifiuti: orientamenti europei ed internazionali". In *Ricicla 2001. Atti dei Seminari*. Rimini: Maggioli Ed. SpA, 2001: 678-695.

In order to establish compliance with national and international commitments, a national Ghg emission inventory is compiled and communicated annually to the competent institutions through compilation of the Common reporting format (Crf) in agreement with the guidelines provided by Unfccc and the European union's greenhouse gas monitoring mechanism[76].

A national inventory report (Nir) is compiled and updated annually in order to reflect revisions and improvements in the methodology and the availability of new information.

In table 5.18 used data sources for activity data, concerning the sector Land use change and forestry, are reported.

TABLE 5.18 Activity data and related data source per Land use change and forestry sector

SECTOR	Activity data	Source
Land use change and forestry	Forest and soil surfaces	Statistical yearbooks – National statistics Institute
	Amount of biomass	State forestry corps
	Biomass burnt	National and regional forestry inventory
	Biomass growth	Universities and research institutes

Emission factors used in the estimation process are consistent with the Ipcc good practice guidance and supported by national experiences and circumstances.

Methodologies used for the estimation process are consistent with the Ipcc good practice guidance: the 1996 Ipcc guidelines have been entirely applied for the categories Changes in forest and other woody biomass stocks (5A), Abandonment of managed lands (5C) and CO_2 emissions and removals from soil (5D) of this sector as detailed data were available

76 Ipcc Wg1 Technical support Unit - Hadley Centre - Meteorological Centre - Meteorological Office. Revised 1996 *Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Emission Inventories: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook*. Bracknell, UK: Ipcc/Oecd/Iea, 1997.
Ipcc Technical support Unit. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories: National greenhouse gas inventories programme*. Hayama, Kanagawa, Japan: Ipcc, 2000.
Eea. *Joint Emep/Corinair Atmospheric Emission Inventory Guidebook*, Copenhagen: Eea, 2001. (Third Edition).

from national statistics and from researches at national and regional level, whereas for category Forest and grassland conversion (5B) guidelines have been adapted to the actual Italian situation.

Concerning Land use change and forestry sector carbon stored in roots, in leaves, in dead wood, in the litter and in the soil has not been estimated because no reliable information is available up to now.

In table 5.19 a summary report for methods and emission factors used, for the Ghg source and sink categories included in the Land use change and forestry sector, is given.

TABLE 5.19 Methods and emission factors for CO_2 and Ghg source and sink categories

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	
	Method applied	Emission factor
Changes in forest and other woody biomass stocks	Ipcc default, Country specific	Ipcc default, Country specific
Forest and grassland conversion	-	-
Abandonment of managed lands	Ipcc default	Ipcc default
CO_2 emissions and removals from soil	Ipcc default	Ipcc default, Country specific
Other	-	-

Among the mentioned Ghg source and sink categories, only the category 5D Emissions and removals from soil refers to soil; in the following a description of the related estimation methodology will be given.

In order to estimate CO_2 emissions or removals from soil in relation to 1990-2002, changes of surface area, by type of agricultural practices, have been considered in the twenty years periods 1970-1990, …, 1982-2002. The land use data were provided by Istat. An estimate of the soil carbon content (soil depth of 30 centimetres) has been done according to the indications of national experts; for one hectare of agriculture land (short and long-term cultivated, set aside) a soil carbon content of 44.5±10 tonnes has been estimated; for forest soils a content of 73±15 tonnes of carbon per hectare has been estimated[77]. For every type of soil

77 Ciccarese L., C. Dolci, e D. Pettenella. "Csem: un modello per la stima del bilancio del carbonio nel settore forestale in Italia". *Sisef, Atti del Convegno*.

(short and long term cultivated, forest, permanent pasture, set-aside), the surface area was multiplied by the unit content of carbon and by the average coefficients suggested by the Ipcc in the

Reference Manual, tables 5-10[78] which take account of the different tillage systems and of the amount of crop residues left to decompose (tillage factor and input factor respectively). Thus, we have estimated the stock of carbon at the beginning and end of the period examined and, therefore, the quantities of CO_2 stored or released. CO_2 emissions obtained are equivalent to 1.4 teragrammes CO_2 for 1990, 2.0 teragrammes CO_2 for 2002.

In the next submission of the national Ghg emission inventory Good practice guidance for Land-use, land-use change and forestry (Lulucf)[79] will be applied, new refined growth curves will be applied and the estimation of carbon stored in roots, leaves, and dead wood and in the litter will also improve the inventory.

The Good practice guidance for Lulucf gives estimation procedures and good practices for estimating CO_2 emissions and uptake by soils from land-use and management that can be applied to all land uses. The methodology considers organic carbon stock changes (CO_2 emissions or removals) for mineral soils, CO_2 emissions from organic soils and emissions of CO_2 from liming of agricultural soils.

As well as in the Ipcc guidelines, carbon stocks are measured to a default depth of 30 centimetre and do not include C in surface residue[80] (i.e. dead organic matter) or changes in inorganic carbon (i.e. carbonate minerals).

78 Ipcc Wg1 Technical support Unit - Hadley Centre - Meteorological Centre - Meteorological Office. *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Emission Inventories: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook.* Bracknell, UK: Ipcc/Oecd/Iea, 1997.

79 Ipcc Technical support Unit. *Good Practice Guidance for Land Use, Land-Use Change and Forestry: National greenhouse gas inventories programme*. Hayama, Kanagawa, Japan: Ipcc, 2003.

80 The Good practice guidance for Lulucf sector provides methods for estimating carbon stock changes associated with dead organic matter pools, with a separate guidance for two types of dead organic matter pools: dead wood and litter.

The equation for estimating the change in carbon stocks in soils is shown below:

$$\Delta C_{LU_{Soils}} = \Delta C_{LU_{Mineral}} - \Delta C_{LU_{Organic}} - \Delta C_{LU_{Lime}}$$

where:

$\Delta C_{LU_{Soils}}$ is the annual change in carbon stocks in soils, [t C yr^{-1}]

$\Delta C_{LU_{Mineral}}$ is the annual change in carbon stocks in mineral soils, [t C yr^{-1}]

$\Delta C_{LU_{Organic}}$ is the annual carbon emissions from cultivated organic soils (estimated as net annual flux), [t C yr^{-1}]

$\Delta C_{LU_{Lime}}$ is the annual carbon emissions from agricultural lime application, [t C yr^{-1}]

The change in carbon stocks in mineral soils is:

$$\Delta C_{LU_{Mineral}} = \Sigma_{ij} \left[\left(SOC_0 - SOC_{(0-T)} \right) \cdot A \right] / T$$

where:

$$SOC_i = SOC_{ref} \cdot F_{LU} \cdot F_{MG} \cdot F_I$$

$\Delta C_{LU_{Mineral}}$ is the annual change in carbon stocks in mineral soils, [t C yr^{-1}]

SOC_0 is the soil organic carbon stock in the inventory year, [t C yr^{-1}]

SOC_{0-T} is the soil organic carbon stock T years prior to the inventory, [t C yr^{-1}]

T is the inventory time period, [yr] (default is 20 yr)

A is the land area of each parcel [ha]

SOC_{REF} is the reference organic carbon stock, [t C yr^{-1}]

F_{LU} is stock change factor for land-use change type

F_{MG} is stock change factor for management regime

F_I is stock change factor for input of organic matter

The change in carbon stocks in organic soils is:

$$\Delta C_{LU_{Organic}} = \Sigma_c \left(A \cdot EF\right)_c$$

where:

$\Delta C_{LU_{Organic}}$ is the CO_2 emissions from cultivated organic soils, [t C yr^{-1}]

A is the land area of organic soils in climate type, c, [ha]

EF is the emission factor for climate type c, [t C ha-1 yr^{-1}]

The change in carbon emission from agricultural lime application is:

$$\Delta C_{LU_{Lime}} = M_{Limestone} \cdot EF_{Limestone} + M_{Dolomite} \cdot EF_{Dolomite}$$

where:

$\Delta C_{LU_{Lime}}$ is the annual C emissions from agricultural lime application, [t C yr^{-1}]

M is the annual amount of calcic limestone or dolomite, [t C y^{r-1}]

EF is the emission factor [t C (t limestone or dolomite)$^{-1}$]

5.6.3 CH_4 and N_2O emissions

A national emission inventory for the most significant greenhouse gases (CH_4 and N_2O) from the agriculture sector is prepared by Apat with the support of the Research center on animal production (Crpa). For the years 1990 and 1995 the inventories were scaled on a provincial basis (corresponding to Nuts3 level), for the other years the assessment was made on a national basis. Emission inventory has been prepared according to national or Ippc methodologies[81].

The agriculture sector in the Italian inventory comprises five source categories: enteric fermentation, manure management, rice cultivation,

81 Apat. *National Inventory Report 2004. Italian Greenhouse Gas Inventory 1990-2002*. Rome: Apat, 2004. (Rapporto n. 42/04).
Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003*. Rome: Apat, in press. www.unfccc.int.

agriculture soils, and field burning of agriculture residues. For this sector, the emission estimation refers to two greenhouse gases: CH_4 and N_2O. Methane emissions from enteric fermentation and nitrous oxide emissions from direct agriculture soils are the most relevant source categories in this sector.

In general, the estimation of emissions both for CH_4 and N_2O have been done by defining an emission factor (Ef) which has been multiplied by the activity data.

5.6.3.1 CH_4 method

The methane inventory is mainly focused on animal husbandry. Detailed methodologies are described in the Nir[82].

Concerning activity data, a number of animal categories have been considered, the main ones are: dairy cattle, non-dairy cattle, buffalo, sheep, goat, horses, mules and asses, swine, poultry and rabbit. In 2002, the dairy cattle category represents 37 percent of total CH_4 emissions within the enteric fermentation category and 35 percent of total CH_4 for the agriculture sector. In general, up to now, data collection and timing availability are the main difficulties faced by Italy, which do not allow the submission of the emission inventory within the time scheduled. For the agriculture sector, population data per each livestock category are collected from Istat. For non-dairy cattle figures have been sorted according to the age of the animal and the type of production. For dairy cattle, also milk production data is used, and has been reconstructed from Istat and other national publications. Also annual crops area is taken from Istat publications. Residue/crop ratio, dry matter fraction of residue and fractions burned in fields come from national data[83].

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82 Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003*. Rome: Apat, in press. www.unfccc.int.

83 Centro studi sull'agricoltura l'ambiente e il territorio. *Impiego dei sottoprodotti agricoli e agro industriali.* Centro studi sull'agricoltura l'ambiente e il territorio, 1988. (Volume 1, edizione fuori commercio).
Crpa/Cnr. *Indagine sugli scarti organici in Emilia Romagna*. Reggio Emilia: Crpa, 1992.
Anpa - Onr. *I rifiuti del comparto agro-alimentare: Studio di settore*. Roma: Anpa, 2001. (Rapporto n. 11/01).

In table 5.20 a summary report for methods and emission factors used for the calculation of methane emissions is presented.

TABLE 5.20 CH_4 methods and Efs per source and sink categories

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	
	Method applied	Emission factor
Enteric fermentation	Ipcc default, Ipcc Tier 2	Ipcc default, country specific
Manure management	Ipcc default, Ipcc Tier 1-Tier2	Ipcc default, Ipcc Tier 1-Tier2
Rice cultivation	Ipcc default	Ipcc default
Agricultural soil	Not occurred	Not occurred
Field burning of agricultural residues	Country specific	Ipcc default

For the enteric fermentation source category, Efs for dairy cattle are calculated on the basis of the Ipcc Tier 2 methodology, which is suggested in the Good practice guidance[84]. Ippc Tier 2 methodology is a detailed methodology which uses different parameters for the calculation of the gross energy intake, considering maintenance, feeding, growth, lactation, draft power, pregnancy produce, etcetera Different sources as parameters for the calculation of Ef for dairy cattle, mainly national values produced by Crpa, Istat, Aia[85] and Osslatte[86], and also other parameters value suggested by the Ipcc Guidelines[87] are used.

Emission factors for non-dairy cattle are based on the ingestion of dry matter and on the protein content of the feed, as well as on the coefficients for conversion into methane of the energy ingested[88]. Emission factors for buffalo, swine, sheep, goats, horses, mules and asses, and swine are Ipcc default values[89].

84 Ipcc Technical support Unit. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories: National greenhouse gas inventories programme*. Hayama, Kanagawa, Japan: Ipcc, 2000.
85 Aia, Associazione italiana allevatori.
86 Osslatte, Osservatorio sul mercato dei prodotti lattiero-caseari.
87 (Vedi nota 89).
88 Apat. *National Inventory Report 2004. Italian Greenhouse Gas Inventory 1990-2002*. Rome: Apat, 2004. (Rapporto n. 42/04).
89 Ipcc Wg1 Technical support Unit - Hadley Centre - Meteorological Centre - Meteorological Office. *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Emission Inventories: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook*. Bracknell, UK: Ipcc/Oecd/Iea, 1997.

For rabbits Ef suggested by Crpa[90] has been used. In table 5.21 a summary for Efs from enteric fermentation referring to year 2002 is presented.

TABLE 5.21 **CH_4 Efs for enteric fermentation activity per animal category sector** *($kgCH_4$/head/year)*

ANIMAL CATEGORIES	Ef	Ipcc default Ef
Dairy cattle	84	100
Other cattle	49	48
Buffalo	55	55
Sheep	8	8
Goat	5	5
Horses	18	18
Mules and asses	10	10
Swine	1.5	1.5
Rabbit	0.08	Not provided

For the manure management source category, a detailed procedure for estimating Efs for cattle and swine has been used. Emission factors for cattle have been elaborated on the basis of research studies for the methodology[91] and national parameters[92]. For swine Efs have been calculated on the basis of national figures following the methodology indicated by Husted[93]. For the remaining livestock categories Efs proposed by Ipcc guidelines in relation to the climatic region, which is cold for Italy

90 Crpa. *Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo*. Reggio Emilia: Crpa, 2000.

91 Husted, S. "An Open Chamber Technique for Determination of Methane Emission from Stored Livestock Manure". *Atmospheric Environment*, 11 (1993): 27.
Husted, S. "Seasonal Variation in Methane Emissions from Stored Slurry and Solid Manures". *J. Env. Qual*., 23 (1994): 585-592.

92 Crpa. *Manuale per la gestione e utilizzazione agronomica dei reflui zootecnici*. Reggio Emilia: Regione Emilia-Romagna - Assessorato agricoltura, 1993.

93 Crpa. "Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di metano". In *Piani regionali di risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle are Padane*. Allegato 2. Reggio Emilia: Crpa, 1997.
Crpa. *Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo*. Reggio Emilia: Crpa, 2000.

(13°C as yearly average temperature), have been used[94]. In Italy, data on manure management systems which is required for the calculation of Efs are: liquid system, solid storage and dry lot, pasture range paddock and other (chicken-dung drying process system).

In table 5.22 a summary for Efs from manure management for the year 2002 is presented.

TABLE 5.22 **CH_4 Efs for manure management activity per animal category** *($kgCH_4$/head/year)*

ANIMAL CATEGORIES	Ef	Ipcc default Ef for cold temperatures
Dairy cattle	20	14
Other cattle	11	6
Buffalo	15	3
Sheep	0.22	0.19
Goat	0.15	0.12
Horses	1.48	1.4
Mules and asses	0.84	0.76
Swine	8	3
Poultry	0.08	0.078

For the rice cultivation source category, Ef chosen is equal to 33 grammes per square metre of CH_4 per year and derived by research studies from Schütz et al[95]. The value has been increased by 20 percent to take into consideration post harvest emissions[96], therefore it becomes 39.6 grammes per square metre CH_4 per year, a country specific value.

94 Ipcc Wg1 Technical support Unit - Hadley Centre - Meteorological Centre - Meteorological Office. *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Emission Inventories: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook.* Bracknell, UK: Ipcc/Oecd/Iea, 1997.

95 Schütz, H. et al. "A 3-year Continuous Record on the Influence of Daytime, Season and Fertiliser Treatment on Methane Emission Rates from an Italian Rice Padd". *Journal of Geophysical Research,* 94, D13 (1989 [a]): 16405-16415.
Schütz, H. W. Seiler, e R. Conrad. "Processes Involved in Formation and Emission of Methane in Rice Paddies". *Biogeochemistry*, 7, (1989 [b]): 33-53.

96 Wassmann, R. et al. "Temporal Patterns of Methane Emission from Wetland Rice Fields Treated by Different Modes of N Application". *Journal of Geophysical Research,* 99, D8 (1994): 16457-16462.

For enteric fermentation source category, a detailed procedure was used for dairy cattle and a simple procedure for non-dairy cattle, buffalo, rabbit, swine, sheep, goats, horses, mules and asses. The estimation of enteric emissions has been carried out by defining an emission factor for each livestock category which has been multiplied by the population of the same category. Estimates were drawn taking into account Italian conditions, considering the availability of specific data for this situation and including information on the type of diet[97].

For the manure management source and specifically for the cattle category, methodology depends on specific manure management practices and environmental conditions, considering the following factors: average monthly temperature by region (emissions are considered negligible below 10°C); amount of manure in solid (or at least capable of being handled) or liquid form and management techniques during the period of manure storage. Cattle quantity of solid and liquid manure is calculated on the basis of cubic meters produced by head and by day per each type of manure, this data is based on research done by Crpa[98]. In estimating CH_4 emissions from cattle all the manure produced, liquid and solid, has been considered as recovered and stocked, including also manure deposited on pastures. The procedure takes into account specific national features regarding rearing methods (feeding, rates of production, breeds reared, etcetera) and manure management[99].

For the rice cultivation source category, a specific study on Italian paddies was carried out in 2000; description of the methodology and results are reported by Tani[100]. Rice cultivation regime in Italy refers only to irri-

97 Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003*. Rome: Apat, in press. www.unfccc.int.

98 Crpa. "Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di metano". In *Piani regionali di risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle are Padane. Allegato 2*. Reggio Emilia: Crpa, 1997.
Crpa. *Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo*. Reggio Emilia: Crpa, 2000.

99 Apat. *National Inventory Report 2004. Italian Greenhouse Gas Inventory 1990-2002*. Rome: Apat, 2004. (Rapporto n. 42/04).
Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003*. Rome: Apat, in press. www.unfccc.int.

100 Tani, A. *Methane Emissions from Rice Paddies: Review, Assessment and Perspectives for Italian Lands*. 2000.

gated regime and rice cropping occurs exclusively in flat fields with one harvest per year. The Ipcc guidelines[101] have been followed to estimate methane emissions. For field burning of agricultural residues source category, a country specific methodology has been used[102].

5.6.3.2 N_2O method

Emission sources for the agricultural soil category are direct and indirect emissions to soil and emissions from animal production. Direct emissions considered as sub-categories are: synthetic fertilisers, animal manure applied to soils, N-fixing crops, crop residues and cultivation of histosols. Indirect emissions considered as sub-categories are: atmospheric deposition and nitrogen leaching and run-off. Detailed methodologies are described in the Nir[103].

Activity data from Istat are fertiliser distributed, nitrogen content, cultivated surface, annual crop production and livestock categories. Other national publications also are used for the residue/crop ratio, dry matter fraction of residues, N fixed by crop species[104].

In table 5.23 a summary report for methods and emission factors used for the calculation of nitrous oxide emissions is presented:

For the manure management source category, the nitrogen excretion factors by livestock are calculated on the basis of European literature as

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101 Ipcc Wg1 Technical support Unit - Hadley Centre - Meteorological Centre - Meteorological Office. *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Emission Inventories: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook.* Bracknell, UK: Ipcc/Oecd/Iea, 1997.

102 Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory* 1990-2003. Rome: Apat, in press. www.unfccc.int.

103 Crpa. "Relazione di dettaglio sulla metodologia adottata per la quantificazione delle emissioni di protossido di azoto". In *Piani regionali di risanamento e tutela della qualità dell'aria. Quadro delle azioni degli enti locali per il settore zootecnico delle aree Padane*. Reggio Emilia: Crpa, 1997.
Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003.* Rome: Apat, in press. www.unfccc.int.

104 Erdamn in Giardini, L. *Agronomia generale*. Bologna: Patron, 1983.
Centro studi sull'agricoltura l'ambiente e il territorio. *Impiego dei sottoprodotti agricoli e agro industriali*. Centro studi sull'agricoltura l'ambiente e il territorio, 1988. (Volume 1, edizione fuori commercio).
Crpa/Cnr. *Indagine sugli scarti organici in Emilia Romagna*. Reggio Emilia: Crpa, 1992.
Anpa - Onr. *I rifiuti del comparto agro-alimentare: Studio di settore*. Roma: Anpa, 2001. (Rapporto n. 11/01).

TABLE 5.23 N_2O methods and emission factors per source and sink categories

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	N_2O	
	Method applied	Emission factor
Enteric fermentation	Not occurred	Not occurred
Manure management	Ipcc default	Ipcc default, country specific
Rice cultivation	Not occurred	Not occurred
Agricultural soil	Ipcc default	Ipcc default, country specific
Field burning of agricultural residues	Country specific	Ipcc default

described by Crpa[105]. Estimate of emissions from manure management systems (liquid system, solid storage and dry lot, pasture range paddock and other) was made on the basis of the methodology and emission factors suggested by the Ipcc guidelines.

For the agricultural soil source category, Efs used for the estimation of emissions are mainly Ipcc default values.

For the manure management source category, the starting point of the methodology is the consideration that nitrogen - present either in an organic form or in the form of ammonia, in the manure at the exit of livestock housing - encounters transformation processes (nitrification, denitrification) depending on whether or not the effluent is in liquid or solid form (loadable). In the second case N_2O emissions are greater, since the presence of aerobic conditions in part of the load allows the formation of oxidized forms of nitrogen, which are not present to a significant extent in manure which has not undergone specific treatment[106].

The proposed methodology, for the manure management source category, allows for the following: definition of the population for every livestock category; estimate of the nitrogen excreted by every livestock category; for every livestock category, to estimate the fraction of nitrogen excreted for every manure management system (the most important

105 Crpa. *Aggiornamento dell'inventario delle emissioni in atmosfera di ammoniaca, metano e protossido di azoto dal comparto agricolo*. Reggio Emilia: Crpa, 2000.

106 Apat. *National Inventory Report 2004. Italian Greenhouse Gas Inventory 1990-2002*. Rome: Apat, 2004. (Rapporto n. 42/04).

objective being the estimation of the amount present in the manure in loadable and liquid form); the application of emission factors (kilogrammes of N_2O per kilogramme of manure) appropriate to every management system. When estimating emissions from manure, the amount relating to manure excreted while grazing is subtracted since this is taken into account in emissions from soils[107].

For the agricultural soils source category, mainly Ipcc default methodology has been used. Direct emissions are quantified by applying suitable Ef for the different types of nitrogen applied to cultivated soils. In particular, the following must be quantified: amount of nitrogen from synthetic fertilisers; amount of nitrogen from animal manure applied to soils (excluding quantities excreted while grazing); amount of nitrogen (or rather the nitrogen which remains in the soil) as a result of nitrogen fixation realized by N-fixing crops; amount of nitrogen (or rather nitrogen which remains in the soil) following the incorporation of crop residues from non N-fixing crops. Emissions from the cultivation of organic soils (Histosols) have been also quantified, as direct N_2O emissions, using the appropriate emission factor in kilogrammes of N_2O per cultivated hectare per year.

Regarding soil emissions, the Ipcc methodology has been modified taking into account some national specifics. In particular, the Ipcc method for the calculation of total nitrogen which returns to the soil as a result of nitrogen-fixing crops does not include crops which are important in Italy, such as forage legumes, and seems not too accurate in the calculation of the total biomass produced. Instead, data for cultivated areas and the quantities of N fixed per hectare were used for the principal leguminous crops. To estimate the amount of nitrogen from N-fixing and non N-fixing crops, returning to the soil with crop residues, national estimates of protein residues gathered from ad hoc surveys were used (residue production in relation to the product or to the area cultivated and protein content of the residue in relation to dry matter content). For cereals, apart from sorghum, for vegetables (potatoes, beetroot, tomatoes, cabbage and artichokes), the net harvest quantities were used, as well as the ratio of product/by product,

107 Apat. *National Inventory Report 2004. Italian Greenhouse Gas Inventory 1990-2002*. Rome: Apat, 2004. (Rapporto n. 42/04).

the dry matter content of the residue and the protein content estimated from Cestaat[108]. For all other crops, estimation of the dry matter content of by products was done according to parameters obtained by the Cnr-Crpa survey on organic waste in the Emilia-Romagna region[109].

Finally, regarding nitrogen from cultivation of histosols the data for surface area, reproduced in the national soil map of the year 1961, have been supplied by the Experimental institute for the study and protection of soil of Florence (Issds). These values have been verified with related data for Emilia-Romagna, the region where this type of soil is prevalent. The national estimate approximately equals 9 thousands hectares. Emission factors have been updated as suggested from the Ipcc Good practice guidance from 5 thousands to 8 thousands kilogrammes of N_2O per hectare.

Emissions from animal manure excreted while grazing have been also calculated, from the nitrogen excreted in this phase, using an appropriate emission factor, kilogrammes of N_2O per kilogramme of N excreted while grazing. Nitrogen excreted amount from animal manure and implied emission factors reflect national circumstances.

Indirect emissions from soils include emissions from the atmospheric deposition and surface runoff of nitrogenous products. In both cases the starting point is an estimate of the nitrogen supply; emissions are therefore calculated by appropriate emission factors, expressed as kilogrammes of N_2O per kilogramme of N supplied by atmospheric deposition and surface runoff respectively.

For field burning of agricultural residues source category, country specific methodology has been used[110]. Residues from agriculture production are estimated for each crop type taking in account the amount of crop produced, the ratio of removable) residue in the crop, dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content

108 Centro studi sull'agricoltura l'ambiente e il territorio. *Impiego dei sottoprodotti agricoli e agro industriali*. Centro studi sull'agricoltura l'ambiente e il territorio, 1988. (Volume 1, edizione fuori commercio).

109 Crpa/Cnr. *Indagine sugli scarti organici in Emilia-Romagna*. Reggio Emilia: Crpa, 1992.

110 Apat. *National Inventory Report 2005: Italian Greenhouse Gas Inventory 1990-2003*. Rome: Apat, in press. www.unfccc.int.

of the residues. On the basis of these parameters CH_4 and N_2O emissions have been calculated. All these parameters refer both to the Ipcc guidelines[111] and to country-specific values, when available[112].

5.7 Agrienvironmental indicators list derived from available agriculture census 2000 data

Agriculture census data set represents a fundamental source of information on agrienvironmental issues. Thus, a full list of available indicators is presented. Referring to territorial level, information, beside disclosure problems, can refer to municipality (Nuts5 level). Furthermore, indicators are organised by environmental theme. Thematic areas identified are the ones defined in the Esepi project (paragraph 4.1): *air pollution, climate change, biodiversity loss, marine environment and coastal zones, ozone layer depletion, resource depletion, toxic substances dispersion, waste,* and *water pollution and water resource.* Furthermore, a number of *contextual variables*, in order to understand the distribution of diverse agriculturefarming systems in the country and to describe main farm characteristics, are listed, and other variables are aggregated under the *farming management and activity diversification* category. Indicators mainly refer to driving forces related to each specific theme.

CONTEXTUAL VARIABLES
- Uaa (percent of total land area)
- Uaa (ha per 100 resident inhabitants)
- Type of farming system (percent of farms per typology of farming

111 Ipcc Wg1 Technical support Unit - Hadley Centre - Meteorological Centre - Meteorological Office. *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Emission Inventories: Reference Manual, Reporting Manual, Reporting Guidelines and Workbook*. Bracknell, UK: Ipcc/Oecd/Iea, 1997.

112 Centro studi sull'agricoltura l'ambiente e il territorio. *Impiego dei sottoprodotti agricoli e agro industriali*. Centro studi sull'agricoltura l'ambiente e il territorio, 1988. (Volume 1, edizione fuori commercio).
Borgioli, E. *Nutrizione e alimentazione degli animali domestici*. Bologna: Edagricole, 1981.
Giardini, L. *Agronomia generale*. Bologna: Patron, 1983.;
Crpa/Cnr. *Indagine sugli scarti organici in Emilia-Romagna*. Reggio Emilia: Crpa, 1992.
Anpa - Onr. *I rifiuti del comparto agro-alimentare: Studio di settore*. Roma: Anpa, 2001. (Rapporto n. 11/01).

system in total farms, share of related Uaa in total Uaa, share of rela ted total farmland area in total farmland area)
- Type of legal personality and management of the holding (percent of total farms per typology of legal personality and management of the holding, share of related Uaa in total Uaa, share of related total farm land area in total farmland area) (2)
- Uaa (ha)
- Total farmland area (ha)
- Uaa (percent of total farmland area)
- Forest (ha, percent of total farmland area)
- Farm fragmentation: number of fragment of land (total number, n per farm, ha of Uaa per fragment of land and ha of total farmland area per fragment of land)

Crop cultivation
- Cereals land area (ha, percent on arable land)
- Vegetables and fruit trees land area (ha, percent of Uaa)
- Arable land (ha, percent of Uaa)
- Permanent crops (ha, percent of Uaa)
- Garden land area for self consumption (ha, percent of arable land)
- Permanent grassland (ha, percent of Uaa)

Livestock breeding
- Bovine and buffaloes (n of heads)
- Ovine and caprine (n of heads)
- Swine (n of heads)
- Poultry (n of heads)
- Farms with livestock (n farms, percent of total farms)

AIR POLLUTION

Fertilisers and organic matter management
- Adoption of a slurry distribution plan (n farms, percent on farms with Uaa)
- Adoption of crop residue burning practice (n farms, percent on farms with Uaa)

Dejection storage (same as in Waste)
– Dejection storage: typology and storage capacity (n farms, volume of storage)

CLIMATE CHANGE
Renewable energy source production
– Short turnover forest land (ha, percent in total wood production land)
– Wood production for energy production purpose (n farms, percent on farms with land)

Crop residue burning practice
– Adoption of crop residue burning practice (n farms, percent on farms with Uaa)

LOSS OF BIODIVERSITY
Intensive farming
– Intensively cultivated land (ha, percent on arable land - vegetable garden included)
Involved crops are: maize (grain and green), rice, potato, sugar beet, industrial crops, vegetables, flowers.

Plant combination
– Uaa and forest and/or wood production land (ha, percent of total farmland area)
– Among arable land crops (ha)
– Between arable land crops and permanent crops (ha)
– Among permanent crops (ha)
– Between permanent crops and permanent grassland (ha)
– Among Uaa (ha, percent total Uaa)

RESOURCE DEPLETION
Water use for irrigation purpose
– Irrigable land (ha, percent in Uaa and wood production area)
– Irrigated land (percent of irrigable)
– Irrigated land (ha, percent Uaa and wood production area)
– Irrigated land per crop (ha)

– Irrigated land per irrigation system (percent)
– Irrigated land per source of water (percent)
– Irrigated land per kind of supply (percent)

SOIL DEPLETION
Soil tillage
– Ploughing deeper than 40 cm (n farms, share of farms ploughing soil con pendenza >5percent, percent farms with Uaa)
– Ploughing lower /equal than 40 cm (n farms, share of farms ploughing soil con pendenza >5 percent, percent farms with Uaa)
– Subsoiling depth more than 40 cm (n farms, share of farms ploughing soil con pendenza >5 percent, percent farms with Uaa)
– Subsoiling depth less than 40 (n farms, share of farms ploughing soil con pendenza >5 percent, percent farms with Uaa)

Crop rotation
– Continuos cropping (ha, percent on arable land)
– Crop shift (ha, percent on arable land)
– Crop rotation (ha, percent on arable land)

Cover and other soil management practices
– Green manure (ha, percent of Uaa)
– Leguminous green manure (ha)
– Mulch (ha, percent of Uaa)
– Land planting (to avoid herbicide treatment) (ha, percent of Uaa)
– Fertilisation with biomasses (ha, percent Uaa)

Management of biomasses of vegetal and animal origin
– Sale (n farms, percent of total answering farms)
– Soil spreading, composting (n farms, percent of total answering farms)

TOXIC SUBSTANCES DISPERSION
Pest management and kind of plant protection products used
– Guided pest mangement (ha, percent of Uaa)
– Integrated pest mangement (ha, percent of Uaa)
– Biological pest mangement (ha, percent of Uaa)

– Chemical plant protection product (ha, percent of Uaa)
– Natural plant protection product (ha, percent of Uaa)
– Herbicides (ha, percent Uaa) da fare

Soil fertilisation
– Fertilisation with biomasses (ha, percent of Uaa)

WASTE
Dejection storage and treatment
– Dejection storage: typology and capacity (n farms, volume of storage)
– Swine stables with facilities for slurry treatment (n, percent of total swine stable)

Management of biomasses of vegetal and animal origin
– Sale (n farms, percent of total answering farms)
– Soil spreading, composting (n farms, percent of total answering farms)

WATER POLLUTION AND WATER RESOURCES
Fertilisers and organic matter management
– Adoption of an annual nutrients distribution plan (n farm, percent of farms with Uaa)
– Physico-chemical soil analysis run in the last 5 years (n farms, per cent of farms with Uaa)
– Adoption of a slurry distribution plan (n farms, percent of farms with Uaa)

FARMING MANAGEMENT AND ACTIVITY DIVERSIFICATION
– Holders' education level (n of holders with a bachelor degree or a laurea, percent of total holders, percent of holders' with bachelor or laurea in agricultural matter over total holders with a bachelor degree or a laurea)
– Holders' age - 55 years and more (n holders, percent of total holders)
– Installation for processing of vegetal products (n farms, percent of farms with Uaa)
– Installation for milk processing (n farms, percent of total farms

producing milk)
- Installation for processing and packaging of farm products (n farms, percent of total farms)
- Activity different from farming but related to agriculture – agri-tourism excluded (n farms, percent of total farms)
- Agri-tourism (n farms, percent of farms with dwellings)

CHAPTER SIX

CONCLUSIONS

The review undertaken on agriculture related policy and related indicator lists revealed that there are several ongoing activities on indicator definition and compilation. Some highlights have been given on existing frameworks in which the lists have been entitled and on their content in terms of indicators. Referring to the frameworks, we can identify the Dpsir and the sustainability schemes, each one having a different target. Referring to lists content, it is possible to see differences and overlapping, that can be complete or partial. Indicator identification might respond to needs of assessment of priority phenomena and of data comparability among Member States, and of performance measurement, thus focusing on relevant policy issues, and to monitor phenomena that might not be already identified as a specific policy target. The main drawback is that the set of indicators requires to be updated over time. However, new priorities and policy targets will also need indicators to monitor their implementation and effectiveness. This means the data demand is not so stable, as priority themes and headline objectives may change over time. Indeed, one of the uses of indicators is to monitor if the existing policies are having the desired effect, or whether further measures are necessary. So while a stable set of indicators may be desirable from a statistical point of view, for policy makers some flexibility is preferable. This emphasises the importance of a stable base of statistical data, which can be combined in different ways to produce different indicators. The analysis focuses on some specific thematic issues that are relevant for agriculture sector, given the existing relationship between economic activity and environmental media. For each single issue the state of art for related legislation has been provided, than an overview - at national level - of indicators, already identified or here proposed, is presented with related basic data availability. For indicators that result from adoption of a model, a description of the estimation methodology is depicted.

The issues covered by the present study were the following.

Farming practices were considered for issues as air, water, soil pollution and depletion, and dispersion of toxic substances and loss of biodiversity.

Their relevance is due to the possibility of reducing pressure on environment, representing critical phases of a productive process, and policy more and more defines legal binding and tools for assessment and monitoring purpose. Farm structure survey represents an exploitable tool for data collection on such matter. Given the complexity of these issues, it might be preferable to identify priority areas to focus on and to investigate over time, identifying also the periodicity of the investigation. Water use is a complex and relevant issue in agriculture conducted in Mediterranean countries. Data source exploitation and data analysis was performed and came to a proposal of some indicators to use as adequate proxies, given the lack of data on quantitative volumes abstracted and consumed by the sector at national level. Issues related to water management can be easily investigated through surveys. The growing attention put on plant protection products use for the associated risk for environment contamination and threat to human health is bringing an increasing data demand forcing data producer to comply with such requirements. Data availability on Ppps sale and use at Istat is provided, giving highlights on indicators that can be calculated. Waste generation and management in agriculture sector is also an arising issue and Istat has been involved in the process of Waste statistics Regulation implementation. The results of two different pilote projects run to define what waste to consider and what role farms play in this phenomenon are presented. Some steps forward have been made in the investigation of waste generation and management through farm structure survey. Nitrogen misuse represents a relevant phenomenon mainly affecting water quality. The gross nitrogen balance has been identified as main indicator in this area, and a calculation at national level is provided showing decreasing surpluses in the last decade. Gas emission is a critical phenomenon that affects environment at local and global level, thus legislation in force is the result of efforts put in policy making activity at several international levels. Agriculture play an important role for emission of some specific gases and the calculation methodology is provided by Apat, which is in charge of setting up the national inventories and of reporting on such phenomenon. Lastly, a list of available indicators at a very detailed territorial level derived from the 2000 agriculture census data set is provided, showing the richness of this data source. The activity done with the present study revealed that data compilation is run directly by different subjects. Than it is necessary to find ways to cooperate and coordinate ongoing activities. Sometimes activities on the same indicator area are conducted as for nitrogen cycle (estimation of nitrogen emission, of the gross nitrogen balance, etcetera) so that methodologies and coefficients used should be harmonised. The study represents just the first step on this path.

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Agrienvironmental indicators: methodologies, data needs and availability

This volume includes the final result of a project co-financed by Eurostat on data needs and availability for the implementation of agrienvironmental indicators according to a shared framework. The aim of integration of the agricultural policy with environmental issues and the implementation of specific legislation on environmental protection led to an increasing demand of statistical data. The present study analyses data demand aspects, priorities to be faced and availability of basic data and methodologies.

The main topics depicted in the volume are agrienvironmental issues and sustainable development aims addressed by existing policy; conceptual frameworks existing at international level on environmental indicators and on sustainability, and the related indicator lists; data availability at national level in order to comply with the mentioned indicators lists, covering the activity carried out in Istat and by other Institutions, such as Apat; integration of such lists on specific topics, whenever the deepening is considered relevant at national level.

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